

# **Syllabus**

## **Physical Chemistry**

### **Semester III and IV**

**To be effective from June 2019**

# **Semester III**

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. Semester-III (PHYSICAL CHEMISTRY)**

**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**PAPER-I (Advanced Thermodynamics) Total Marks: 70 Total Periods: 45**

**UNIT I: Statistical Thermodynamics of Ensembles (11 Periods)**

Phase Space, The Liouville theorem, Ergodic Hypothesis, Ensemble and probability, ensemble averages and postulates. Details of types of ensemble: Canonical and Micro-canonical and Grand canonical ensemble. Probability distribution, partition function and thermodynamic function of canonical ensemble, Equilibrium constant and canonical ensemble, Partition function for Grand canonical ensemble, Fluctuations, Mean distribution and mean square deviation, Fluctuation in energy in a canonical ensemble

**UNIT II: Statistical Thermodynamics of Ideal Gases and Solid (11 Periods)**

Ideal mono atomic gas, Thermodynamic function for mono atomic gas (statistical derivation of Helmholtz free Energy function, pressure, Internal energy, Entropy) Gibbs Paradox, Partition function and Thermodynamic function for diatomic and polyatomic gas (Helmholtz free energy, Internal energy, heat capacity, entropy). Derivation of Sackur-Tetrode equation. Treatment of diatomic and polyatomic molecules – entropy, vibrational entropy and rotational entropy, Internal rotation in polyatomic molecules, Statistical thermodynamic of solid, characteristic of crystalline solid, Einstein model.

**UNIT III: Thermodynamics of Liquid Mixtures (12 Periods)**

Types of molecular interactions in solution of electrolytes and non-electrolyte, Fugacity and activity coefficient in solution, ideal and non-ideal behaviour of phase equilibria (isothermal and isobaric), semi empirical equations explaining multi component thermodynamics properties for binary data, Theories of solutions non-electrolyte liquids: van Laar theory, van der Waals theory, Scatchard-Hildebrand theory, Lattice theory. Theory of electrolytes: limitations/modifications of Debye Huckle limiting law, Bromley's Method, Pitzer's Method

**UNIT IV: Thermodynamics of Gas State (11 Periods)**

Ideal Gas law, empirical equation for ideal gas, deviation of real gas from ideal behaviour, Adiabatic expression of ideal gas, thermodynamic representation of real gas: Fugacity, Reference state for real gas, Determination of activity coefficient for real gas: Approximate method, graphical method, virial expression representation of real gas, The van der Waals equation : correction due to excluded volume, force of attraction, Internal pressure, Second Virial Coefficient, van der Waals equation as function of pressure and temperature, intermolecular forces, critical phenomena, phase transition and van der Waals, Reduced van der Waals equation, other equation of state

**BOOKS:**

- Statistical Thermodynamics by M. G. Gupta, New Age Publication
- Statistical Thermodynamics : Fundamental and Applications by Normanad Laurendeau, Cambridge Press
- Molecular Thermodynamics of Fluid Phase Equilibria by J.M.Prausnitz, R.N. Lichtenthaler, E.G. Azevedo
- Thermodynamic Properties of Nonelectrolyte Solutions By William Acree, Academic Press
- Physical Chemistry : Concepts and Theory: Kenneth Schmitz, Elsevier
- Advanced Physical Chemistry by Puri, Sharma and Pthania

<b>VEER NARMAD SOUTH GUJARAT UNIVERSITY</b>		
<b>M.Sc. Semester-III (PHYSICAL CHEMISTRY)</b>		
<b>SYLLABUS TO BE EFFECTIVE FROM JUNE 2019</b>		
<b>PAPER-II (Molecular Spectroscopy)</b>	<b>Total Marks: 70</b>	<b>Total Periods: 45</b>
<b>UNIT-I</b>	<b>IR and Raman Spectroscopy</b>	<b>(11 periods)</b>
Theory of IR and Raman, selection rules, IR absorption, Raman scattering, Mutual exclusion rule, complimentary techniques, Instrumentation - FTIR and Raman, Cells and sampling techniques, Resonance Raman spectroscopy, Interpretation of IR spectra using correlation charts, Advantages of FTIR spectroscopy, Mid-IR Reflection – DRS, ATR, Data processing in Near IR, Applications in structure elucidation of inorganic and organic molecules.		
<b>UNIT-II</b>	<b>NMR Spectroscopy</b>	<b>(12 periods)</b>
Theory of NMR, Relaxation, population of energy levels, Larmor precession, chemical shift and factors affecting it, references and solvents, Spin-spin splitting, Coupling constant, Magnetic Anisotropy, Instrumentation, Shift Reagents, Interpretation of simple NMR spectra, Signal averaging, FT-NMR, Pulse FT-NMR spectroscopy, <sup>13</sup> C NMR spectra, Calculation of chemical shift in <sup>13</sup> C NMR, NMR in medical diagnostics, Double resonance technique, Multi-dimensional NMR, Problems to elucidate structure from NMR spectra.		
<b>UNIT-III</b>	<b>Molecular Mass Spectroscopy</b>	<b>(11 Periods)</b>
Instrumentation, Methods of ion production (EI, CI, FI, FD, Electro Spray, MALDI), Ion separators, Ion collection and recording, Double focusing, Time of flight analyser, Quadruple-mass spectrometer, Sample handling techniques, Resolution, Parent peak, Base peak, Metastable ions isotope effect, Molecular formula from mass spectra, Nitrogen rule, Ring rule, Fragmentation rules, Behavior of classes of compounds, Interpretation of mass spectra, Additional applications, Problems to elucidate structure from mass spectral data.		
<b>UNIT-IV</b>	<b>Molecular Luminescence Spectroscopy</b>	<b>(11 periods)</b>
Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); theory of luminescence, energy level diagram, Deactivation process,; instruments for measuring fluorescence (fluorometer and spectrofluorometer);, factor affecting, Emission and excitation spectra, wavelength selector, detector, application and problems.		

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. Semester-III (PHYSICAL CHEMISTRY)**

**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**PAPER-III (Electro Analytical Techniques ) Total Marks: 70 Total Periods: 45**

**UNIT-I Potentiometric Titration and Chronopotentiometry (11 periods)**

(a) Fundamentals of potentiometry, Instrumentation, electrode system, accuracy of direct potentiometric measurements and its limitations, potentiometric titrations, neutralization titrations, end- point detection, oxidation- reduction, precipitation titrations, complexometry titrations with example, applications and advantages. (b) Chronopotentiometry  
Principle, Instrumentation and procedure, applications.

**UNIT-II DC-Polarography (11 periods)**

Theory and Applications of Polarography, Types of currents: Residual Current, Migration Current and Diffusion Current, Nature of the Limiting Current: 1) Kinetic currents, 2) Catalytic currents and 3) Adsorption currents, Electro capillary maxima, Maxima of first kind and second kind , Maxima suppressors, DME as electrode, Wave equation, Ilkovic equation (derivation), Reversible electrode reactions at DME half wave potential, Interference and removal of oxygen, Reversible Electrode Reactions of Metal Complexes at D.M.E (Ligane method) Determination of stability constants of complexes. Amperometric titrations: Principle, DME & RPE, curves, Biamperometric titration.

**UNIT-III Morden Polarographic Methods (12 periods)**

**A.C. Polarography:** Principle of Sinusoidal alternating applied potential, AC peak polarogram, Peak current equation, Characteristic of AC polarographic peak, Importance of signal to noise ratio for the sensitivity, Comparison with DC polarography.

**Square-wave Polarography:** Principle of alternating rectangular wave voltage applied, Frequency of square wave applied, Problems of large condenser currents in A.C., Peak polarogram, Peak current equation, Limitations of techniques.

**Pulse Polarography:** Effect of capillary response with frequency of applied square wave potential , Principles and difference between Normal Pulse Polarography and Differential Pulse Polarography, Importance of charging and Faradaic currents.

**UNIT-IV Ion selective electrodes (11 Periods)**

Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, Silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Liquid ion exchange electrode – Calcium selective ion electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO<sub>2</sub> sensing electrode, Micro ion selective electrode, enzyme electrodes. Application and Numericals

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. Semester-III (PHYSICAL CHEMISTRY)**

**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**PAPER-IV (Physical Chemistry of Materials) Total Marks: 70 Total Periods: 45**

**UNIT I: Biophysical Chemistry (12 Periods)**

Bioenergetics: Standard free energy change in biochemical reactions (exergonic and endergonic). Coupled reaction, Energy rich compounds and energy coupling (Formation and hydrolysis of energy rich bonds in energy rich molecule), Enzyme Kinetics: Michaelis-Menten, Michaelis-Menten for Inhibition and Activation, Lineweaver-Burke plots. Enzyme inhibition reversible and irreversible inhibition, Immobilized enzymes, Techniques and methods of immobilization of enzymes, Application of immobilized enzymes. Cell Membrane: Structure and Transport functions of cell membrane.

**Unit II: Phase Equilibria of Multi Component Systems (11 Periods)**

Reduced Phase rule, Application of reduced phase rule to Two component systems: System with congruent and incongruent M.P., Phase rule for three component systems, Representation, methods of computing composition of ternary systems : methods of parallel and perpendicular lines, lever arm rule, Systems of three liquid component exhibiting partial miscibility (Formation of (a) one pair, (b) two pair and (c) three pairs of partially miscible liquids System composed of two solids and liquid components (a) crystallization of pure components (b) double salt formation (c) hydrate formation (d) formation of solid solution (Phase transitions in the ternary system

**UNIT III: Solid State Chemistry (11 Periods)**

Ionic Crystals & Their structures, detailed explanation of types of packing and coordination number, Radius ratio rule and prediction of packing of crystals, Polarization, Crystalline solids: Geometry of AB<sub>2</sub> type: Fluorite (CdI<sub>2</sub>), antiferroites (CdCl<sub>2</sub>), Rutile structures (TiO<sub>2</sub>). AB<sub>2</sub> type: ReO<sub>3</sub>, BiI<sub>3</sub>, A<sub>2</sub>B<sub>3</sub> type: Fe<sub>2</sub>O<sub>3</sub>, Corundum Al<sub>2</sub>O<sub>3</sub>, Ternary Compounds ABO<sub>3</sub> type: Perovskite, AB<sub>2</sub>O<sub>4</sub> type : Spinel structure Perfect & Imperfect crystals, Schottky defect, Frenkel defect, thermodynamics of Schottky & Frankel defects, Line defects: Dissociation, Extended defects: Lineage boundary, grain boundary, stacking fault

**UNITIV: Electronic Behavior of Materials (11 Periods)**

Metals, Insulators and Semiconductors, Electronic structure of solid, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap. Temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization. **Superconductivity**: Introduction, theory of super conductivity, Meissner effect, Type I&II superconductors, crystal structure of high temperature semiconductors.

**BOOKS:**

- Phase equilibria by Mats Hillert
- Biochemistry by C.B.Powar and G.R. Chatwal
- Physical chemistry by P.W.Atkins & dePaula 7Th Edition
- Advanced physical chemistry by Gurtu & Gurtu
- West A.R.,Solid State Chemistry and its Applications, Plenum
- Solid state chemistry : introduction by Lesley E.Smart Elaine A.Moore, CRC press
- West A.R.,Solid state Chemistry,John Wiley
- Solid State Chemistry by D.K.Chakraburti, New Edge InternationPublication 1996.
- West A.R.,Solid State Chemistry and its Applications,Plenum

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**  
**M.Sc. SEMESTER-III (PHYSICAL CHEMISTRY)**  
**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**Full Experiment (one) +Viva 4 credit**  
**Half Experiment (Two) 4 credit**

**FULL EXPERIMENT (Any Seven)**

1. To Study the kinetics of reaction between  $K_2S_2O_8$  and KI. Determine rate constant, order of reaction and influence of ionic strength on rate constant
2. Determination of CMC of surfactant by conductance method and calculate thermodynamic parameters for micellization
3. To study the kinetics of hydrolysis of ethyl acetate by NaOH at two different temperatures by conductance measurement and find out energy of activation of the reaction.
4. Determine the effect of salts on the cloud point of nonionic surfactant.
5. Determination of constants of Mark-Houwink equation for polymer by viscosity method
6. Determine ionic composition of synthetic sea water samples by flame photometer.
7. Determine parachor/density/refractive index of binary solutions.
8. To determine the  $Ca^{+2}$ ,  $Mg^{+2}$  and  $Fe^{+2}$  content in a sample of dolomite ore.
9. Study influence of ionic strength on solubility of  $CaSO_4$  and determine thermodynamic solubility product and mean ionic strength.

**HALF EXPERIMENT (Any Seven)**

1. Study the ratio of complex formation formed by titration of  $Zn^{2+}$  with potassium ferrocyanide potentiometrically.
2. Electrogravimetric determination of copper from solution
3. Equivalence conductance of solutions of strong electrolytes and weak electrolytes. Application of Kohlrausch's law. Onsager constant.
5.  $K_a$  of weak organic acid [benzoic acid] conductometrically.
6. Study stability constant of complex formation between Fe (III) and salicylic acid
7. Determine ionization constant of bromophenol blue using pH meter.
8. Preparation of simple colloids and determination flocculation value for different salts.
9. Study Hydrolysis constant of methyl acetate catalysed by HCl and equi-normal urea hydrochloride, determine degree of hydrolysis for the salt.
10. Determine basicity of organic acid by conductometer
11. Structure Identification and Elucidation by IR/NMR/MS spectroscopy

# **Semester IV**

VEER NARMAD SOUTH GUJARAT UNIVERSITY

M.Sc. Semester-IV (PHYSICAL CHEMISTRY)

SYLLABUS TO BE EFFECTIVE FROM JUNE 2019

PAPER-I Advanced Chemical Kinetics Total Marks: 70 Total Periods: 45

**UNIT I: Theories of Reaction Rates (12 Periods)**

Arrhenius theory of reaction rates, collision theory of bimolecular gaseous reaction, limitations and extension of collision theory, Rate theories based on thermodynamics, rate theories based on statistical mechanics, conventional transition-state theory (CTST), statistical mechanics and chemical equilibrium, Derivation of the rate equation, Thermodynamic formulation of CTST, few Applications of CTST, Assumptions and limitation of CTST, Extension of CTST: Vibration CTST

**Unit II: Reactions in Solution Phase and Gas Phase (11 Periods)**

**Solution Phase Reaction:** Solvent effects on reaction rates, factors determining reaction rates in solution, reaction between ions, ion dipole and dipole-dipole reactions. Effect of ionic strength. Substituent and correlation effects – Hammett equation. Linear free energy relationship.

**Gas Phase Reaction:** Theories of unimolecular gaseous reaction: Lindmann-Christiansen hypothesis, Hinselwood treatment, Rice Ramsperger Kassel (RRK) theory, RRKM theory

**UNIT III: Kinetics of Catalysis and Adsorption (11 Periods)**

Catalysis Characteristic and types of catalyst, Homogeneous and heterogeneous catalysis and their commercial processes, General catalytic mechanisms: Equilibrium treatment (Arrhenius Intermediates), Steady state treatment (Van't Hoff intermediates), Activation energies for catalysed reaction. Acid-base catalysis, General acid base catalysis, Mechanism of acid base catalysis, Bronsted catalysis law and acidity functions.

Kinetics of Adsorption: Isotherm for simple, Dissociation, competitive adsorption, statistical thermodynamics of Adsorption, mechanism for unimolecular and bimolecular surface reaction.

**UNIT IV: Kinetics of Complex Reactions (11 Periods)**

Kinetics of (I) Reversible reaction: when first order reaction opposed by second order reaction, when second order reaction opposed by first order reaction, Second order reaction opposed by one of the same order (II) Parallel reaction (III) Feedback, non-linearity and Oscillation reactions: (i) The Lotka - Volterra mechanism (iii) The Brusselator mechanism (V) Explosion (VI) Photochemistry: Photo physical Processes, Fluorescence and Fluorescence Quenching, Measurement  $T_f$ , Fluorescence Resonance Energy Transfer (V) Electron transfer, Kinetic Model of Electron Transfer

**BOOKS:**

- Chemical kinetics by K.J.Laidler
- Advanced Physical Chemistry by Puri Sharma
- Physical Chemistry by Atkins and Paula
- Chemical kinetics by S.K.Jain Chemical Kinetics by Gurdeep Raj
- Chemical Kinetics & Dynamics by J.I. Steinfeld, J.S. Francisco & W.L.Hase. Printice Hall)
- Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre, Pearson

<b>VEER NARMAD SOUTH GUJARAT UNIVERSITY</b> <b>M.Sc. Semester-IV (PHYSICAL CHEMISTRY)</b> <b>SYLLABUS TO BE EFFECTIVE FROM JUNE 2019</b> <b>PAPER-II (Atomic Spectroscopy)      Total Marks: 70      Total Periods: 45</b>		
<b>UNIT-I</b>	<b>Atomic X-RAY Spectroscopy</b>	<b>(11 periods)</b>
Emission of X-ray, continuum and line spectra, X-ray absorption, absorption spectra, Apparatus, Source (monochromatic X-ray), Sample handling, Wavelength and energy dispersive device, Detector, Chemical analysis by X-ray absorption, X-ray fluorescence: Theory, instrumentation and applications, X-ray diffraction: Theory, instrumentation and applications.		
<b>UNIT-II</b>	<b>Atomic Absorption and Flame Emission Spectroscopy</b>	<b>(12 periods)</b>
<b>(a) Atomic Absorption Spectroscopy (AAS)</b> Principle of AAS, Instrument, Continuous sources and line sources, Flames, Flame atomizers, Non flame atomizers (furnaces), Monochromator and Detector, Interference with AAS Quantitative Analysis with AAS, Applications, Numerical.		
<b>(b) Flame Emission Spectroscopy (FES)</b> Flame as a source of atomic vapour, Flame atomization, Flame photometer, Applications and limitations comparison with AAS		
<b>UNIT-III</b>	<b>Electron Spin Resonance Spectroscopy</b>	<b>(11 Periods)</b>
Introduction, Factors affecting the g-value, Limitations of ESR, Difference between ESR and NMR, Instrumentation, Electron nucleus coupling, Hyperfine interactions-isotropic and anisotropic coupling constants, The spin Hamiltonian, Quantitative analysis, Sensitivity, Choice of solvent, applications of ESR, Study of free radicals, Electronic and Hyperfine splitting, Triplet states- zero field splitting and Kramer's degeneracy, Analytical applications of ESR, Structural determination by ESR, Study of inorganic compounds by ESR, Transition elements, Biological systems		
<b>UNIT-IV</b>	<b>Atomic Emission and Fluorescence Spectroscopy</b>	<b>(11 periods)</b>
<b>Atomic Emission Spectroscopy:</b> Emission spectroscopy with plasma sources, Instrument, AES with electrical discharge, Electrodes of AES, DC- arc, spark, Laser microprobe, Salient features of the emission spectrograph, Qualitative and Quantitative analysis applications,		
<b>Fluorescence Spectroscopy:</b> Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference with AFS.		

<b>VEER NARMAD SOUTH GUJARAT UNIVERSITY</b> <b>M.Sc. Semester-IV (PHYSICAL CHEMISTRY)</b> <b>SYLLABUS TO BE EFFECTIVE FROM JUNE 2019</b> <b>PAPER-III (Separation Techniques )      Total Marks: 70      Total Periods: 45</b>		
<b>UNIT-I</b>	<b>Solvent Extraction</b>	<b>(11 periods)</b>
<p>Principal of solvent extraction, Nernst distribution law, Distribution coefficient, Equations for the solute dissociating or associating in one phase, limitations of distribution law, Application : partition chromatography, Distribution ratio, selectivity ratio, Successive extractions, Extraction of metal ion with chelating agent with necessary equation, Extraction involving association of ion pairs, extraction by solvation, types of Multiple extractions, multiple extraction with successive portion, basic concept, Apparatus and bi nominal distribution for Craig pseudo/ continuous counter current extractions. True counter current extraction: Fractional distillation, Use of crown ethers and Cryptans for extraction, extraction equilibria with crown ethers, factors affection extraction with crown ether, numerical of distribution coefficient and multiple extraction.</p>		
<b>UNIT-II</b>	<b>Theory of Chromatography</b>	<b>(11 periods)</b>
<p>Methods of elution, Ideal and non-ideal chromatography, Plate theory, Rate theory, Reasons for broadening of lands, Van Deemter equation and significance of terms involved, Optimum velocity, Resolution, Methods to improve resolution, GLC, Supports for liquid stationary phases, Selection of columns, FSOT, Selective Detectors- FPB, TID, Temperature programming in GC, Derivatisation in GC, Qualitative analysis from retention parameters, Quantitative analysis, Headspace Analysis, Thermal Desorption.</p>		
<b>UNIT-III</b>	<b>Liquid Chromatography</b>	<b>(12 periods)</b>
<p><b>(a) Ion-exchange Chromatography:</b> Resins used, Principle of exchange, Factors affecting the exchange, Capacity of resin and its determination, Techniques, IEC with eluent suppressor columns, Applications.</p> <p><b>(b) Gel-permeation Chromatography:</b> Principle, Types of gels, Theoretical principles, Techniques and applications.</p> <p><b>(c) Adsorption Chromatography:</b> Principle, column packings, adsorbents, mobile phase, technique of separation, detectors, identification of compounds, applications, Chiral Chromatography.</p> <p><b>(d) Affinity Chromatography:</b> Introduction, classification, column matrices, affinity ligands, elution methods, applications.</p>		
<b>UNIT-IV</b>	<b>Solid Phase Extraction and Micro Extraction</b>	<b>(11 Periods)</b>
<p><b>(a) Solid Phase extraction (SPE):</b> Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE</p> <p><b>(b) Solid phase micro-extraction (SPME):</b> Introduction, theoretical considerations, experimental, Methods of analysis: PMEGC, Methods of analysis: SPME-HPLC-MS, Automation of SPME, New development in micro extraction (liquid micro extraction, membrane micro extraction). Development in micro extraction (liquid micro extraction, membrane micro extraction).</p>		

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. Semester-IV (PHYSICAL CHEMISTRY)**

**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**PAPER-IV (Polymer Chemistry )**

**Total Marks: 70**

**Total Periods: 45**

**UNIT I: Solution Behaviour of Polymer Solution**

**(12 Periods)**

Criteria for polymer dissolution, Factors affecting swelling and dissolution: Effect of molecular weight and degree of crystallinity on dissolution, Size and shape of polymer molecules in solution, Thermodynamics aspects of polymer dissolution, cohesive energy density, Solubility parameter and its uses and determination, Flory-Huggins theory, Enthalpy of mixing,  $\Delta S$ ,  $\Delta H$  and  $\Delta G$  of mixing, Thermodynamics of dilute polymer solution, vapour pressure, Phase equilibria and phase separations in polymer solutions, Flory interaction parameter and determination. Unperturbed dimensions of polymer coil, Good/poor/theta and non-solvents, Viscosity of polymer solutions and the size of polymer coil, Effect of molecular weight on viscosity, determination of intrinsic viscosity in theta conditions. Concentrated polymer solutions and physical gelation, Newtonian & Non-Newtonian solutions.

**Unit II: Characterisation of Amorphous and Crystalline Polymers**

**(11 Periods)**

Thermal stability and thermal transitions in polymers, Melting versus glass transition, Glass transition temperature, its cause and importance, Relation between  $T_g$  and  $T_m$ , Factors affecting glass transition temperature: Chain flexibility, effect of plasticizers, blending and copolymerization of  $T_g$ , Determination of glass transition method by dilatometry, Crystalline polymers, Fringe micelle model, Factors affecting polymer crystallinity, Degree of crystallinity in polymers, Polymer crystallization, Spherulites and crystallites, Polymer single crystals, Chain folding during crystal formation, Crystallizability and crystallinity, Effect of crystallinity on properties of polymer.

**UNIT III: Copolymerization and Fractionation**

**(11 Periods)**

Kinetics of free radical copolymerization, reactivity ratios and their determination, Mayo-Lewis method, Fineman-Ross method, Disadvantages of F-R method, Kelen-Tudos (K-1) method Reactivity in copolymerization: Alfrey & Price method, Prediction of copolymer composition, Ionic co polymerization, copolycondensation, Ideal, alternate & azeotropic copolymerization, Graft and block copolymers, Polymer mixtures: IPNs, Composites, Blends and Alloys

Polymer Fractionation: fractional precipitation techniques, partial dissolution technique, gradient elution technique, GPC technique

**UNIT IV: Polymer Degradation and Reactions**

**(11 Periods)**

Polymer degradation: Definition, Types: thermal, mechanical, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiations, oxidative and hydrolytic degradation

Polymer reactions: Hydrolysis, acetolysis, aminolysis, hydrogenation, addition and substitution reaction, reaction of various specific groups, cyclation reaction and cross linked reactions, reaction leading to graft and block copolymers, miscellaneous reactions.

**BOOKS:**

- Principles of Polymer Science : P. Bahadur& N. V. Sastry, Narosa
- Polymer Science – Gowariker et al New Ages International
- Textbook of Polymer Science, J. W. Billmeyer, John Wiley & Sons.
- Physical Chemistry of Macromolecules, Basic principal and issue S.F. SUN, John Wiley & Sons.
- Polymer Chemistry Charles E. Carraher, Jr., Marcel Dekker, Inc.

**VEER NARMAD SOUTH GUJARAT UNIVERSITY**

**M.Sc. SEMESTER-IV (PHYSICAL CHEMISTRY)**

**SYLLABUS TO BE EFFECTIVE FROM JUNE 2019**

**Full Experiment (one) + Viva 4 credit**

**Half Experiment (Two) 4 credit**

**FULL EXPERIMENT (Any Seven)**

1. Determination of the primary salt effect on the kinetics of ionic reactions (Persulphate-iodide reaction) by isolation method.
2. To calculate the surface area of adsorbed molecule in a monolayer, CMC, effectiveness from surface tension measurements of aqueous solutions of surfactant.
3. Determinations of pKa value of acid-base Methyl red indicator by spectrophotometry.
4. To carryout fractionation of a polydispersed polymer by viscosity method
5. Ion exchange separation of  $\text{Fe}^{+3}$  and  $\text{Co}^{+2}$  and determination of  $\text{Fe}^{+3}$  spectrophotometrically.
6. Determine partition function of two organic compounds in ether – water system and find out molecular condition of organic compound in ether.
7. Determine equilibrium constant of reversible reaction between  $\text{Ag}^{+2}$  and  $\text{CaSO}_4$
8. Determine relative strength of two acids ( $\text{HCl}$  and  $\text{H}_2\text{SO}_4$ ) and study hydrolysis of ester.
9. Potentiometric titration of f halide mixture of  $\text{KCl}$ ,  $\text{KBr}$ ,  $\text{KI}$  against std.  $\text{AgNO}_3$  solution

**HALF EXPERIMENT (Any Seven)**

1. Determination of rate constant, order of reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
2. Spectrophotometric determination of - Cobalt and Chromium.
3. Photometric titration of iron-EDTA.
4. Investigate the formation of complex between nickel and o-phenantroline using spectrophotometer.
5. Determination of dissociation constant of a buffer pH-metrically
6. To determine the degree of hydrolysis and hydrolysis constant for the hydrolysis of aniline hydrochloride by conductance method.
7. Determination of  $\text{Ca}^{+2}$  and  $\text{Cu}^{+2}$  in a mixture using EDTA titration spectrophotometrically.
8. To determine the % purity of aspirin sample tablet
9. Estimate concentration of  $\text{H}_2\text{SO}_4$ ,  $\text{CH}_3\text{COOH}$  and  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  by conductometric titration with  $\text{NaOH}$  Solution.

### Books for Paper II and III of semester 3 and 4

1. Vogel's Text book Quantitative Chemical Analysis 5<sup>th</sup> edition by G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney.
2. Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage Learning, 7<sup>th</sup> edition)
3. Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
4. Nuclear Analytical Chemistry – J. Tolgyessy and S. Verga vol. 2, university Park press, (1972)
5. Radiochemistry and Nuclear methods – W.D. Ehmann and D.E. Vance, John Wiley and Sons.
6. Indian Pharmacopeia Volume I and II.
7. Extraction technique in analytical science, John R. Dean, Wiley (2009)
8. Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
9. Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Vogel, 3<sup>ed</sup>, ELBS, 1964.
10. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., New York, 2<sup>nd</sup> edition).
11. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, New York), 5<sup>th</sup> edition.
12. Instrumental Methods of Analysis: H. R. Willard, L. L. Merritt, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co., New York), 6<sup>th</sup> edition.
13. Modern Methods of Chemical Analysis: Pecsok, Shield & Cairns (John Wiley), 2<sup>nd</sup> edition.
14. Introduction to Instrumental Analysis (1987), R. D. Braun (McGraw-Hill Book Company), New Delhi.
15. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
16. Introduction to Modern Liquid Chromatography: L. R. Snyder & J. J. Kirkland (John Wiley & Sons, New York).
17. Treatise on Analytical Chemistry: I. M. Kolthoff & P. J. Elving (John Wiley & Sons, New York).
18. Handbook of Analytical Chemistry: L. Meites (McGraw-Hill, New York).
19. Basic concepts of Analytical Chemistry by S.M. Khopker
20. Standard Methods of Chemical Analysis: Vol. I & II (6<sup>th</sup> edition), D. Van Nostrand Co. Inc. (London).
21. Official Methods of Analysis: Published by Association of Official Analytical Chemists, Washington.
22. Instrumental Methods of Chemical Analysis: B. K. Sharma (Goel Publishing House, Meerut).
23. Instrumental methods of Chemical Analysis by H. Kaur.
24. Environmental Chemistry: B. R. Sharma, H. Kaur (Goel Publishing House, Meerut).
25. Inorganic Quantitative Analysis: A. I. Vogel (Orient Longman).
26. "Polarography", J. D. Talati (In Gujarati), University Granth Nirman Board.
27. "Polarography": Kolthoff I. M. and Lingane J. J. (Vol. I & II) (Interscience Publishers, New York).
28. "Polarographic Techniques": L. Meites (Interscience Publishers, New York).
29. Principles of Instrumental Analysis (5<sup>th</sup> ed.) by Skoog, Holler and Nieman (Saunders College Publications).

30. Undergraduate Instrumental Analysis (5<sup>th</sup> ed.), J. W. Robinson (Marcel Dekker Inc.).
31. Fundamentals of Molecular Spectroscopy, by Banwell.
32. Electronic Absorption Spectroscopy and related techniques, D.N. Sathyanarayan, (New Age International ND. 1996) Uni. Press, Hyderabad.
33. Introduction to Spectroscopy (3<sup>rd</sup> ed.) by Pavia Lampman Kriz, Cengage Learning  
Harcourt College Publishers.