SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2019-20
M. Sc. (Applied Chemistry)
Semester – II

PT02CACH21 Inorganic Chemistry – II

Unit – I Wave mechanics

Operator algebra, Free particle; particle in a box; quantization; symmetry of the wave functions; use of the box model; cubical box; Particle on a sphere; normalization of the wave functions; rotation of a diatomic molecule, One dimensional harmonic oscillator, time independent perturbation theory for non-degenerate case, the variation theorem

Unit-II Magnetochemistry

Magnetic susceptibility; sources of paramagnetism; diamagnetic susceptibility; Pascal constants and constitutive corrections; antiferromagnetism; types of antiferromagnetism; Ferromagnetism; ferrimagnetism ;, quenching of orbital magnetic moment by crystal field; Spin paring: spin paring in octahedral complexes; spin paring in non-octahedral complexes, Term symbols, magnetic properties of the compounds of lanthanides and actinides

Unit-III Bioinorganic Chemistry

Introduction to Bio-Inorganic chemistry, Iron-Sulphur proteins, Cytochromes of the electron transport chain, Cytochrome P-450 enzymes, Coenzyme B_{12}, Blue copper proteins Metals in medicine: Antibiotic and related compounds, Metal deficiency and diseases, chelation therapy for metal ion detoxification, Metal ions in clinical diagnosis

Unit – IV Corrosion

Introduction, Dry or chemical corrosion, wet or` electrochemical Corrosion, mechanism, pilling Bed worth rule, Types of corrosion-galvanic corrosion, concentration cell corrosion, Differential aeration corrosion, soil corrosion, Pitting corrosion, Intergranular corrosion, Microbial corrosion, Stress corrosion, Waterline corrosion, Erosion corrosion, Factors influencing corrosion, Corrosion Control: Proper designing, using pure metal, using metal alloys, cathodic protection, modifying the environment, use of Inhibitors.

Reference Books :

- Introductory Quantum Chemistry, A. K. Chandra, Tata McGraw-Hill Publishing Company Ltd. 4th ed. (2004).
- Quantum Chemistry, R. K. Prasad, New Age International Publishers, 4th ed. (2010).
- Quantum Chemistry, N. Levine, Pearson India Pvt. Ltd., 7th ed. (2016).
- Quantum Chemistry Through Problem and Solutions, R. K. Prasad, New Age International Publishers, 1st ed. (2006).
- Introduction to Magnetochemistry, Alan Earshaw, Academic Press, Academic press London and new york 1st ed. (2013).
- Elements of Magnetochemistry, Dutta and Symal, East-West Press Pvt. Ltd. 2nd ed. (2004).
- Bio-inorganic Chemistry an Introduction, J. A. Cowan, Wiley-VCH, 2nd ed. (1997).
- Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, Saunders College Publishing, 9th ed. (2013).
- Metal ions in Biochemistry, P. K. Bhattacharya, Alpha Science International Ed. 1st Ed. (2005).

Books for further Reading :

- Organotransition Metal Chemistry, John F. Hartwing, University Science Books, Sausalito, 1st ed. (2009).
- An Introduction to Quantum Chemistry, M. Satake, Y. Mido, H. Yasuhisa, S. Taguchi, M. S. Sethi, S. A. Iqbal, Discovery Publishing House, 2nd print (2006).
- Elements of Bioinorganic Chemistry, G. N. Mukerjee, Arabinda Das, U. N. Dhur & Sons Pvt. Ltd. 4th ed. (1993).
- Bioinorganic Chemistry, G. R. Chatwal, A. K. Bhagi, Himalaya Publishing House, 1st ed. (2014).
- Bioinorganic Chemistry, Bertini, H. B. Gray, S. J. Lippard, University Science Books, 1st ed. (1994).
- Inorganic Chemistry, Shriver and Atkins Oxford Press, 5th ed. (2009).
- Bio-inorganic Chemistry, R.W. Hay – R.W. Hay, Ellis Horwood Limited Publishers, 1st ed. (1990).
- Bioinorganic Chemistry, Bertini, Gray, Lippard, & Valentine Viva books Pvt Ltd (2007).

PT02CACH22 Organic Chemistry – II

Unit – I Aromaticity and aromatic substitution reactions:

Concept of aromaticity, Annulenes, aromaticity in charged rings, homoaromaticity, fused ring systems, heterocyclic rings.

Introduction to aromatic/electrophilic substitution reactions, reaction mechanism of Friedel-Crafts alkylation and acylation reactions, Types of alkylation and acylating agents, nitration, sulfonation, and halogenation of aromatic compounds. Reactivity of substrates, Orientation of electrophilic substitution reactions in various aromatic substrates. Nucleophilic aromatic substitution reactions.

Unit – II Organic transformations using reagents and their mechanism:

Reactions of Enamines: Formation, reactivity and Synthetic Applications. Hydroboration reactions: Synthetic Applications. *Oxidation reactions*: using various oxidizing agents, Oppenauer oxidation, Tishchenko Reaction, Woodward-Prevost hydroxylation. *Reduction reactions:* Catalytic hydrogenation using homogeneous and heterogeneous catalysts, various reducing reagents. *Organometallic compounds as reagents*: Synthetic applications of organolithium, lithium dialkyl cuprate, Grignard reagents, organozinc, organocadmium, organomercury, organoboranes, organoaluminium, organothalium, organosilicon and organotin.

Unit – IV Free radical reactions :

Formation, detection, characterization, stability/ reactivity, properties of free radicals, sources of free radicals, charged free radicals, free radical substitution reactions, free radical addition reactions, rearrangement and fragmentation reactions involving free radicals, electron transfer reactions, intramolecular free radical reactions.

Unit – V Organic Photochemical reactions :

Energy transfer, sensitization and quenching. Singlet and triplet states and their reactivity. Photorchemistry of carbonyl compounds, alkenes, dienes and aromatic compounds. Singlet oxygen generation and reactions. Norrish reactions of acyclic ketones. Patterno-Buchi, Barton, photo-Fries and Di-ph methane rearrangement reactions. Applications of photoreactions and their applications for industrial synthesis.

Reference Books :

- Advanced Organic Chemistry, Part-A: Structure and Mechanisms, F. A. Carey and R. J. Sundberg, Kluwer Academic/ Plenum Publishers 5th ed. (2008).
- Advanced Organic Chemistry: Reaction Mechanism and Structure, Jerrry March, John Wiley, 4th ed. (2006).
- A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Pearson Pub. 6th ed. (2006).
- Organic Synthesis, M. B. Smith, Academic Press, 4th ed. (2016).
- Organic Chemistry-Clayden, Greeves, Warren and Wothevs, Oxford Univ. Press, 2nd ed. (2014).

Books for further reading :

- Organic Chemistry Natural Products Vol. 1 & 2, O. P. Agrawal, Krishna Prakashan Media Pvt. Ltd. 41st ed. (2015).
- Principles of Organic Synthesis, R. O. C. Norman, A. Coxon, Blackie Academic & Pro Publisher, 3rd ed. (1993).
- Synthetic Approaches in Organic Chemistry, R. K. Bansal, Narosa Publishing House, 1st ed. (2001).
- Organic Reaction Mechanism, R. K. Bansal, New Age International Pvt. Ltd., 4th ed. (2010).
- Organic Photochemistry Principle and Application, J. Kagan, Academic Press, latest ed. (2012).

PT02CACH23 Physical Chemistry – II

Unit – I Chemical Kinetics and Reaction Mechanism :

Basics of chemical kinetics : rate of reaction, factors influencing the rate of reaction, rate laws, rate law, consecutive reactions, chain reaction, parallel reactions, ionic reaction and salt effect, opposing reactions, reactions in flow system, enzyme catalyzed reactions, kinetics of fast reactions. Arrhenius equation, concept of activation energy, thermodynamic formulation of transition state theory.

Unit – II Solid State Chemistry :

Structural principle in solid state chemistry, types of solids based on bonding, nature of packing, conductivity. Preparation of solids, Solid state reactions, Perfect and imperfect crystals, types of defects, intrinsic and extrinsic defects, point defects, Band structure of metals, insulators and semiconductors, X-ray diffraction for structure determination of solids, Bragg methods, Powder methods, Miller indices, Neutron diffraction, Symmetry in solids, types of symmetry in cubic crystal system.

Unit – III Nuclear Chemistry :

Radioactive decay, nuclear reactions, Q value, cross sections, types of reactions, chemical effects of nuclear transformation, equilibrium, Nuclear fission and nuclear fusion. The separation of stable isotopes, the separation of unstable isotopes, Nuclear fuels and reactors, processing nuclear materials.

Unit – IV Symmetry and Group theory :

Concepts of molecular symmetry : symmetry elements, symmetry operations, definitions and theorems in group theory, Molecular point groups : Identification and classification, notation of points groups, matrix representation of symmetry operations, types of matrices, matrix notation for symmetry elements : E, C_n, i, σ, S_n. Matrix representation of point groups : product and square rule, inverse rule, Construction of character tables : rules, reducible and irreducible representations.

Reference Books :

- Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 7th ed. (2017).
- Physical Chemistry, Ira N. Levine, Tata McGraw Hill Publishing House, 6th ed. (2011).
- Kinetics and Mechanism, A. A. Frost, R. G. Pearson, John Wiley & Sons, 2nd ed. (1958).
- Principles of the Solid State, H. V. Kheer, New Age International Publisher, 2nd ed. (2017).
- Chemical Kinetics, K. J. Laidler, Mc-Graw hill Publisher, Pearson Publication, 3rd ed. (1997).
- Solid State Chemistry, D. K. Chakrabarthy New Age International, 2nd ed. (2006).
- Solid State Chemistry and Its Applications, Anthony R. West, John Willey & Sons, 2nd ed. (2014).
- Elements of X-ray Diffraction, B. D. Cullity Addision – Wesley Publ. Co., 2nd ed. (1978).
- Essentials of Nuclear Chemistry, H. J. Arnikar, Wiley Eastern Limited, 4th ed. (2011).
- Elements of Nuclear Chemistry, R. Gopalan, Vikas Publishing House Pvt. Ltd. 1st ed. (1999).
- Group Theory and Its Chemical Applications, P. K. Bhattacharya, Himalaya Publishing House, 1st ed. (2010).
- Group Theory in Chemistry, M. S. Gopinathan, V. Ramakrishnan, Vishal Publishing Co. 2nd Reprint ed. (2013).
- Symmetry and Spectroscopy of Molecules, K. Veera Reddy, New Age International Publishers, 2nd ed. (2009).
- Symmetry and Group Theory for Chemists, N. N. Das, Asian Books Private Limited. 1st ed.

Books for further Reading :

- Crystal – Structural Analysis, M. J. Buerger John Wiley and Sons, 3rd ed. (1962).
- Elements of Physical Chemistry, Peter Atkins, Julio De Paula, David Smith, Oxford University Press, 7th ed. (2017).
- Nuclear Chemistry, Bernard G. Harvey, Prentice - Hall, Inc., Englewood Cliffs, 1st ed. (1965).
- Principal of Physical Chemistry, B. R. Puri, L. R. Sharma and M. S. Pathania, V. P. D. Publisher, 47th ed. (2017).

PT02CACH24 Practicals

Inorganic Chemistry :

Ores analysis (7 hrs)

1. Analysis of Hematite
   1) Acid insoluble residue
   2) Iron as Fe_2O_3
   3) Iron by redox method (volumetrically)

2. Determine the amount of Ca(II), Mg(II), Fe(III) and Carbonate in the given sample of Calcite ore.
3. To analyze the given sample of Pyrolusite
   1) Acid insoluble residue
   2) Iron as Iron oxide
   3) Mn by using EDTA
   4) MnO_2 oxalic acid method/Iodometric method

4. To determine the amount of Al and Fe in the given sample of Bauxite ore
   1) Al as Al_2O_3
   2) Fe as Fe_2O_3
5. Analysis of Industrial waste
   Determination of Calcium fluoride, Calcium and Carbonate from Industrial waste
6. Analysis of Cement: (White/Black Cement)
   Determination of SiO_2, Fe^{+3}, Al^{+3}, Ca^{+2}, Mg^{+2} in a given sample.

Alloys analysis:

1. Analysis of German silver
2. Analysis of BRONZE
3. Analysis of Brass
4. Analysis of Steel
   Miscellaneous

Organic Chemistry :

Single step preparations:

1. Preparation of Cinnamic acid by Perkin's reaction
2. Synthesis of 7-hydroxy 4-methyl coumarin
3. Synthesis of chalcone
4. Synthesis of phenyl salicylate
5. Synthesis of fluorescein from reaction of resorcinol and phthalic anhydride

Multi step preparations

1. Synthesis of flavone
2. Preparation of Sulpha drug (p-Aminobenzene sulphanilamide)
3. Preparation of dyes

Reference Books:

- Modern Analytical Chemistry, D. Harvey, The McGraw-Hill Pub. 1st ed.
- Instrumental Methods of Analysis, G.W. Ewing, McGraw Hill Ltd. 4th ed.
- Physical Methods in Inorganic Chemistry, R. S. Drago, John-Wiley Pub. 1st ed. (2012)
- A Textbook of Practical Organic Chemistry, A. I. Vogel, Longman. Pearson education, 5th ed. (2003).
- Practical Organic Chemistry, F. G. Mann and B. C. Saunders, Longman. Pearson education, 4th ed. (2009).

PT02CACH25 Practicals

- To verify Beer-Lambert's law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample spectrophotometrically.
- To determine the solubility of calcium oxalate in presence of KCl. (Ionic strength effect).
- Analysis of Pharmaceutical tablets.
- To estimate the amount of D-glucose in given solution colorimetrically.
- To determine the acid value of given oil.
- To determine zero shear viscosity (η_o) of a polymer solution at different temperatures.
- To titrate pH metrically a dibasic acid solution against alkali and calculate the first and second neutralization of the acid.
- To determine the decomposition kinetics of a polymer by TGA using iso-conversional method.
- To determine the relative strength of HCl and H_2SO_4 by studying the hydrolysis of methyl acetate.
- Determination of CMC of given surfactant by drop weight methods.
- To determine the percentage purity of glucose by iodimetry.
- Determination of acid value of polyester resin.
- To determine the epoxy equivalent weight of given epoxy resin.
- To determine chemical oxygen demand (COD) in a given water sample.
- Extraction of caffeine from dry tea leaves and its quantitative determination.
- To determine the pKa Value of an indicator by spectrophotometric method.

Reference Books :

- Experiments in Physical Chemistry, J. M. Wilson, R. J. Newcombe, A. R. Denaro, R. M. W. Rickett, Pergamon Press, Oxford 2nd Revised and enlarged ed. (2013).
- Findlay's Practical Physical Chemistry, B. P. Levitt, Longman Group Limited, 9th Edition.
- A Laboratory Manual of Experiments in Physical Chemistry, D. Brennan, C. F. H. Tipper, McGraw-Hill Publishing Company Ltd., 1st ed. (1967).
- Experimental Physical Chemistry, R. C. Das, B. Behera, Tata McGraw-Hill Publishing Company Ltd., 1st ed. (1983).

Books for further readings :

- Advanced Physico-Chemical Experiments: A Textbook of Practical Physical Chemistry and Calculations. J. Rose, Sir Isaac Pitman & Sons Ltd., 1st ed. (1964).
- Vogel's "Textbook of Quantitative chemical analysis" by G. H. Jeffery, J. Basserr Edition.5th ed. (1989).
- Encyclopaedia of Industrial Chemical Analysis, Vol. 14, p. 601, Wiley India, (2007).

PT02EACH21 Instrumental Methods of Analysis

Unit – I Separation Methods :

Principle, classifications of chromatographic methods, adsorption and partition chromatography, nature of partition forces, chromatographic behaviour of solutes, Column efficiency and resolution, Gas chromatography : detector, optimization of experimental conditions. Ion exchange chromatography, Thin layer chromatography (TLC), Gas chromatography (GC), High-performance Liquid chromatography (HPLC). Preparation of column, solvent systems and detection methods.

Unit – II Electroanalytical Methods :

Polarography and Voltammetry : Introduction, Instrumentation, Ilkovic equation and its verification, Determination of half wave potential, application, 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 :** Basic principles, instrumentation, nature of titration curves and applications.

Unit – III Spectroanalytical Methods :

Atomic Absorption and Emission : Theoretical principles and instrumentation in absorption, flame photometry, Analytical application, ICP-AES (Inductively coupled plasma atomic emission spectroscopy). **ESR and Mossbauer** : Principles, Instrumentation and Analytical applications of both the techniques.

Unit – IV Thermal Methods of Analysis :

Thermogravimetry (TGA): Definition, types of TGA, instrumentation, information from TGA curve, factor affecting TGA curves (instrumental as well as characteristics of sample factors); Application of thermogravimetry, Calculation of percent decomposition and composition of compounds, limitation and advantages of TGA. Derivative thermogravimetry (DTG) and its advantages. **Differential Thermal Analysis (DTA)** : Definition, Theoretical basis of DTA, Instrumentation for DTA apparatus, Factors affecting the DTA curve, Application of DTA, Advantages and disadvantages of DTA. **Differential Scanning Calorimetry (DSC)** : General definition, Nanochemistry basics, distinction between molecules, nanoparticles and bulk materials. Physico-chemical considerations of nanomaterials, Sizedependent properties.

Reference Books :

- Instrumental Methods of Analysis, Willard, Merrit, Dean and Settle, CBS Publishers & Distributors 7th ed. (2004).
- Fundamentals of Analytical Chemistry, D. A. Skoog, D. M. West, Thomson Brooks/Cole 9th ed. (2013).
- Atomic and Molecular Spectroscopy, Mool Chand Gupta, New Age International Publishers, Latest ed. (2001).
- Physical Chemistry: A Molecular Approach, Donald A. McQuarrie, John D. Simon, Viva Books, Viva Student Edition, Revised ed. (2011)
- Fundamentals of Molecular Spectroscopy, C. N. Banwell, E. M. McCash, Tata McGraw Hill publishing, 4th ed. (2017).
- Electrochemical Methods, A. J. Bard, L. R. Faulkner, Wiley- India edition, 2nd ed. (2001).

Books for further reading :

- Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks/Cole publisher, 5th ed. (2009).
- Physical Chemistry, Ira N. Levine, Tata-McGraw Hill Edition, 4th ed. (2011).
- Molecular Spectroscopy, J. D. Graybeal, McGraw Hill Revised and Subsequent ed. (1993).
- Modern Spectroscopy, J. M. Hollas, John Wiley & Sons, (2003).
- High Resolution Spectroscopy, J. M. Hollas, Butterworths Heinemann Ltd. (1982).
- Instrumental method of Chemical Analysis, B. K. Sharma, Krishna Prakashan Media Pvt. Ltd., (2014).
- Instrumental Methods of Chemical Analysis, V. K. Ahluwalia, ANE Books (2015)

PT02EACH22 Advanced Characterization Techniques

Unit – 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.

Unit – II Rheology :

Introduction, Subject and goals, Continuum mechanics as a foundation rheology, Viscoelasticity : liquids, solids, gels, Rheometry experimental methods, analysis and modelling of rheomechanical responses in static and dynamic modes, Applications of rheology in Polymers, Food and processing industries, paint, high energy materials etc. as case studies.

Unit – III Optical Rotatory Dispersion and Circular Dichromism :

Introduction, Circular Birefringence, Circular Dichromism, Cotton effect, Optical Rotatory Dispersion, Comparison of ORD and CD curves, Axial Haloketone rule, The octant rule, Instrumentation for ORD and CD measurements, Applications.

Unit – IV 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.

Reference Books :

- Impedance Spectroscopy : Applications to Electrochemical and Dielectric Phenomena, Vadim F. Lvovich, John Wiley & Sons, 1st ed. (2012).
- Electrochemical Impedance Spectroscopy, Mark E. Orazem, Bernard Tribollet, John Wiley & Sons. Physical Chemistry of Polymers, A. Tager, Mir Publishers, 2nd ed. (1978).
- Rheology : Concepts, methods and Applications. Alexander Ya. Malkin, Avraam I. Isayev, Chem Tec Publishing, 3rd ed. (2017).
- Understanding Viscoelasticity, Phan-Thien, Nhan, Springer Publication, 3rd ed. (2017).
- Principles of Instrumental Analysis, D. A. Skoog, E. James Holler, S. R. Crouch, Thomson Brooks, 7th ed. (2017).

- Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr., J. A. Dean, F. A. Settlw Jr., CBS Publishers and Distributors, 7th ed. (2004).
- Fundamentals of Analytical Chemistry, Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Brooks/Cole Cengage Learning, 9th ed. (2014).

Books for further reading :

- Introduction to Polymer Rheology, Montogomery T. Shaw, Wiley Publication, 1st ed. (2012).
- Instrumental Methods of Chemical Analysis, Gurdeep R. Chatwal, Sham K. Anand, Himalaya Publishing House, 5th ed. (2014).
- Instrumental Methods of Chemical Analysis, B. K. Sharma, Goel Publishing House, 24th ed. (2011).
- Instrumental Methods of Chemical Analysis, V. K. Ahluwalia, ANE Books Pvt. Ltd. 1st ed. (2015).