

**SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2018-19
M.Sc. CHEMISTRY
SEMESTER-IV
PHYSICAL CHEMISTRY**

Course Structure

Sr. No.	Course Code	Name of the Course
1.	PS04CPHC21	Atomic Spectroscopy and Microscopic Techniques
2.	PS04CPHC22	Chemistry of Solid Materials
3.	PS04CPHC23	Electro-analytical Methods
4.	PS04CPHC24	Practicals : Polymer Synthesis by Various Techniques
		<u>OR</u>
5.	PS04CPHC25	Project work*
6.	PS04CPHC26	Practicals : Polymer Characterization
		<u>OR</u>
7.	PS04CPHC27	Project work*
8.	PS04CPHC28	Comprehensive Viva
9.	PS04EPHC21	Photochemistry and Energy Systems
10.	PS04EPHC22	Advanced Characterization Techniques – II

* **Project work** (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

SARDAR PATEL UNIVERSITY
Programme & Subject : M. Sc. (Physical Chemistry)
Semester – IV
Syllabus with Effect from : June 2018

Paper Code : PS04CPHC21	Total Credits : 4
Title of Paper : Atomic Spectroscopy and Microscopic Techniques	

Unit	Description in detail	Weightage (%)
I	Electron Spectroscopy : Introduction of electronic spectroscopy (PES, UPS, XPS, ESCA); Principle and theory, Instrumentation, application and problems.	25
II	Atomic absorption and Flame Emission Spectroscopy : Absorption of radiation by atoms, equipment, radiation sources, atomizers, detectors, interferences in atomic absorption spectroscopy, applications. Introduction to plasma, various type of emission spectroscopy, instrumentation, inductively coupled plasma spectrometer, flame photometer, applications.	25
III	Luminescence Spectroscopy : Atomic Fluorescence, Introduction to molecular luminescence (fluorescence, phosphorescence and chemiluminescence); Theory of luminescence, instrumentation (spectrofluorometer), applications. Microscopic techniques - I : Introduction to TEM and SEM : Electron gun, electron acceleration, Condenser lenses, specimen stage, vacuum system, Operating principle, Penetration of electrons into a solid, TEM image, secondary electron images, Backscattered electron images.	25
IV	Microscopic techniques - II : AEM (Analytical Electron Microscopy) : The Bohr model of the atom, X-ray emission spectroscopy, X-ray energy dispersive spectroscopy, Quantitative analysis in TEM and SEM. Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM): Basic principles and theory, instrumentation, operating parameters and applications.	25

Reference Books :

- Introduction to Instrumental Analysis, Robert D. Braun. Pharma Med Press.
- Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Harcourt Asia – Harcourt College Publishers.

- Undergraduate Instrumental Analysis, James W. Robinson, Marcel Dekker Inc.
- Microscopic and Spectroscopic Imaging of the Chemical State, Michael D. Morris, Marcel Dekker, Inc.
- Instrumental Methods for Chemical Analysis, B. K. Sharma, Goel Publishing House.
- Instrumental Methods for Chemical Analysis, V. K. Ahluwalia, Ane Books Pvt. Ltd.
- Physical Principles of Electron Microscopy : An Introduction to TEM, SEM and AEM, Ray F. Egerton, Springer Publication.

Paper Code : PS04CPHC22	Total Credits : 4
Title of Paper : Chemistry of Solid Materials	

Unit	Description in detail	Weightage (%)
I	<p>Geometrical Crystallography : Periodicity in Crystals – Representation of a pattern, translational periodicity, representation of a lattice, notation of planes in lattice. Symmetry Element, screw axes, glide plane. Symmetry groups – Point groups.</p> <p>Crystal Structure : Forms of solids, law of constancy of interfacial angles, crystal systems, crystal classes, lattice structure, unit cell, designation of crystal faces, law of rational indices, planes of cubic lattice, types of lattices.</p>	25
II	<p>Crystal Defects and Non-Stoichiometry : Perfect and imperfect crystals, intrinsic and extrinsic defects – point defects, line and plane defects, Vacancies – Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation.</p> <p>Solid State Reactions : Types of solid state reactions, experimental procedures, co-precipitation as a precursor to solid state reactions, Wagner mechanism of solid state reactions, sol-gel method, kinetics of solid state reactions</p>	25
III	<p>Diffraction Methods for Crystal Structure : X-ray diffraction – Diffraction and Intensities of diffracted beam, Laue and Bragg methods and conditions, Miller Indices, Index reflections, relation to inter planer spacing, Debye-Scherer method of X-ray structure analysis, identification of unit cells, Structure of simple lattices, structure factor and its relation to intensity and electron density, procedure for an X-ray structure analysis, Electron Diffraction, Neutron Diffraction.</p>	25
IV	<p>Electronic Properties and Band Theory : Metals, insulators and semi conductors, electric structure of solids – band theory, Free electron theory, band structure of metals, insulators and semi conductors, intrinsic and extrinsic semi conductors, doping of semi conductors, <i>p</i>- and <i>n</i>- type semiconductors, <i>p-n</i> junctions, super conductors.</p> <p>Optical Properties :</p>	25

Optical reflectance, Lasers, Organic solids – electrically conducting solids, organic charge transfer complex, organic metals.
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Reference Books :

- Crystallography and Crystal Chemistry, F. B. Bloss, Halt Reinhold & Winston Inc.
- Introduction to Solids, L. V. Azaroff, Mc-Graw Hill Co., New York.
- Principles of the Solid State H. V. Kheer Wiley Eastern.
- Solid State Chemistry and Its Applications, Anthony R. West, John Willey & Sons.
- Crystal – Structural Analysis M. J. Buerger John Wiley and Sons, New York.
- Solid State Chemistry : An introduction, Lesley Smart, Elaine Moore, Nelson Thornes.
- Solid State Chemistr D. K. Chakrabarthy New Age International.
- Elements of X-ray Diffraction, B. D. Cullity, Addison – Wesley Publication Co.
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Paper Code : PS04CPHC23	Total Credits : 4
Title of Paper : Electro-analytical Methods	

Unit	Description in detail	Weightage (%)
I	pH metry & its applications : Introduction, Construction and working of different electrodes, Ion selective electrodes, applications of pH-measurements, Acid-base titrations, Polybasic acid-base titrations, Determination of dissociation constant of weak acids and weak bases, Determination of hydrolysis constant and degree of hydrolysis	25
II	Potentiometry : Introduction, Principle, Types of electrodes and its classifications, Chemical cell with and without transference, concentration cell with and without transference, EMF and thermodynamics of cell reactions, Measurements of single electrodes, Determination of activity coefficient from EMF measurements, Potentiometric titration methods, oxidation – reduction titration, argentometric titration, applications	25
III	Conductometry and High Frequency Conductometry : Introduction, Definition of basic terms and their interrelationship, factors affecting conductance, types of cell, conductometric titrations, Applications – different types of acid-base titrations, complex formation titration, Determination of degree of dissociation, dissociation constant, basicity of organic acids, solubility and solubility product of sparingly soluble salts, degree of hydrolysis and hydrolysis constant, Advantages of conductometry titration. High Frequency Conductometry : Introduction, Types of cells, Instrumentation, Importance of relationship between conventional conductance measurement and capacitance, advantages and disadvantages, applications.	25

IV	Voltammetric Techniques : Introduction, Principle, Instrument, Electrode system, advantages and disadvantages, components of limiting currents, polarography – polarography maxima, half-wave potential, Determination of relationship between half wave potential & diffusion coefficient, Factors governing diffusion current, calibration curve method. Voltammetric methods and its applications, Amperometry – Principle, Apparatus, Different types of amperometric titration, advantages and disadvantages, applications.	25
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Reference Books :

- Principles of Instrumental Analysis, Douglas A. Skoog, F. James Hooer, Timothy A. Nieman.
- Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, CBS Publishers & Distributors.
- Contemporary Chemical Analysis, J. F. Rubinson and K. A. Rubinson, Princtice-Hall International Inc..
- Introduction to Instrumental Analysis, Robert D. Braun, McGraw-Hill Book company, New Delhi.
- The Principles of Electrochemistry, Duncan A. MacInnes, Dover Publications Inc., N.Y.
- Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, Meerut.
- Instrumental methods of Chemical Analysis, V. K. Ahluwalia, Ane Books Pvt. Ltd.

Paper Code : PS04CPHC24	Total Credits : 4
Title of Paper : Practicals – Polymer Synthesis by Various Techniques	

List of Practicals

1. Carry out emulsion polymerization of methyl acrylate.
2. Preparation of methacrylic acid-methacrylamide copolymer by free radical polymerisation
3. Preparation of Polyvinyl Alcohol (PVA).
4. Preparation of polysulphide rubber (Thiokol)
5. To polymerize styrene by suspension polymerization method.
6. To polymerize methyl methacrylate by suspension polymerization method
7. Carry out adiabatic solution polymerization of acrylamide.
8. Prepration of polystyrene by free radical polymerization

9. To synthesis phenol-formaldehyde resin (Novolak
10. To synthesis epoxide resin (Liquid).
11. Preparation of Epoxy Resin (solid).
12. To synthesis Urea-Formaldehyde resin
13. To synthesize an unsaturated Polyester resin from maleic anhydride and propylene glycol.

Reference Books:

1. Principles of Polymer Science by P. Bahadur and N.V.Sastry
2. Techniques of polymer synthesis and characterization, Braun, Cherdron and Kern
3. Experimental Plastics Technology, J.A. Brydson and K.J. Saunders

OR

PS04CPHC25 : Project Work*

Project work (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

Paper Code : PS04CPHC26	Total Credits : 4
Title of Paper : Polymer Characterization	

List of Practicals

1. To determine the epoxy equivalent weight of given epoxy resin. (doixan) (solid)
2. To determine the epoxy equivalent weight of given epoxy resin. (doixan) (liquid)
3. To determine epoxy equivalent weight of the given resin by the Pyridinium Chloride method (solid)
4. To determine epoxy equivalent weight of the given resin by the Pyridinium Chloride method (liquid)
5. To determine free formaldehyde in the given Phenol-Formaldehyde resin.
6. To determine free formaldehyde in the given Urea-Formaldehyde resin.
7. Determination of viscosity average molecular weight of polystyrene in toluene by dilute solution.
8. Determination of viscosity average molecular weight of PMMA in toluene by dilute solution.
9. Determination of radius of a molecule by viscosity measurements (glycerol).
10. To determine the order of reaction – decomposition and Activation Energy with the help of TGA – DSC Technique.
11. To determine critical micelle concentration of the given sample with the help of Steady-state fluorescence technique.
12. To determine molar mass and second virial coefficient of the given polymer sample with the help of Debye method.
13. To measure the viscosity of hydrogel (Biopolymer Carbopol).

Reference Books :

1. Principles of Polymer Science by P. Bahadur and N.V.Sastry
2. Introduction to the chemical analysis of plastics, A. Krause and A. Lange
3. Handbook of Epoxy Resins, McGraw-Hill, New York, H. Lee and K. Neville
4. Encyclopedia of Industrial Chemical Analysis, Volume-5
5. Principles of polymer Systems, F. Rodriguez, Mc. Graw-Hill Book Co., New York
6. Experimental Plastics Technology, J. A. Brydson and K. J. Saunders

OR

PS04CPHC27 : Project Work*

Project work (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

PS04CPHC28 : Comprehensive VIVA

Paper Code : PS04EPHC21	Total Credits : 4
Title of Paper : Photochemistry and Energy Systems	

Unit	Description in detail	Weightage (%)
I	Photochemistry – I : Introduction of photochemistry, laws of photochemistry, Electronic energy levels, atomic and molecular term symbols, single-triplet state, intensity and strength of electronic transition, selection rules of electronic transition, Jablonski diagram and photophysical processes, Franck-Condon principle.	25
II	Photochemistry – II : Life times excited states of atoms and molecules, charge transfer transition, steady state and time resolved emission, emission spectra, factors affecting excited state energy : solvent effect, etc. Quantum yield expression, excimer and exciplex, Stern-Volmer analysis, deviation from Stern-Volmer kinetics, Nature of changes on electronic excitation, Potential energy diagram, Emission spectra, Environmental effect on absorption and emission spectra, excited dipole moment, acidity constant values, redox potential	25
III	Photochemistry – III : Photoinduced electron transfer rates, free energy dependence of electron transfer on rate, Photoinduced electron transfer, FRET, rate and efficiency calculation of FRET, Quenching by added substances, Measurement of emission characteristics : Fluorescence,	25

	phosphorescence and Chemiluminescence, Nonsteady State Methods for Determination of Fluorescent Lifetime, Pico-second studies, Techniques for study of Transient Species in Photochemical Reactions, Lasers in photochemical kinetics.	
IV	<p>Energy Systems : Alternative energy needs and option, Fossil fuels : petroleum, natural gas and coal – origin, processing production of value added products – available current conversion technologies. Electrochemical power sources ; theoretical background, types of cells, Fuel cells – classification – chemistry of fuel cells and biochemical fuel cells. Solar Energy conversion devices – photovoltaic cells – photoelectrochemical cells – semiconductor electrolyte junctions, Design and mechanism of solar cells, Silicon solar cells and alternatives, thin film solar cells and third generation solar cells, Thermodynamics limit of light concentrators, Thermodynamics of light conversion.</p>	25

Reference Books :

- Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee, Age International Publishers.
- Principles of Molecular Photochemistry : An introduction, Nicholas J. Turro, V. Ramamurthy, J. C. Scaiano, Viva Publications.
- Principles and Applications of Photochemistry, Brian Wardle, John Wiley & Sons.
- Principles of Fluorescence Spectroscopy, J. R. Lakowicz, Springer, Int. Ed.
- Fuel Cells, Vladimir S. Bagotsky, John Wiley & Sons.
- Chemical and Electrochemical Energy Systems, R. Narayanan and B. Vishwanathan, Orient Longmans.
- Solar cell Materials – Developing Technologies, Ed. Gavin J. Conibeer, Arthur Willoughby, John Wiley & Sons.

Paper Code : PS04EPHC22	Total Credits : 4
Title of Paper : Advanced Characterization Techniques – II	

Unit	Description in detail	Weight age (%)
I	Impedance Spectroscopy : Fundamental of Electrochemical Impedance Spectroscopy – Concept of complex impedance, Complex dielectric, modulus and impedance data representations, Electrochemical Experiment : Charge and material transport, Fundamental ambiguity of impedance spectroscopy analysis, Graphical representation of impedance spectroscopy data – Nyquist and Bode representation of complex impedance data for ideal electrical circuits, Dielectric data representation, Applications.	25
II	Optical Rotatory Dispersion and Circular Dichroism : Introduction, Circular Birefringence, Circular Dichroism, Cotton effect, Optical Rotatory Dispersion, Comparison of ORD and CD curves, Axial Haloketone rule, The octant rule, Instrumentation for ORD and CD measurements, Applications.	25
III	Microwave Spectroscopy : Introduction, Differences between Microwave spectroscopy and IR Spectroscopy, Theory of Microwave Spectroscopy, Diatomic molecules as a Rigid rotator, Selection Rules for Rotational Spectra, Instrument for Microwave spectroscopy, Applications.	25
IV	Separation Techniques : Chromatography : Introduction, Different types of chromatography methods, Introduction, Principles, Applications of Gas Chromatography, High Performance Liquid Chromatography, Gel Chromatography, Ion-Exchange Chromatography, Electro Chromatography.	25

Reference Books :

- Impedance Spectroscopy : Applications to Electrochemical and Dielectric Phenomena, Vadim F. Lvovich, John Wiley & Sons.
- Electrochemical Impedance Spectroscopy, Mark E. Orazem, Bernard Tribollet, John Wiley & Sons.
- Principles of Instrumental Analysis, D. A. Skoog, E. James Holler and S. R. Crouch, Thomson Brooks.
- Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr., J. A. Dean, F. A. Settlw Jr., CBS Publishers and Distributors.
- Fundamentals of Analytical Chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Brooks/Cole Cengage Learning.
- Instrumental Methods of Chemical Analysis, Gurdeep R. Chatwal, Sham K. Anand,
- Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House.
- Instrumental Methods of Chemical Analysis, V. K. Ahluwalia, Ane Books Pvt. Ltd.