FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

SATAVAHANA UNIVERSITY-KARIMNAGAR

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

M.Sc. PHYSICAL CHEMISTRY

III SEMESTER SYLLABUS

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PHYSICAL CHEMISTRY

III SEMESTER

Paper- I

(Common for all Specializations)

MCHE (SPT) 301 T: Spectral Techniques

SPT-09: 2DNMR techniques and combined applications of UV, IR, ^{1}H NMR, ^{13}C NMR and mass spectroscopy

SPT-10: NQR and Mossbauer Spectroscopy

SPT-11: ORD, Photo Electron and AUGER Electron Spectroscopy

SPT-12: X-ray Spectroscopy & X-ray Diffraction Techniques

SPT-09: 2D-NMR techniques and combined applications of UV, IR, ^{1}HNMR, ^{13}CNMR and mass spectroscopy: (15Hrs)

2D NMR: Principles of 2-D NMR, Classification of 2D-experiments. 2D - J- resolved spectroscopy. Homonuclear and Heteronuclear 2D-J-resolved spectroscopy. Correlation spectroscopy (COSY) Homo COSY (^{1}H-^{1}H COSY), TOCSY (Total Correlation Spectroscopy), Hetero COSY (^{1}H,^{13}C COSY,HMQC), long range ^{1}H, ^{13}C COSY (HMBC), NOESY and 2D-INADEQUATE experiments and Introduction to the analytical approach towards the structure elucidation of simple

Combined applications of UV, IR, ^{1}H NMR, ^{13}C NMR and mass spectroscopy: Organic molecules by combined application of UV, IR, ^{1}H NMR ^{13}C NMR and Mass spectra their applications.

SPT-10: NQR and Mossbauer Spectroscopy (15 Hrs)

Nuclear Quadrupole Resonance: Quadrupole nuclei and quadrupole moments-prolate and oblate nuclear charge distributions-energies of quadrupolar transitions-electric field gradient, coupling constants and splitting

Mossbauer Spectroscopy: Principles, Experimental Considerations and Presentation of the Spectrum - Isomer Shifts – Quadrupole splitting and Magnetic hyperfine splitting - Selection Rules.

Iron Compounds: Low-spin and High-spin Fe(II) and Fe(III) Complexes - π-bonding Effects in Iron complexes - Study of High-spin Low-spin Cross-over c) Diamagnetic and Covalent Compounds - Structural aspects of Iron Carbonyls.Tin Compounds: Tin Halides and Organotin Compounds.

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SPT-11: ORD, Photo Electron and AUGER Electron Spectroscopy: (15 Hrs)

Optical Rotatory Dispersion (ORD) spectroscopy: Optical rotation, circular birefringence, circular dichroism and Cotton effect. Plain curves and Anomalous curves and their applications in determining configuration and in study of conformational changes. Empirical and semiempirical rules-The axial haloketone rule, the octant rule, Helicity rule, Lowe's rule. Application to the study of absolute configuration and conformations of organic molecules.

Photoelectron Spectroscopy: Principle and Instrumentation, Types of Photoelectron Spectroscopy – UPS & XPS, Binding Energies, Koopman's Theorem, Chemical Shifts.

Photoelectron Spectra of Simple Molecules: N_2, O_2, F_2, CO, HF, NH_3 and H_2O - Vibrational Structure of PES Bands, Potential energy curves, Interpretation of Vibrational spectral data for ionized (M^+) species, Prediction of Nature of Molecular Orbitals. ESCA in qualitative analysis.

AUGER Electron Spectroscopy: Principles, Instrumentation and Applications.

SPT-12: X-ray Spectroscopy & X-ray Diffraction techniques: (15 Hrs)

X-ray fluorescence (XRF) spectra: Absorption techniques, Absorption edge fine structure (AEFS spectra) and extended X-ray absorption fine structure (EXAFS) spectra Basic Theory, Applications, Instrumentation.

X-ray diffraction: Bragg condition. Miller indices. Experimental methods of X-ray diffraction. Laue method and Debye-Scherrer method. Primitive and nonprimitive unit cells. Index reflections. Identification of unit cells from systematic absences in diffraction pattern. Structure factor and its relation to intensity and electron density. Description of the procedure for an X-ray structure analysis. Typical examples, Advantages and Limitations of X-ray Diffraction.

Electron Diffraction by Gases: Principles - Radial Distribution Curves - Interpretation of Results for simple gas phase molecules-Advantages and Limitations.

Neutron Diffraction: Principles - Application in Hydrogen Bonding Studies - Combined use of X-ray and Neutron Diffraction Studies - Advantages and Limitations.

BOOKS SUGGESTED:

1. Spectroscopic identification of organic compounds by R.M.Silverstein. G.C.Bassler and T.E.Morrill.
2. NMR-A multinuclear introduction by William Kemp.
3. Principles of Instrumental analysis, Skoog, Holler and Nieman, Harcourt Asia PTE Ltd.
4. Principles of Instrumental Analysis, Skoog and Leary, Saunders College Publishing.
5. International series of Monographs, Vol. **53**: Photoelectron Spectroscopy, Edited by D. Beckerand D. Betteridge 1972.

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6. Sructural methods in inorganic chemistry, E.A.V. Ebsworth.
7. Modern Spectroscopy, J. M. Hollas, John Wiley & sons.
8. Fundamentals of Molecular Spectroscopy, Banwell & McCash.
9. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill.
10. Molecular Spectroscopy, J. D. Graybeal, McGraw Hill.
11. Basic principles of Spectroscopy, R. Chang, McGraw Hill.
12. Physical Methods in Chemistry, R. S. Drago, Saunders College.
13. NMR Spectroscopy: Basic principles, concepts and applications in chemistry, H. Gunther, John Wiley & sons.
14. Introduction to Magnetic Resonance, A. Carrington & A.D. Maclachalan, Harper & Row.
15. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R. V. Parish, Ellis Harwood.
16. NMR basic principles - Atta-ur-Rahman.
17. Two dimensional NMR Spectroscopy-Applications for chemists and biochemists, edited by W. R. Croasmun & R. M. K. Carlson, VCH.
18. X-ray diffraction procedures for polycrysralline and amorphous materials, H. P. Klug & L. E. Alexander, John Wiley.
19. Physical Chemistry, Ira N. Levine, McGraw Hill.
20. Atkin's Physical Chemistry, P. Atkins & Julio de Paula, Oxford University Press.
21. Organic spectroscopy by William Kemp.
22. Spectroscopic methods in organic chemistry by D.H. Williams and I. Fleming.
23. Practical Pharmaceutical Chemistry by A. H. Beckett and J.B. Stenlake.

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PAPER-II

MCHE (PC) 302 T: Chemical Kinetics, Photo Chemistry, Electrochemistry and Supramolecular Chemistry

PC-09 : Chemical Kinetics-II
PC-10 : Photochemistry-II
PC-11 : Electrochemistry -II
PC-12 : Supramolecular Chemistry

PC-09: CHEMICAL KINETICS – II: (15Hrs)

Reactions in solution: Factors affecting the reaction rates in solution. Diffusion controlled reactions. Influence of dielectric constant and ionic strength on ion - ion, and ion - dipole. Primary and secondary salt effects. Kinetic isotope effects: Primary and secondary isotope effects. Solvent isotope effects.

Fast reactions: Flow methods and the stopped - flow technique. Relaxation methods (T - jump and P- jump). Kinetic equations for chemical relaxation.

Enzyme kinetics: Michaelis - Menten mechanisms of enzyme catalyzed reactions involving one and two intermediates. Steady-state approximation. Derivation of kinetic equations. Evaluation of kinetic parameters. Lineweaver–Burk plot, Enzyme- substrate complex: Fischer's lock and key and Koshland's induced fit hypotheses. Specificity of enzyme - catalyzed reactions. Discussion of the various types of forces involved in the formation of E - S complex. pH dependence of enzyme-catalyzed reactions – the kinetics and the equations involved.

PC –10: PHOTOCHEMISTRY – II: (15 Hrs)

Formation of excimers and exciplexes – PE diagram and quantum yields. Energy transfer mechanism for bimolecular quenching. Long - range coulombic energy transfer – critical transfer distance. Short - range electron exchange energy transfer. Triplet - triplet energy transfer and sensitization.

Experimental study of radiative transitions. Emission spectroscopy. Emission quenching measurements. Flash photolysis and its applications.

P-type delayed fluorescence. The experimental study of photochemical reactions, Product analysis, chemical methods in the study of intermediates, spectroscopic methods, ESR and CIDNP, rate coefficients for photochemical processes and identification of excited states.

Electronic transitions in transition metal complexes. Ligand field (LF) and charge transfer (CT) electronic states. $Ru(bpy)_3^{2+}$ as sensitizer for photoredox reactions, examples. Photochemical cleavage of water.

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PC –11 : ELECTROCHEMISTRY – II **(15 Hrs)**

The electrode - electrolyte interface. The electrical double layer. The Helmholtz - Perrin parallel-plate model, the Gouy-Chapman diffuse - charge model and the Stern model. Quantum aspects of charge transfer at the interfaces. Tunneling.

Electrodics: Charge transfer reactions at the electrode - electrolyte interface. Exchange current density and overpotential. Derivation of Butler - Volmer equation. High field approximation- Tafel equation, low field, equilibrium- Nernst equation. The symmetry factor and its significance.

Corrosion: Electrochemical corrosion.mechanism. short - circuited energy producing cell. The corrosion current and the corrosion potential. Homogeneous theory of corrosion. Evans diagrams. Potential- pH (Pourbaix) diagrams of iron. Methods of corrosion rate measurement. Mechanism of anodic dissolution of iron. Corrosion inhibition by organic molecules.

PC- 12: SUPRA MOLECULAR CHEMISTRY **(15 Hrs)**

Molecules, super molecules and supramolecular Chemistry.

Molecular recognition – factors involved. Ionophores. Molecular receptors – design principles. Types of interactions between host and guest molecules.

Molecular receptors for alkali metal ions, ammonium ions, anions and neutral molecules. Crown ethers, cryptands, spherands, cyclodextrins and calixaranes.

Threading of a linear molecule through a cyclic molecule. Creation of rotaxanes and catenanes.

Thermodynamics of host-guest complexation. Enthalpy and entropy contributions. Complexation free energies.

Applications. Supramolecular catalysis - examples. Transport of ions across membranes. Molecular wires and molecular switches.

BOOKS SUGGESTED:

1. Chemical Kinetics, K. J. Laidler, McGraw Hill
2. Kinetics and Mechanism, A. A. Frost & R. G. Pearson, John Wiley & sons
3. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman & J. Kuriacose, McMillan
4. Chemical Kinetics and Reaction Mechanisms, J. H. Espenson, McGraw Hill
5. Physical Organic Chemistry, N. S. Isaacs, ELBS
6. The Physical basis of Organic Chemistry, Howard Maskill, Oxford University Press

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7. Biophysical Chemistry, Cantor & Schimmel, W. H. Freeman and Company

8. Principles of Physical Biochemistry, Kensal E van Holde, W. Curtis Johnson & P. Shing Ho, Prentice Hall

9. Physical Biochemistry : Principles and Applications, David Sheehan, John Wiley

10. Lehninger Principles of Biochemistry, D. L. Nelson & M. M. Cox, MacMillan

11. Biochemistry, L. Stryer, W. H. Freeman and Company

12. Molecular Photochemistry, N. J. Turro, W. A. Benzamin

13. Fundamentals of Photochemistry, Rohatgi-Mukherjee, Wiley Eastern

14. Essentials of Molecular Photochemistry, A. Gilbert & J. Baggott, Blackwell Science

15. Introduction to Molecular Photochemistry, C. H. J. Wells, Chapman and Hall

16. Physical Chemistry, Ira N. Levine, McGraw Hill

17. Atkin's Physical Chemistry, P. Atkins & Julio de Paula, Oxford University Press

18. The New Chemistry, Editor-in-chief Nina Hall, Cambridge University Press

19. Modern Electrochemistry, J. O. M. Bockris & A. K. N. Reddy, Plenum

20. Introduction to Electrochemistry, S. Glasstone

21. Supramolecular Chemistry – concepts and perspectives by Jean-Marie Lehn

22. Principles and methods in supramolecular chemistry, Hans-Jorg Schneider and A.Yatsimirsky, John Wiley and Sons

23. The New Chemistry, Editor in chief : Nina Hall, Cambridge University press

24. Analytical Chemistry of Macrocyclic and Supramolecular Compounds, S.M.Khopkar, Narosa Publishing House

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PAPER –III

MCHE (PC) 303T: Quantum Chemistry and Group Theory

PC –13: Applications of Schrödinger equation
PC - 14: Angular momentum & approximate methods
PC - 15: Bonding in molecules
PC - 16: Group theory

PC – 13 : Applications Of Schrödinger Equation (15 hrs)

Systems with discontinuity in the potential field. A simple potential barrier. A potential barrier with a finite thickness. Quantum mechanical tunneling – examples - α-particle emission, inversion of NH_3, hydrogen transfer reactions.

The harmonic oscillator – detailed treatment. Wave functions and energies. Vibration of a diatomic molecule – harmonic oscillator model.

The rigid rotator – detailed treatment. Wave functions and energies. Spherical harmonics. Rigid rotator as model for a rotating diatomic molecule.

The hydrogen atom – detailed treatment. Angular and radial functions. Atomic orbitals. Measurability of the ground-state energy of hydrogen atom. Orthonormal nature of hydrogen-like wave functions. Probability calculations.

Atoms in external field, Zeeman and anomalous Zeeman effect.

PC – 14: Angular Momentum and Approximate Methods (15 hrs)

Angular momentum operators. Commutation relations of angular momentum operators and their consequence. Eigen functions of L^2 and L_z and the eigen values. Magnitude and orientation of angular momentum vectors.

Electron spin. Spin operators. Pauli principle and the Pauli exclusion principle.

Approximate methods. The variation method. Constuction of variation function by the method of linear combinations. H and He atom.

Perturbation theory (first order and nondegenerate). Wave function and energy corrections. Application of perturbation theory to the helium atom.

Time- dependent perturbation theory. Interaction of radiation and matter. Allowed and forbidden transitions.

Multielectron atoms. The Hartree-Fock self-consistent field method. Basis functions. Slater-type orbitals (STOs).

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PC – 15: Bonding in Molecules **(15 hrs)**

Born-Oppenheimer approximation. MO theory of H_2^+ ion. Calculation of MOs and their energies. Evaluation of the overlap integral. Probability curves and enegy diagram. MO theory of H_2 molecule. Calculation of energy. Atomic and molecular term symbols.MO theory of polyatomic molecules (general ideas). MO treatment of H_2O. Symmetry-adapted linear combinations. MOs of H_2O.

Concept of hybridization – sp, sp^2, and sp^3 hybrid orbitals.

Semiempirical MO methods. The Huckel theory of conjugated systems. HMO calculations on ethylene, allyl system, butadiene, cyclopropenyl system and benzene. π–electron charges and bond orders. Introduction to extended Huckel theory.

Orbital symmetry and reactivity: $H_2 + F_2 \rightarrow 2HF$ reaction. 2NO $N_2 + O_2$ reaction. Electrocyclic reactions, cycloaddition reactions.

PC – 16: GROUP THEORY (15 hrs)

Matrices: Addition and multiplication of matrices. Diagonal matrix. Unit matrix. Transpose of a matrix. Adjoint of a matrix. Inverse of a matrix. The determinant of a square matrix. Expansion of a determinant. Properties of determinants

Symmetry operations forming a group. Classes of symmetry operations. Matrix representation of symmetry operations and point groups. Generation of representations for point groups. Reducible and irreducible representations.

The Great Orthogonality theorem (proof not required) and its consequences. Relation between reducible and irreducible representations. Character tables. Construction of character tables for C_{2v} and C_{3v} groups.

Quantum mechanics and group theory. Wave functions as bases for irreducible representations. The direct product – vanishing of integrals. Projection operators. Symmetries of vibrations. IR and Raman activity.

BOOKS SUGGESTED:

1. Quantum Chemistry, Ira N. Levine, Prentice Hall
2. Introduction to Quantum Chemistry, A. K. Chandra, Tata McGraw Hill
3. Elementary Quantum Chemistry, F. L. Pilar, McGraw Hill
4. Molecular Quantum Mechanics, P. W. Atkins & R. S. Friedman, Oxford University Press
5. Coulson's Valence, R. McWeeny, ELBS
6. The Chemical Bond, J. N. Murrel, S. F. A. Kettle & J. M. Tedder, John Wiley
7. Valency Theory, J. N. Murrel, S. F. A. Kettle & J. M. Tedder, ELBS
8. Chemical Applications of Group Theory, F. A. Cotton, John Wiley & Sons

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PAPER-IV (ELECTIVE – I)

MCHE (PC) 304 T: Polymer Chemistry

PC- 17: Polymerization & Kinetics of polymerization
PC- 18: Structure and properties of polymers
PC- 19: Processing of Polymers
PC- 20: Functional polymers

PC -17: Polymerization & Kinetics Of Polymerization (15 hrs)

Classification of polymers. Types of polymerization. Kinetics and mechanism of free radical polymerization. Degree of polymerization, kinetic chain length and chain transfer coefficient – Trommsdorff effect. Effect of pressure and temperature on chain polymerization.

Kinetics and mechanism of linear stepwise polymerization, cationic, anionic polymerization. Coordination polymerization. copolymerization reactions and copolymer composition. Reactivity ratios and their determination. Alfrey and Price Q-e scheme for monomer and radical reactivity. Block and graft copolymers.

Polymerization in homogeneous and heterogeneous systems. Bulk, solution, suspension and emulsion polymerizations.

PC -18: Structure And Properties Of Polymers (15 hrs)

Polymer solutions. The process of polymer dissolution. Thermodynamics of polymer dissolution. Entropy, heat and free energy of mixing of polymer solutions. Conformations of dissolved polymer chains. The freely jointed chain. Short-range and long-range interactions. The Flory-Huggins theory of polymer solutions. Dilute polymer solutions. Flory-Krigbaum theory.

Mechanical properties of polymers. The elastic state. Rubber-like elasticity and viscoelasticity. Newtonian and non-Newtonian behaviour. Maxwell and Voigt-Kelvin models of viscoelastic behaviour.

The crystal structure of polymers. Morphology of crystalline polymers. Crystallization and melting. Determination of T_m. Thermodynamics of crystalline melting. Heats and entropies of fusion. Degree of crystallinity. Factors affecting the crystallization. The glassy state – glass transition temperature T_g of polymers. Factors influencing T_g. Glass transition temperature and melting point. Molecular weight distribution – measurement of molecular weights by end group analysis, osmometry and GPC

PC -19: Processing Of Polymers (15hrs)

General Applications of Polymers. Polymer Processing - Fillers, Additives, Lubricants, Catalysts, Colorants, Lamination, Adhesives , Calendering and Composites.

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Moulding of Polymers- Process and Advantages and limitations of Compression moulding, Injection Moulding, Extrusion Moulding, Blow Moulding.

Casting- Types, Vacuum Casting, Potting, Encapsulation, Film Casting, Pultrusion technique. Fibre Reinforced Plastics, preparation and properties.

Synthetic Fibres- Rayons, (Nitro cellular, Cupammonium, Diacetate, Viscose), Nylons, Dacron, Dry & Wet methods of fibre formation. Mercerization

PC -20: Functional Polymers **(15hrs)**

Smart materials – their uses in sensing devices and communication networks.

Conducting polymers. Electrically conducting polymers and their uses (polyanilines, polypyrrole, polyacetylene and polythiophene). Photoconductive polymers. Liquid crystal polymers – smectic, nematic and cholesteric structures.

Ionic exchange polymers. Cationic and anionic exchange polymers and their uses. Eco-friendly polymers.

Membrane separation and Filtration – micro, ultra and nanofiltration. Separation of gases – permeselectivity and gas permeability of representative polymers. Liquid separation – dialysis, electro osmosis and reverse osmosis. Fire retarding polymers, photonic polymers.

Polymers in biomedical applications – artificial organs and controlled drug delivery.

BOOKS SUGGESTED:

1. Textbook of Polymer Science, F. W. Billmeyer Jr, John Wiley & sons
2. Polymer Science, V. R. Gowarikar, N. V. Viswanathan & J. Sreedhar, Wiley Eastern
3. Contemporary Polymer Chemistry, H. R. Alcock & F. W. Lambe, Prentice Hall
4. Physics and Chemistry of Polymers, J. M. G. Cowie, Blackie Academic and professional
5. Ploymer Chemistry, B. Vollmert
6. Physical Chemistry of Polymers, A. Tagers, Mir Publishers
7. A text book of polymers, Vol. I,II,III, M.S. Bhatnagar , S. Chand

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Paper- IV (ELECTIVE – II)

MCHE (PC) 304 T: Environmental Chemistry

PC-17: Pollution in Atmosphere
PC-18: Pollution in Hydrosphere
PC-19: Heavy Metal and Radiochemical Pollution.
PC-20: Analysis of Air, Water and Metal Pollutants

PC-17: Pollution in Atmosphere (15 hr)

Typical Composition of Unpolluted Dry Air - Major Air Pollutants:

Carbon Monoxide, Nitrogen Oxides, Sulphur Oxides, Particulate Matter, Hydrocarbons, Chloroflurocarbons. Carbon Monoxide: Sources and Sinks, Concentration Profile, Effects on Human Health, Control of CO Emissions.

Nitrogen Oxides (NO_x): Reactions Leading to Formation of NO_x, Sources and Sinks, Concentration Profile, Harmful Effects of NO_x on Human Beings, Plants, Materials and Control of NO_x Emissions.

Sulphur Oxides (SO_x): Reactions Leading to Formation of SO_x, Sources of SO_x. Harmful Effects on Human Beings, Plants and Materials - Control of SO_x Emissions - Acid Rain: Formation and Toxic Environmental Effects.

Particulate Matter: Sources, Inorganic and Organic Particulate Matter - Effects on Human Beings, Materials and Climate - Control of Particulate Emissions.

Hydrocarbons: Sources - Types of Polluting Hydrocarbons - Hydrocarbons and Photochemical Smog Formation - Harmful Effects of Photochemical Smog - Control of Hydrocarbon Emissions.

Green House Effect: Causes, Consequences and Abatement of Green House Effect - Ozone Depletion - Mechanism, Causes, Consequences and Abatement of Ozone Depletion - Bhopal Gas Tragedy and Sevozo Disaster.

PC-18: Pollution in Hydrosphere (15 hr)

Types of Water Pollutants and their Effects - Sources of Water Pollution: Domestic, Industrial, Agricultural, Soil, Thermal and Radioactive Wastes - Types of Persistent Pollutants - Biomagnification of Persistant Pollutants, Effects of Biomagnified Pollutants on Human Beings (DDT) – Tripolyphosphates: Their Role in Eutrophication of Water Bodies - Ecological Consequences of Eutrophication, Bacteriological Contamination of Water - Dissolved Oxygen in Natural Waters - Depletion of Dissolved Oxygen - Biological Oxygen Demand and Chemical

Oxygen Demand as Indicators of Extent of Water Pollution - Nitrates, Nitrites, Nitrosoamines in Water: Their Toxic Effects On Human Beings - Treatment of Drinking Water Supplies.

PC-19: Heavy Metal and Radiochemical Pollution **(15 hr)**

Essential and Toxic Elements in Nature - Mechanism of Metal Ion Toxicity - Effects on NonMetalloenzymes, Metalloenzymes, Cell Membranes, Nucleic Acids - Concepts of Speciation, Biomethylation and Biomagnification.

Mercury: Sources of Pollution. Speciation and Environmental Forms of Mercury - Biochemical Effects of Different Species of Mercury - Minamata Bay Episode as a Case Study of Mercury Poisoning.

Arsenic: Sources of Pollution - Speciation and Environmental Chemistry of Arsenic - Biochemical Effects of Different Species of Arsenic.

Lead: Sources of Lead Pollution - Speciation and Pathways of Lead in Environment - Biochemical Effects of Lead.

Cadmium: Sources of Pollution – Speciation - Biochemical Effects of Cadmium Poisoning. Radiochemical Pollution: Sources, Chemical Changes due to Radiation on Water.

Organic Compounds - Harmful Effects of Radioactive Pollutants on Living Organisms - Permissible Limits of Radiation - Control and Disposal of Radioactive Wastes - Chernobyl Disaster.

PC-20: Analysis of Air, Water and Metal Pollutants **(15 hr)**

Air Quality Standards - Sampling (Particulates and Gaseous Pollutants) - Analysis of Pollutants: SO_2 (Modified West-Gaeke Spectrophotometric Method, Pulsed Fluorescence Spectrometry), H_2S (Spectrophotometry – Ethelyne Blue Method), NO-NOx (Chemiluminescence Technique, Colorimetric Technique- Saltzman Method) – CO (NDIR Spectrometry, GC), Hydrocarbons (Ionization Analysis), Aromatic Hydrocarbons in Automobile Exhausts, Petrol, Air, O_3 (Chemiluminiscene and Spectrophotometry) - Particulate Matter Analysis (High Volume Method).

Water Sampling, Preservation and Preconcentration Methods and Physical Analysis - Colour, Odour, Temperature, pH, EC, Redox Potential and Total Dissolved Solids (Turbidimetry). Chemical Analysis of Anions: CN^-, Cl^-, F^- (Spectrophotometry, Ion Selective Potentiometry and Titrimetry), NO_2^- and NO_3^- (Spectrophotometry), SO_4^{2-}, PO_4^{3-}, HCO_3^-, CO_3^{2-}, Hardness of Water (Titrimetry), Ammonical Nitrogen (Spectrophotometry) - Determination of DO, BOD, COD, TOC in Water.

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BOOKS SUGGESTED

1. Environmental Chemistry, John. W. Moore and Elizabeth Moore Academic press New York

2. Principles of Environmental Chemistry, Stanley E. Manahan 2nd Ed.

3. Environmental Chemistry, 4th ed. A.K. De. New Age International Publishers, 2000

4. Environmental Pollution Analysis, S.M. Khopkar Wiley Eastern Ltd. 1995

5. Environmental Chemistry, Colin Baird W.H. Freeman and Company New York 1995.

6. Text Book of Environmental Chemistry, Ayodhya Singh, Campus Books International publishers

7. Chemistry of the Environment, II Edn Thomas G.Spiro William M.Stigliani

8. Fundamental Concepts of Environmental Chemistry, G.S.Sodhi Narosa Publishing House.

9. Environmental Analytical Chemistry, F.W.Fifield,P.J.Haines,Blackie Academic & Professional

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LABORATORY COURSES – III SEMESTER

PAPER-V

MCHE (PC) 301 P: Chemical Kinetics Lab-I **9 hrs/ week**

***(Note:** The data obtained in all the experiments are to be analyzed by the students both by the usual graphical methods and by regression (linear/nonlinear) techniques using a PC.)*

- Study of peroxydisulphate – iodide reaction:

  Individual orders of the reactants by initial rate methods

  Effect of temperature on reaction rate

  Effect of ionic strength on reaction rate

- Study of peroxydisulphate – iodide clock reaction: Individual orders of the reactants ,effect of ionic strength on uncatalyzed and Cu(II)-catalyzed reactions

- Study of acetone – iodine reaction by titrimetry

  Order w.r.t.[iodine]

  Order w.r.t. [acetone]

  Order w.r.t. [H^+]

SUGGESTED BOOKS

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
2. Experimental Physical Chemistry: V. Athawale and P. Mathur.
3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.
4. Practical in Physical Chemistry: P.S. Sindhu
5. Advanced Practical Physical chemistry: J.B.Yadav
6. Vogel Text book of Quantitative Analysis, 6th edition, Pearson education Ltd. 2002

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PAPER-VI

MCHE (PC) 302 P: Instrumentation Lab - I 9 hrs/ week

Conductometry:

- Conductometric titrations:

  Mixture of strong and weak bases vs strong acid

  Mixture of strong and weak acids vs weak base

  Mixture of strong acid, weak acid and $CuSO_4$ vs strong base

  Mixture of halides (chloride + iodide) vs $AgNO_3$

  Formic acid, acetic acid, chloroacetic acid, dichloroacetic acid and trichloroacetic acid and their mixtures vs strong base

  Precipitation titration: K_2SO_4 vs $BaCl_2$
- Dissociation constants of weak acids
- Effect of solvent on dissociation constant of a weak acid
- Verification of Onsager equation
- Composition of Cu(II) – tartaric acid complex by Job's method

pH metry:

- pH – metric titrations:

  Monobasic acids vs strong base

  Dibasic acid vs strong base

  Tribasic acid vs strong base

  Mixture of strong and weak acids vs strong base
- Determination of dissociation constants of monobasic/dibasic acids by Albert – Serjeant method
- Determination of dissociation constant of acetic acid in DMSO, acetone and dioxane
- Determination of pK_a and pK_b of glycine (calculation using a computer program)
- Determination of stability constant of a metal complex (calculation using a computer program)

♦ SUGGESTED BOOKS

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
2. Experimental Physical Chemistry: V. Athawale and P. Mathur.
3. Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.
4. Practical in Physical Chemistry: P.S. Sindhu
5. Advanced Practical Physical chemistry: J.B.Yadav
6. Vogel Text book of Quantitative Analysis, 6th edition, Pearson education Ltd. 2002

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SCHEME OF EVALUATION

Max. Marks: 100

External Assessment	**80 M**
For the experiment & data analysis	: 60 marks
Sample submission/Graph	: 10 marks
Viva – voce	: 10 marks
Internal Assessment	**20 M**
Day to day work and regularity	: 10 marks
Record work	: 10 marks

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