Fergusson College (Autonomous) Pune

Learning Outcomes-Based Curriculum

for

M.Sc. I - Analytical Chemistry

With effect from June 2019

Programme Structure

Semester	Course Code	Course Title	Credits
I	CHA4101	Fundamentals of Physical Chemistry	4
	CHA4102	Fundamentals of Inorganic Chemistry	4
	CHA4103	Advanced Organic Chemistry and Spectroscopy	4
	CHA4104	Analytical Chemistry Practical - I	4
	CHA4105	Analytical Chemistry Practical - II	4
			20
II	CHA4201	Advanced Physical Chemistry	4
	CHA4202	Advanced Inorganic Chemistry	4
	CHA4203	Reaction Mechanism in Organic Chemistry	4
	CHA4204	Chemistry Practical Course - III	4
	CHA4205	Chemistry Practical Course - IV	4
			20

Programme Learning Outcomes

PO1	Deep understanding of concepts, principles, methods and theories in chemistry and its different subfields (analytical, inorganic, organic and physical)
PO2	Recognize and apply the principles of atomic and molecular structures to predict chemical properties and reactivity.
PO3	Investigate chemical systems and processes in the laboratory and in nature.
PO4	Understand interaction between scientific theory and experimentation.
PO5	Apply appropriate methodologies in order to conduct chemical syntheses, analyses or other chemical investigations
PO6	Identify, formulate, research literature, and analyse scientific problems
PO7	Interpret, evaluate chemical information and compare the findings with scientific literature.
PO8	Present the scientific findings in lucid way.
PO9	Apply appropriate techniques, resources, and modern methodologies for synthesis and chemical analysis with an understanding of the limitations.
PO10	Learn to use of different software related to Chemistry (Chemdraw, ISIS Draw, Origin)

CHA4101-Fundamentals of Physical Chemistry
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
Students will learn to apply mathematical tools to calculate thermodynamics, quantum mechanics and kinetic based properties.	Classroom teaching, tutorials
They will use simple models to understand the physical phenomenon associated with thermodynamics and kinetics.	Classrooms lectures with demonstrations
They will understand the role of quantum mechanics in chemistry and the relationship between statistical mechanics and quantum mechanics	Problem solving sessions, PowerPoint presentations
They will study the derivation of rate equation from mechanistic data.	Interpretation of data, videos
They will try to formulate and solve scientific problems based on the fundamentals of physical chemistry.	Class room lectures, discussions

Unit No.	Title of Unit and Contents
I	Quantum Chemistry Postulates of quantum mechanics, wave functions and probabilities, operators, commutation relationships, Hermitian operators, Commutators. Eigenfunctions and eigenvalues of operators, States as probability distributions and expectation values. Schrodinger equation, particle in a box and degeneracy. Applications- Solution of the Schrodinger equation for the hydrogen atom, radial and angular probability distributions, atomic orbitals, shape of orbitals, radial function, its square and radial distribution curve for atomic orbitals.
II	Statistical thermodynamics: Recapitulation of fundamental concepts of thermodynamics, significance of statistical thermodynamics over classical thermodynamics. Statistical view of entropy, Laws of thermodynamics from statistical considerations, Molecular view of temperature and heat capacity, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, Boltzman distribution law, molecular energy levels, Ensembles and canonical ensembles, equilibrium constant in terms of partition functions, residual entropy, translational, rotational and vibrational partition functions, obtaining thermodynamic properties from partition functions.
III	Chemical Kinetics a. Recapitulation : Elementary reaction, half integral order reaction- differential and integral equations, reversible reaction, parallel reaction, consecutive recation, principle of microscopic reversibility, steady state approximation- elucidating mechanism of a reaction. b. Theories of Reaction Rates i) Arrhenius theory, collision theory and transition state theory, enthalpy, free energy and entropy of activation, correlation of steric factor in collision theory and entropy of activation, rationalizing steric factor.

	ii) Unimolecular reactions, dependence of rate constant on pressure, dielectric constant and ionic strength (primary and secondary salt effect). Enzyme catalysis – MichaelisMenton mechanism, Lineweaver and Eadieplot,Linear free energy relationship, potential energy surface.

Learning Resources

1. Physical Chemistry - P.W.Atkin and De Paule 8th edition (2010)
2. Physical Chemistry - T. Engel and P. Reid, Pearson Education (2006)
3. Physical Chemistry and molecular approach - D. Mcquarie and J. Simon (University Science) (2000)
4. Quantum Chemistry - I. Levine 5th edition, Prentice Hall, 1999
5. Chemical kinetics, Keith J. Laidler , 3rd Edition Pearson Education (2003)

CHA4102 - Fundamentals of Inorganic Chemistry
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
Students will learn to identify symmetry elements and recognize symmetry operations generated by each symmetry elements for a given molecule	Classroom lectures, chemical model demonstrations
They will learn to combine symmetry operations and set up multiplication table for simple point group	Classroom teaching, Power point presentations
They will try to determine the point group of a molecule by the systematic method and also reduce reducible representation to the component irreducible representation by block diagonalization and by the reduction formula.	Classroom teaching,Problem solving
They will solve problems with critical thinking and reasoning as applied in scientific problems.	Discussion, problem based methods

Unit No.	Title of Unit and Contents
I	**Symmetry, Group theory and Spectroscopy** a. Definitions and Theorems of Group Theory Defining properties of a group, group multiplication table, some examples of group, subgroups, classes b. Molecular Symmetry and Symmetry Groups Symmetry elements and operations, Symmetry planes and reflections, the inversion centre, proper/improper axes and rotation, products of symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry elements and optical isomerism, symmetry point groups, classes of symmetry operations, classification of molecular point groups. c. Representations of Groups, the great orthogonality theorem and its applications, Character tables d. Reducible and irreducible representations, Wave function as a basis for irreducible representations e. Symmetry Adapted Linear Combinations (SALC)- projection operators and their use of constructing SALC f. Molecular Orbital Theory Transformation properties of atomic orbitals, MO's for Sigma bonding ABn molecules (tetrahedral AB_4) g. Application of group theory to infrared spectroscopy Introduction, selection rules, polyatomic molecules, possible vibration in a linear molecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR spectra related to symmetry of some compounds, IR spectra of complex compounds.
II	**NMR of Inorganic Compounds** a. Concept of nuclear spin and resonance, fundamentals of coupling and decoupling, coupling constants. Predicting Intensity of NMR lines bybinomial, trinomial, tetranomial etc.

	b. Structure elucidation by ^{19}F and ^{31}P NMRspectroscopy. Examples: ^{19}F NMR spectra of interhalogen compounds, ^{19}F and ^{31}P NMR to deduce structures of PF_3R_2 type compounds, ^{31}P NMR of Wilkinson catalyst, geometrical isomers of platinum compounds, *trans effect* and *meridonial, facial* isomers of rhodium compounds. c. General trends in chemical shifts, factors influencing chemical shift- geometry, electronegativity, charge and oxidation state, coordination number, effect of ligands, coordination effect on transition metal. General trends in coupling constant, factors influencing coupling constant- gyromagnetic ratio, periodicity, 's' character in the bond,hybridization, coordination number, electronegativity, trans effect, inter bond angles lonepairs and oxidation state.
III	**Electron Absorption Spectroscopy** a. Concept & Scope of Ligand Fields, Energy levels of transition metal ions, Free ion terms,Spin-orbit coupling. b. Ligand Field Theory of Coordination Complexes Effect of ligand field on energy levels of transition metal ions, weak cubic ligand field effect on Russell-Saunders terms, strong field effect, Selection rules, Orgel diagram, Correlation diagrams, Tanabe-Sugano Diagrams, Spin-Pairing energies. c. Electronic spectra of Transition Metal Complexes, Spectra of 1^{st}row ions, Spectrochemical &Nephalauxetic series, Charge transfer & luminescence spectra, Calculations of Dq, B, β parameters. Magnetic properties of coordination complexes.

Learning Resources

1. Chemical Applications of Group Theory, 3rd Edn., Author - F. A. Cotton (Wiley, New York)
2. Symmetry and spectroscopy of molecules, 2nd Ed. 2009; K. Veera Reddy, (New Age International Publication)
3. Group Theory and its Chemical Applications, P.K. Bhattarchrya
4. Inorganic Chemistry : Shriver & Atkins (4th edition 2003, Oxford)
5. Concise Inorganic Chemistry, J. D. Lee, Fourth Edn.(Chapman and Hall)
6. Inorganic chemistry: principle of structures and reactivity, Huheey, Keiter, Keiter, Medhi, Pearson Education, 4th Edn. (2007).
7. Inorganic Chemistry: Catherine Housecroft
8. Inorganic Chemistry: Messler&Tarr, Pearson Publishers 3rd Edition
9. Organometallic Chemistry-A Unified Approach: R. C. Mehrotra& A. Singh
10. Symmetry and group theory-Vijayalaxmi
11. Physical Methods in Chemistry, R. S. Drago, Saunders, Harcourt Brac Javanovich College Publishers, (1992).
12. NMR spectroscopy in Inorganic Chemistry, J. A. Iggo, Oxford University press (2001).
13. Ligand field theory & its applications: B.N. Figgis & M.A. Hitachman (2000) Wiely VCH Publ.

CHA4103: Advanced Organic Chemistry and Spectroscopy
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
Theywill understand the concept of aromaticity of benzenoid and non-benzenoid system.	Discussions with approach for problem solving
They will learn Aromatic Substitutionreactions	Classroom teaching and power point presentations
They will learn synthesis and applications of Organometallic compounds and Ylides ofPhosphorus, Nitrogen and Sulphur	Classroom teaching and power point presentations
Students will get the knowledge of use of various oxidizing and reducing agents in synthetic organic chemistry.	Classroom teaching with experiments in laboratory
They will learn the use of reducing agent: strong, mild reducing agents	Classroom teaching with experiments in laboratory
They will recognize and understand stereochemistry and be able to apply E/Z, D/L configuration, optical activity in different types of molecules.	Classroom teaching, demonstrations with the help of models
They will be well versed with the use of spectroscopic methods for determining structures.	Classroom teaching and tutorials
They will be familiarized with basic concepts of Carbon magnetic Resonance and Mass spectrometry	Classroom teaching with videos
They will be able to solve problems employing spectroscopic methods including UV spectroscopy, infrared and NMR spectroscopy	Discussion and approach for problem solving

Unit No.	Title of Unit and Contents
I.	Aromaticity: Benzenoid, non-benzenoid, antiaromatic, nonaromatic and aromatic compounds
II.	Aromatic Substitution: Recapitulation of Aromatic Nucleophilic and Electrophilic substitution, Benzyne generation under different condition (basic and neutral), orientations and regioselectivity in arynes, and SN^i reactions
III.	Organometallics and Ylides: a. Reactions of organometalic reagents involving Li, Zn, Cu, Mg, Al, Si etc., Hydroboration and synthesis of borane reagents b. Ylides: Phosphorus, Nitrogen and Sulphur ylides in organic synthesis
IV.	a. Oxidation reactions: CrO_3, PDC, PCC, IBX, $KMnO_4$, MnO_2, Swern, SeO_2, $NaIO_4$, $Pb(OAc)_4$, Pd-C, OsO_4, m-CPBA, H_2O_2, Oxone, TEMPO, O_3, etc. b. Reduction reactions:Boranes and hydroboration reactions, MPV reduction and reduction with H_2/Pd-C, Willkinsons catalyst, DIBAL, transfer hydrogenationetc.
V.	Stereochemistry: a. Recapitulation R and S, E and Z, D and L nomenclature of compounds and chirality in allenes, hemisprane, spiranes andbiphenyls b. Prochiral relationship, stereospecific and stereoselective reactions,

VI.	Structure determination by spectroscopic techniques a. UV: Factors affecting UV absorption and interpretation of UV spectra b. IR: Basic ideas about IR frequencies, interpretation of IR spectra c. ^{1}H-NMR: Fundamentals of ^{1}H-NMR, factors affecting chemical shift, integration coupling (1st order analysis) d. Introduction to CMR and mass spectrometry e. Problems based on UV, IR and ^{1}H-NMR

Learning Resources

1. Organic Chemistry–by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
2. Guide book to Reaction Mechanism –Peter Sykes
3. Advanced Organic Chemistry –by J. March 6th Edition
4. Stereochemistry of organic compound-by Nasipuri
5. Stereochemistry of carbon compound-by E.L. Eliel
6. Advanced Organic Chemistry (part A) –by A. Carey and R.J. Sundberg
7. Organic Chemistry (5th Edn.) Robert. T.Morrison & N. Boyd. Hill edn.
8. Stereochemistry conformations and mechanism by P.S. Kalsi
9. Organic chemistry –by Cram, Hammond, Pine and Handrickson
10. Introduction to spectroscopy – D.l. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition
11. Spectroscopic methods in organic melecules – D.H. William & I Flemming Mc Graw Hill

CHA4104 Analytical Chemistry Practical - I
Credits: 4

Unit No.	Contents
I	Organic Practicals a) Separation of three component mixture b) Purification techniques
II	Physical Practicals a) pH metry: To determine dissociation constant and isoelectric point of an amino acid by pH metry b) Conductometry : To determine concentrations of strong acid and weak acid present in the mixture by titration with strong base by coductometric measurements. c) Spectrophotometry: i. To estimate amount of copper by photometric titration with EDTA ii. To determinemolecular weight of Cobalt Complex/ amine picrate. d) Potentiomerty: To determine stability constant of a silver ammonium complex. e) Thermodynamics: To determine molar volume and partial molar volume of the components. f) Theoretical experiment: To plots the polar graphs for s and p orbitals using origin software

CHA4105 Analytical Chemistry Practical - II
Credits: 4

Unit No.	Contents
I	Inorganic Practicals 1. Analysis of silica and manganese from pyrolusiteore. 2. Determination of tin and lead from solder. 3. Synthesis and Characterization of Chloro penta-ammine cobalt (III) chloride 4. Synthesis and Characterization ofNitro penta-amminecobalt (III) chloride 5. Synthesis and Characterization ofPotassium tri-oxalato aluminate 6. Synthesis and Characterization ofTris acetylacetonato iron (III) 7. Synthesis and Characterization ofTrans-bis glycinato copper (II) 8. Determination of equilibrium constant of M – L systems Fe(III)–sulphosalicylic acid by Job's continuous variation method spectrometrically. 9. Verification of Debye Huckle theory of ionic conductance for strong electrolytes KCl, $BaCl_2$, $K_3[Fe(CN)_6]$ by conductometry. 10. Analysis of aluminium from alum 11. Synthesis of MnO_2/ZnOnanoparticle and its application. 12. Analysis of Electronic spectra of transition metal complexes atleast forone system (d^n Oh or Td) and calculation of crystal field parameters, inter electronic repulsion parameter and bonding parameter.
II	Physical Practicals a) Chemical kinetics: i. To study Kinetic decomposition of diacetone alcohol by dilatometry. ii. To determine an order of iodide and persulphate ions by fractional change method. iii. To investigate the rate constant of an autocatalytic reaction between potassium permanganate and oxalic acid. iv. To investigate effect of Brönsted primary salt on reaction v. To determine temperature coefficient and energy of activation of acid catalyzed ester hydrolysis reaction. b) Conductometry i. To study hydrolysis of ethyl acetate by NaOH using conductometric measurements. ii. To determine solubility product and thermodynamic properties of sparingly soluble salt by conductometry.

Learning Resources

1. Text book of Quantitative Analysis, A.I. Vogel 4th Edn. (1992).
2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4. General Chemistry Experiments, Anil. J Elias, University press (2002)
5. Ligand Field Theory, B. N. Figgis.

CHA4201 Advanced Physical Chemistry
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
Students will learn spectroscopic techniques including Microwave and Mossbour, IR and Raman , NMR and Electron spectroscopy of molecule based on physical and mathematical models.	Classroom teaching and problem solving
They will try to apply theoretical aspects for various spectroscopic techniques such as emission, absorption, scattering and NMR	Classroom learning with help of videos
They will interpret different types of molecular spectra and to evaluate valuable data from it.	Discussion and problem solving
They will deduce electronic structure of molecules w.r.t Valence Bond Theory (VBT) and Molecular Orbital (MOT)	Power point presentations
Students will study simplification introduced by Hückel for studying organic conjugated molecules	Classroom teaching with videos

Unit No.	Title of Unit and Contents
I	Molecular spectroscopy: a. Electromagnetic spectra, spectral regions, spectral line width, spectral line intensity. Spectrophotometer, resolving power, signal to noise ration, introduction to Fourier transitions. b. Visible spectrophotometry and colorimetry: Theory of spectrophotometry and ccolorimetry, fundamental laws of absorption, Lambert's law, Beer's law, additivity of absorbance, instrumentation, applications. c. Rotational Spectroscopy: Rotational spectra, classification of molecules, rigid and non rigid rotor, diatomic molecules, effect of temperature and isotope substitution on the rotation spectra, linear and nonlinear polyatomic molecules, relative intensities of spectral lines, stark effect. d. Vibrational Spectroscopy: Vibrating diatomic molecule, simple and anharmonic oscillator, diatomic vibrating rotator, vibrational and rotational spectrum of CO, breakdown of the Born Oppenheimer approximation, overtones and combinations, the vibration of polyatomic molecules, instrumentation of IR, principle and application of FTIR. e. Raman Spectroscopy: Introduction, Rotational Raman- spectra, Vibrational Raman , Spectra, polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications in structure elucidation. f. Electronic spectroscopy of molecules: Born – Oppenheimer approximation, electronic spectra of diatomic molecules, intensity of vibrational – electronic spectra: the Franck-Condon principle, dissociation energy and dissociation products, rotational fine structure of electronic – vibration transitions, the Fortrat diagram, predissosiation .

	g. Magnetic resonance spectroscopy: ^{1}H NMR, chemical shift, spin spin coupling, factors affecting chemical shifts. Introduction to ^{13}C NMR, g factor, applications. h. Mossbauer spectroscopy : Principles and applications of Mossbauer spectroscopy
II	Chemical bonding: Introduction to electronic structure of molecule, Born Oppenheimer's Approximation, Quantum Theory of molecules, Approximate solution of Schrödinger equation, Approximate method –Variation Method, Valance bond theory (VBT) and Molecular Orbital Theory(MOT), Molecular orbital treatment of hydrogen molecule ion and hydrogen molecule, , Approximations underlying Huckel theory, Applications of Huckel theory to ethylene, allyl system, butadiene and benzene, alternate and non-alternate hydrocarbons.
III	Nuclear and radiation Chemistry a. Types and detection of ionizing radiations- α, β, γ decay and their energies b. Applications of radioisotopes- neutron activation analysis, isotope dilution analysis, radiometric titration and problem solving.

Learning Resources

1. Fundamentals of molecular spectroscopy: C.N. Banewell and E.Mc. Cash (Fourth edition).
2. Elements of Nuclear Chemistry, H.J. Arnikar, 4 th edition, New Age Publishers (2008).
3. Physical Chemistry, T. Engel and P. Reid, Pearson Education (2006).
4. Atkins Physical Chemistry, P. W. Atkins and DePaula (Oxford, Eighth Edition)
5. Physical Chemistry and molecular approach - D. Mcquarie and J. Simon (University Science) (2000)

CHA4202 Advanced Inorganic Chemistry
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
Students will learn the fundamental concepts in lnorganic reaction mechanism.	Classroom teaching with the help of power point presentations
They will develop the ability of effective problemsolving.	Discussion and problem solving
They will be able to describe role of different metal ions in biological system.	Classroom teaching and videos
They will learn to recognize the biological reactions of alkali and alkaline earth metals, nitrogen fixation.	Classroom teaching and tutorials
Students will understand the details of different organometallic compounds of alkali and alkaline earth metals.	Classroom teaching and tutorials

Unit No.	Title of Unit and Contents
I	**Inorganic reaction mechanism** a. Rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction. b. Ligand substitution reactions of: i) Octahedral complexes ii) Square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. c. Redox reactions: Inner and outer sphere mechanisms, complimentary and non-complimentary reactions. d. Isomerization reactions and applications.
II	**Bioinorganic Chemistry** a. Metalloporphyrins with special reference to haemoglobin and myoglobin, b. Metalloenzymes, c. Oxygen transport d. Electron- transfer reactions; e. Nitrogen fixation, f. Metal complexes in medicine. g. Photosystems
III	**Organometallic Chemistry** I) Organometallic compounds of transition metals: Synthesis, properties,structure and bonding of the following organometallic compounds: a. Alkyl and Aryl derivatives b. Carbenes and Carbynes (Fischer and Tropsch) c. Alkene complexes (Zeise's salt) d. Alkyne complexes (diphenylacetylene platinum (0)) e. Allyl complexes (diallyl nickel) **f.** Cyclopentadiene complexes (ferrocene)

	II) Homogenous and Heterogenous Catalysis: Comparison Fundamental reactions steps, turn-over number, turn over frequency catalytic cycle. III) Organometallics as Catalysts in Organic Reaction IV) Organometallics in medicine, agriculture, and their biological and environmental aspects
IV	**Inorganic cage and cluster compounds** a. Bonding in boranes b. Wade's rule c. STYX numbers d. Heteroboranes e. Carboranes f. Cluster compounds with ligands and without ligands (Zintl ions) g. Electron precise compounds and their relation to clusters. h. Metal-Metal bonding and Metal Clusters i. Electron Count and Structures of Clusters

Learning Resources

1. D. Banerjea, Coordination Chemistry, Tata McGraw Hill, New Delhi, 1993.
2. F. Basalo and R. G. Pearson, Mechanism of Inorganic Reactions, 2nd ed., Wiley, New York, 1967
3. D. Benson, Mechanisms of Inorganic Reactions in solutionMcGraw – Hill, New York, 1968
4. J. O. Edwards, Inorganic ReactionMechanisms, Benjamin, NewYork, 1974
5. Principle of Bioinorganic Chemistry: S.J. Lippard and J,M. Berg
6. Bioinorganic Chemistry: Inroganic Elements in Chemistry of Life: W.Kaim and B. Schwederski
7. Bioinorganic Chemistry: Bertini, Gray, Lippard and Valentine
8. Bioinorganic Chemistry: R.J.P. Willams
9. Bioinorganic Chemistry: Robert Hay
10. Bioinorganic Chemistry: M.N. Hughes
11. James Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th Edition, Harper Collins, 1993
12. Puri, Sharma and Kalia, Principles of Inorganic Chemistry – 31st Edition, Milestone Publishers, 2010
13. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd. Calcutta, 2001
14. R. C. Mehrotra, A. Singh, Organometallic Chemistry: A unified approach- 2nd Edition, New Age International Publication, 2006
15. Nanomaterials & Nanochemistry, 2007, Catherine Brechignac, Philippe Houdy, Marcel Lahmani, ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York.
16. Nanomaterials Chemistry, Recent Developments and New Directions C.N.R. Rao, A. Muller, and A.K. Cheetham, ISBN 978-3-527-31664-9, 2007 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.
17. Nano-Surface Chemistry, 2001, Morton Rosoff, ISBN: 0-8247-0254-9, Marcel Dekker Inc. New York.
18. The Chemistry of Nanomaterials, CNR Rao, Muller Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.
19. Semiconductor Nanomaterials, Challa S.S.R. Kumar, ISBN: 978-3-527-32166-7, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2010.

CHA4203 Reaction Mechanism in Organic Chemistry
Credits: 4

Learning Outcomes	Suggested Pedagogical Processes
They will explore the basic concept and principles of photochemistry	Classroom teaching with presentation and demonstration
They will explore the basic concept and principles of pericyclic reactions	Classroom teaching with presentation and use of models
They will learn formation and synthetic applications of carbanions, enamines and ynamines	Classroom teaching with presentation and demonstration
They will learn formation, stability and synthetic applications of carbene and nitrene intermediates.	Classroom teaching with presentation
They will learn NGP of Nitrogen, Sulphur and Carbon bearing groups	Classroom teaching with presentation and use of models
They will try to apply variety of rearrangement in organic transformation reactions	Classroom teaching with experiments in laboratory
They will explore concept of Free radical	Classroom teaching with presentation
They will Mechanistic aspects of Ester hydrolysis	Classroom teaching with presentation

Unit No.	Title of Unit and Contents
I.	Photochemistry**:** General basic principles, initiators and sensitizers photochemistry of carbonyl compounds, alkenes, dienes, polyenes and aromatic compounds, photorearrangements and named reactions
II.	Pericyclic reactions: Electrocyclic, Cycloaddition, Sigmatropic and ene reactions. 1,3-dipolar additions, Analysis by correlation diagrams, FMO approach and ATS concept. Application of pericyclic reactions.
III.	Carbanions, Enamines and ynamines- Formation, stability and related name reactions
IV.	Reactions of carbenes and nitrenes: *N*-heterocylcic carbene and nitrenes-generation, stability and reactivity
V.	Neighbouring group participation: NGP involving Nitrogen, Sulphur and Carbon atoms, C-C and C=C.
VI.	Rearrangements: Anionic, cationic and free radical
VII.	Free radical - Generation, stability, Nucleophilic and electrophilic radicals, characteristics reactions, -free radical substitution, addition to multiple bonds, Radicals in synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors, cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds, Oxidative coupling, C-C bond formation in aromatics, SNAr reactions, Mechanisms in biological chemistry
VIII.	Ester and amide hydrolysis (only major acid, base catalyzed and neutral condition mechanisms)

Learning Resources

1. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston)
2. Advanced organic chemistry by J. March, 6th Ed.
3. Advanced organic chemistry. F. A. Carey and R. J. Sundberg, 5th Ed. Springer (2007)
4. A guidebook to mechanism in organic chemistry – Peter Sykes 6th Ed. Orient Longman
5. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001)
6. Radicals in Organic Synthesis B. Giese, Pergamon press (1986)
7. Physical Organic chemistry – J. Hine
8. A guidebook to mechanism in organic chemistry – Peter Sykes 6 Th Ed. Orient Longman
9. Modern Synthetic reactions- H.O. House

CHA4204 Chemistry Practical Course - III
Credits: 4

Unit No.	Contents
I	Organic Practicals a. TLC b. Column Chromatography c. Distillation d. Use of chemistry software like ChemDraw, Chemsketch e. Single stage preparations: oxidation, reduction, alkylation, formylation, cycloaddition etc.
II	Physical Practicals a. Radioactivity: 1. To determine counting errors of Giger Muller counter. 2. To determine E_{max} of β radiation and absorption coefficients in Al by Geiger Muller counter b. Viscometry To determine radius of glycerol molecule by viscosity. c. Conductometry To study the hydrolysis of NH_4Cl by Conductometry. d. Spectrum Analysis To analyze crystal structure from single crystal X-ray pattern. e. Theoretical Experiment To study statistical treatment of experimental data. f. pH metry To determine Hammett constant of ortho, meta, para amino/nitro benzoic acid.

CHA4205 Chemistry Practical Course - IV
Credits: 4

Unit No.	Contents
I	Inorganic Practicals: 1. Analysis of silica and iron from hematite ore 2. Analysis of cupronickel/stainless steel alloy. 3. Synthesis and characterization of Tris (ethylene diammine)Ni(II) thiosulphate. 4. Synthesis and characterization of Tris triphenylphosphine copper nitrate 5. Synthesis and characterization of Cis and Trans dichloro bis(ethylenediamine) Co (III) chloride. 6. Synthesis and characterization of Tris acetylacetonato manganese 7. Synthesis and characterization ofPostassium trioxalato chromate 8. Determination of iron by solvent extraction techniques using 8-hydroxyquinoline reagent. 9. Separation of mixture of Zn(II) and Mg(II) using Amberlite IRA 400 anion exchanger and quantitative estimation of separated ions Zn(II) and Mg(II). 10. Estimation of phosphate from waste water by calibration curve method. 11. Synthesis of Fe_2O_3/ZnS nanoparticles.
II	Physical Practicals a. Conductometry i. To determine equivalent conductance at infinite dilution, dissociation constant of Acetic Acid and to study DebeyHuckel Limiting law ii. To determine critical micellar concentration (CMC) and G of micellization of sodium dodecyl sulphate (SDS). b. Potentiometry i. To determine Solubility and solubility product of a sparingly soluble salt. ii. To determine strength of commercial vinegar by potentiometric titration c. Potentiometry: To estimate amount of halides present in the mixture d. pH metry: To determine dissociation constants of tribasic acid (phosphoric acid) e. Spectrophometry To study simultaneous determination of cations from binary mixture

Learning Resources

1. Text book of Quantitative Analysis, A.I. Vogel 4th Edn. (1992).
2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
4. Ligand Field Theory, B. N. Figgis.