SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Sc. PHYSICAL CHEMISTRY
(For students admitted from the academic year 2014-2015)
CURRICULUM AND SYLLABUS

FACULTY OF SCIENCE AND HUMANITIES
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203

M.Sc. PHYSICAL CHEMISTRY
(For students admitted from the academic year 2014-2015)
CURRICULUM AND SYLLABUS

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	Total of L+T+P	C
SEMESTER I						
PCY14101	Inorganic Chemistry-I	3	3	-	6	4
PCY14102	Organic Chemistry-I	3	3	-	6	4
PCY14103	Physical Chemistry-I	3	3	-	6	4
PCY14104	Nanochemistry	3	3	-	6	3
PCY14105	Inorganic Chemistry Practical	-	-	6	6	3
Total		12	12	6	30	18
SEMESTER II						
PCY14201	Inorganic Chemistry-II	4	1	-	5	4
PCY14202	Organic Chemistry-II	4	1	-	5	4
PCY14203	Physical Chemistry-II	4	1	-	5	4
PCY14204	Analytical Chemistry	4	1	-	5	4
PCY14205	Organic Chemistry Practical	-	-	5	5	3
PCY14206	Physical Chemistry Practical	-	-	5	5	3
Total		16	4	10	30	22

SEMESTER III						
PCY14331	Applications of Quantum Mechanics and Group Theory	4	1	-	5	4
PCY14332	Molecular Spectroscopy	4	1	-	5	4
xxxxxxxx	Elective - 1(List IB)	4	1	-	5	4
xxxxxxxx	Elective - 2 (List II)	3	1	-	4	3
PCY14333	Advanced Physical Chemistry Practical	-	-	6	6	3
PCY14305	Applications of Computer in Chemistry	2	1	-	3	2
PCY14306	Mini Project*	-	-	2	2	2
Total		17	5	8	30	22
SEMESTER IV						
xxxxxxxx	Elective- 3 (List IB)	4	1	-	5	4
PCY14402	Career Comprehensive Course*	2	-	-	2	2
PCY14403	Project Work	-	-	12	12	12
Total		6	1	12	19	18
Total number of credits to be earned for the award of degree		80				

Mode for opting specialization: The number of seats in each specialization course would be upto a maximum of 30% of the total eligible candidates

LIST - I (B) (MAJOR ELECTIVES)

SEMESTER	SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	L+T+P	C
III	PCY14E03	Polymer Chemistry	4	1	-	5	4
	PCY14E04	Nuclear and Radiation Chemistry	4	1	-	5	4
IV	PCY14E53	Advanced Analytical Methods	4	1	-	5	4
	PCY14E54	Photo Chemistry Advanced	4	1	-	5	4

LIST - II (INTERDISCIPLINARY ELECTIVES)

SEMESTER	SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	L+T+P	C
III	PCY14E07	Scientific research methodology	3	1	-	4	3
	PCY14E08	Chemistry of nano science and Technology	3	1	-	4	3
	PCY14E09	Industrial Chemical Analysis and Quality Control	3	1	-	4	3
	PCY14E10	Environmental Chemistry	3	1	-	4	3
	PCY14E11	Industrial Chemistry	3	1	-	4	3

Note:

* - Continuous Assessment (Full Internals)

L – Lecture Hours, T – Tutorial Hours, P – Practical Hours & C – Credits

SEMESTER I

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14101	Inorganic Chemistry-I	3	3	-	6	4
INSTRUCTIONAL OBJECTIVES						
(i)	To study in depth about atomic structure , periodic table , bonding and structure					
(ii)	To gain knowledge about the main group chemistry					
(iii)	To acquire knowledge about coordination chemistry					
(iv)	To study in detail about the reaction mechanism of complexes					

UNIT I Atomic Structure and Periodic Table

Atom as nucleus with orbital electrons, concept of wave-functions, quantum numbers and spin, shape of s, p and d orbitals and their radial distribution functions, electronic configuration of atoms, Aufbau principle, Pauli Exclusion Principle and Hund's rule. Slater's rules for the determination of screening constants; arrangement of elements in Groups in the Periodic Table- s-block, p-block, d-block and f- block elements; periodic properties, ionic radii, ionization potential, electron affinity, electronegativity (Pauling, Mulliken and Aflred-Rochnow scales) atomic states and term symbols.

UNIT II Bonding and Structure

Types of bonds, ionic, covalent, coordinate, double and triple bonds, orbital symmetry and overlaps. Concept of MO and VB theory, concept of hybridization, the extent of d orbital participation in molecular bonding, bond energy and covalent radii. Concept of resonance, bond moment and molecular dipole moment; polarizing power and polarizability and Fajan's rules.

UNIT III Main Group Chemistry

Main Group Chemistry: Chemistry of boron – borane, higher boranes, carboranes, borazines and boron nitrides. Chemistry of silicon – silanes, higher silanes, multiple bonded systems, disilanes, silicon nitrides, siloxanes and silicates. P-Ncompounds, cyclophosphazenes and cyclophosphazanes. S-N compounds – S_4N_4,(SN)x.

Ionic Model-Lattice energy–Born-Lande equation – Kapustinski equation - High Tc superconductors–Solid state reactions–Types and examples.

UNIT IV Coordination Chemistry

Theories of Metal-Ligand bond: VB theory and its limitations – Crystal field theory - splitting of d-orbitals under various geometries – Factors affecting splitting–CFSE and evidences for CFSE (Structural and thermodynamic effects) – Spectrochemical series – Jahn Teller distortion – Spectral and magnetic properties of complexes – Site preferences - Limitations of CFT – Ligand field theory – MO theory – sigma – and pi-bonding in complexes–Nephelauxetic effect–The angular overlap model.

UNIT V Reaction Mechanism of complexes

Coordination Chemistry–Reaction Mechanism: Kinetics and mechanism of reactions in solution–labile and inert complexes – Ligand displacement reactions in octahedral and square planar complexes – acid hydrolysis, base hydrolysis and anation reactions – trans effect – theory and applications. Electron transfer reactions – electron exchange reactions – complementary and non-complementary types –inner sphere and outer sphere processes – Application of Electron transfer reactions in inorganic complexes - isomerization and racemization reactions of complexes – Molecular rearrangement – reactions of four and six- coordinate complexes – Interconversion between stereoisomers. Reactions of coordinated ligands–Template effect and its application for the synthesis of Macrocyclic ligands – Unique properties.

Text Books

1. Day, M.C and Selbin,J (1985): Theoretical Inorganic Chemistry, 2nd Edition, Affiliated East West Press Pvt.Ltd.
2. Cotton, F. A and Wilkinson,G (2009): Advanced Inorganic Chemistry,4th Edition, A Wiley- Interscience Publication,John–Wiley &Sons, USA.
3. Huheey, J.E (1983): Inorganic Chemistry, 3rd Edition, Harper & Rowpublisher, Singapore.

References

1. Kettle, S.F.A. (1996): Physical Inorganic Chemistry – A Coordination Chemistry Approach, Spectrum, AcademicPublishers, OxfordUniversityPress.
2. Adamson, A.W (1975): Inorganic Photochemistry,John Wiley&Sons,NewYork.
3. Basolo, F. and Pearson, R.G (1967): Mechanism of Inorganic Reactions, John Wiley, New York.

SEMESTER I

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14102	Organic Chemistry-I	3	3	-	6	4

INSTRUCTIONAL OBJECTIVES	
(i)	To gain knowledge on the importance of basic organic chemistry
(ii)	To acquire knowledge about aromaticity
(iii)	To understand the substitution reaction mechanisms
(iv)	To acquire knowledge in stereochemical aspects of organic molecules
(v)	To gain knowledge about the reagents and their application to organic chemistry

UNIT I Structure, Bonding and Reactive Intermediates

Structure and Bonding Localized Chemical Bonding: Electronic Structure of molecules; VB and MO - Inductive and Field Effects, Bond distances, Bond angles and Bond energies. Delocalized Chemical Bonding: Bond energies and Bond distances in compounds containing delocalized bonds - Cross conjugation- Resonance - Hyperconjugation and Keto – Enol tautomerism.

Reactive Intermediates: Generation, Structure, Stability and Reactivity of Carbocations and Carbanions, Free radicals, Carbenes, Nitrenes and Benzynes.

UNIT II Aromaticity

Huckel's theory of aromaticity, Concept of homoaromaticity and antiaromaticity.Electron occupancy in MO's. Systems with 2, 4, 8 and 10 electrons, systems of more than 10 electrons, alternant and non-alternant hydrocarbons (azulene type). Bonding properties of systems with$(4n + 2)\pi$ electrons and $4n\pi$ electrons, Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds. Annulenes, Sydnones and Fullerenes. NMR concept of Aromaticity

UNIT III Substitution Reactions

Aliphatic Nucleophilic substitutions: The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by σ and π- bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions and norbornyl system. The S_N^i mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate, attacking nucleophile, leaving group and reaction medium.

Aromatic Nucleophilic Substitution: The S_NAr, S_N1, benzyne and $S_{RN}1$mechanisms. Reactivity - effect of substrate, structure, leaving group and attacking nucleophile.

UNIT IV Stereochemistry

Fundamentals of Organic Stereochemistry: Principles of symmetry-Stereoisomerism-Optical isomerism-Definitions-Conventions used in Stereochemistry: Newmann, Sawhorse and Fischer notations and interconversions and representations. Nomenclature, correlation of configuration, Cahn-Ingold-Prelog rules for simple molecules, Optical activity and chirality-Types of molecules exhibiting optical activity-Fischer projection-absolute configuration. Molecules with more than one chiral center-molecular chirality-Atropisomerism-Biphenyl, allenes and spiranes. Methods of determining configuration.Prochiral centers-Asymmetric synthesis-racemisation and resolution.

Geometrical Isomerism: E&Z Nomenclature, Determination of configuration of geometrical isomers. Stereochemistry of addition and elimination reactions. Stereoselective and stereospecific synthesis (Elementary examples)Conformational Analysis. Basic concepts of conformation analysis-conformation of ethane, substituted ethane, n-butane and cyclohexane

UNIT V Reagents

Use of the following reagents in organic synthesis:, Diazomethane, Dicyclohexylcarbodiimide, DIBAL, Grignard, Lead tetraacetate, Lithium aluminium hydride, Lindlar's catalyst, N-Bromosuccinimide, Osmium tetraoxide, PCC, Raney Nickel, Selenium dioxide, Wittig reagent.

Text Books

1. March,J (2000): Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 5th edition, Wiley.
2. Morrison, R.Tand Boyd, R.N (1992): Organic Chemistry, 6th edition, Pearson.

References

1. Nasipuri, D (2002): Stereochemistry of organic compounds-Principles and applications,, 2nd edition, New Age International.
2. Bansal,R.K (1975): Organic Reaction Mechanisms, Tata McGraw Hill.

SEMESTER I

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14103	Physical Chemistry-I	3	3	-	6	4

INSTRUCTIONAL OBJECTIVES	
(i)	To understand the theories and concepts of electrochemistry.
(ii)	To suggest the applications of electrochemistry.
(iii)	To understand the thermodynamic properties and its determination.
(iv)	To make the students understand and appreciate the concepts of chemical kinetics.

UNIT I Ions in Solutions

Conductivity of solutions and their measurement - the Arrhenius ionisation theory - transport numbers and mobilities of ions - measurement of transport numbers - Hittorff method and moving boundary method - ionic activities and activity coefficients and their determination by various methods - Debye-Huckel-Onsager theory - ionic atmosphere - Debye-Huckel limiting law - dissociation constant of acids and bases.

UNIT II Electrochemical Cells

Electromotive force - measurement of EMF – the cell EMF and the cell reaction - reversible cells - types of half cells - classification of cells - the standard EMF of a cell - electrochemical potential - standard electrode potentials - calculation of the EMF of a cell - Nernst equation and its limitations - calculation of solubility products - standard free energies and entropies of aqueous ions - electrode concentration cells - electrolyte concentration cells - cells with liquid junctions - oxidation - reduction reactions, measurement of PH, concentration cells - decomposition voltages - concentration polarisation and over voltage - polarography.

UNIT III Chemical Kinetics - I

Simple collision theory, absolute reaction rate theory(ARRT),thermodynamic treatment, potential energy surfaces, application of ARRT to simple bimolecular process; chain reactions – general characteristics, study of kinetics of chain reaction like H_2-Br_2 reaction, decomposition of acetaldehyde and N_2O_5 ,study of H_2- O_2 explosive reactions. Theory of unimolecular reactions-Lindemann, Hinshelwood, RRKM and Slater treatment- steady state approximation, principle of microscopic reversibility and detailed balancing - kinetic isotope effect.

UNIT IV Chemical Thermodynamics

Second law of thermodynamics-concept of entropy-Gibbs function- Gibbs –Helmholtz equation- Maxwell relations- Thermodynamic equation of state- thermodynamics of systems of variable composition- partial molar quantities, partial molar volume-chemical potential, Gibbs-Duhem equation – Experimental determinations of fugacity of real gases. Third law of thermodynamics – absolute entropies-determination-exception to third law – Unattainability of absolute zero

UNIT V Surface Phenomenon and Catalysis

Introduction-adsorption of gases on solids- physisorption and chemisorptions, adsorption isotherms- Freundlich – Langmuir-BET-Temkin adsorption isotherm-Adsorption on liquid surface-surface tension-Gibbs's adsorption isotherm-surface area determination.

Specific and general acid-base catalysis. Bronsted catalysis law. Acidity functions. Enzyme catalysis (single substrate reactions only).Michaelis-Menton kinetics. Influence of pH and temperature on enzyme catalysis. Kinetics of heterogeneous catalysis (Langmuir Hinshelwood mechanism and Eley-Rideal mechanism)

Text Books

1. Gurudeep Raj (2006): Advanced Physical chemistry, 32nd edition, Goel Publishing House, Krishna Prakashan Media (P) Ltd.
2. Bockris J.O.M and Reddy, A.K.N (2008): Electrochemistry, volumes 1 and 2, Springer.
3. Laidler,J (1987): Chemical Kinetics, 3rd edition, Harper & Row.

References

1. Glasstone,S (2004) : An Introduction to Electrochemistry, Affiliated East West press, New Delhi.
2. Arthur W. Adamson, Alice P. Gast (1997): Physical chemistry of surfaces, 6thEdition,Wiley Eastern Ltd.
3. Glasstone, S (2012): Thermodynamics for chemists, East West press.

SEMESTER I

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14104	Nanochemistry	3	3	-	6	3

INSTRUCTIONAL OBJECTIVES	
(i)	To educate students on the basics of nanochemistry
(ii)	To make students understand the various techniques involved in the characterisation of nanomaterials
(iii)	To acquire knowledge on the synthesis of nanomaterials
(iv)	To envision the importance of nanomaterials

UNIT I Nanochemistry – An Introduction

Definition of nanodimensional materials - Some historical milestones in the saga of nano forms - Size effects - Importance of nanomaterials - Classification of nanomaterials - Simple examples of unique properties of nanosized materials - Elementary aspects of bionanotechnology - Some important recent discoveries innanoscience and technology.

UNIT II Techniques in Nanochemistry

Techniques for characterisation of nanoscale materials (Basic aspects): Atomic force microscopy (AFM)-Transmission electron microscopy (TEM)-Resolution and scanning transmission electron microscopy (STEM) Scanning Tunneling Microscopy (STM) Scanning nearfield optical microscopy (SNOM) and surface plasmon spectroscopy.

UNIT III Synthesis of Nanomaterials

Chemical methods in preparation of nanomaterials: Sol – gel technique – co-precipitation hydrolysis –sonochemical method – combustion technique – colloidal precipitation – template process.

Inorganic Nanoparticles and Nanoporous Materials: Oxide nano particles – Oxomolybdates – Nano catalysis – Porous silicon –Transition and Non transition metal phosphates.

UNIT IV Carbon Clusters and Nanostructures

Nature of carbon bond – New carbon structures – Carbon clusters: Discovery of C60 – Alkali doped C60 – Superconductivity in C60 – Larger and smaller fullerenes. Carbon nanotubes: Synthesis – Single walled carbon nanotubes –Structure and characterization – Mechanism of formation – Chemically modified carbon nanotubes – Doping – Functionalizing nanotubes – Application of carbon nanotubes. Nanowires – Synthetic strategies – Gas phase and solution phase growth – Growth control – Properties.

UNIT V Organic Films and Supramolecular Assembly

Organic films - insulating and passivating layers – electron transfer – Organicnanostructures – Optical properties – Organic semiconductors – Active organic devices. Polymerization – Sizes of polymers – Nanocrystals – Conductivepolymers – Block co-polymers. Supramolecular structures – Transition-metal mediated types - Dendritic molecules – Supramolecular dendrimers – Micelles –Biological nanostructures – Examples of proteins

Applications of nanomaterials: Applications of Nanoparticle in various fundamental research, industries, medical field and environmental issue; toxicity, biosafety and ethical issue in application of Nanoparticles.

Text Books

1. Rao, C. N. R, Muller,A and Cheetam, A.K. (Eds) (2004): The Chemistry of Nanomaterials, Vol.1, and 2, Wiley – VCH, Weinheim.
2. Poole,C. P and Owens,Jr: F. J (2003): Introduction to Nanotechnology Wiley Interscience, New Jersey.
3. Kenneth J. Klabunde (Ed) (2001), Nanoscale materials in Chemistry, Wiley-Interscience, New York.

References

1. Pradeep, T (2007): Nano: The Essentials in understanding nanoscience and nanotechnology, Tata McGraw Hill, New Delhi.
2. Gleiter,H (2000): Nanostructured Materials: Basic Concepts, Microstructure and Properties.
3. Tang, T and Sheng, P. (2004): Nano Science and Technology – Novel Structures and Phenomena, Taylor & Francis, New York, 2004.

SEMESTER I

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14105	Inorganic Chemistry Practical	-	-	6	6	3
INSTRUCTIONAL OBJECTIVES						
(i)	To enable the students, to apply the principle in the semi-micro analysis of an inorganic salt mixture.					

Semi – micro qualitative analysis:

Analysis of mixtures containing two familiar and two less familiar cations from the following W, Pb, Se, Te, Mo, Cu, Cd, As, Sb, Ce, Be, Th, Zr, Ti, V, Cr, Mn, U, Ni, Co, Zn, Ca, Ba, Sr, Li, Mr (insoluble and interfering anion may be avoided).

Any eight combinations of different salts.

General scheme for distribution of marks in practical examination

Time: 6 h (One day Examination) Marks: 50 (External) + 50 (Internal)
Identification of ions: 20 Marks
Procedure : 10 Marks
Record : 10 Marks
Viva-Voce : 10 Marks
Internal : 50 Marks
Total : 100

Text Books

1. Vogel's (1987): Qualitative Inorganic Analysis, Revised by G Svehla, 6th Edition, Longman.
2. Ramanujam,V.V (1974):Inorganic Semi-micro Qualitative Analysis", The National Publishing Co, Chennai.

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14201	Inorganic Chemistry-II	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To understand the various concepts of acids and bases
(ii)	To understand the basic principles of Ionic bond
(iii)	To gain knowledge in nuclear chemistry
(iv)	To educate students on the various spectroscopic techniques and its applications to some selected molecules

UNIT I Acids and Bases

Acids and Bases: Bronsted and Lewis acids and bases, pH, pKa, acid–base concept in non-aqueous media, buffer solution, Protonic acids – Proton Affinities –Differentiation and Leveling solvents – Hammet Ho scale – Acidic behavior of the binary hydrides – Cosolvating agents – Oxy acids – Organic acids – Acetic acid and the Inductive Effect, Aromatic Acids and Resonance Effects – Hydrolysis and Aquo acids – Basic precipitations – Amphoteric oxides – Nonprotonic concepts of Acid – Base reactions – Lux Concept – Solvent Ion theory of Acids and Bases – Liquid Ammonia, Acetic acid as a solvent, Bromine trifloride, Dinitrogen tetraoxide, Liquid hydrogen chloride – Hard and Soft Acids and Bases – Classification – Acid – Base strength and Hardness and Softness – Symbiosis – Theoretical basis of Hardness and Softness –Electronegativity and Hardness and Softness.

UNIT II Ionic Bond and Crystal Structure

Radius Ratio rules – Calculation of some limiting radius ratio values for C . N . 3 (planar triangle), C.N. 4 (tetrahedral), C.N. 6 (octahedral).Classification of Ionic structures – AX (ZnS, NaCl, CsCl), AX_2 (fluorite, rutile, beta-cristobalite) and AX_3types (Structures only), Layer structure – CdI_2, Nickel arsenide structures –Lattice energy–Born-Lande equation derivation–Important points arising from Born –Lande equation – Schottky defect and Frenkel defect – explanation and calculation of number of defects formed per cm^3– Metal excess defect – F centers and interstitial ions –Metal deficiency defect – positive ions absent – extra interstitial negative ions – Semiconductors and transistors – Rectifiers – Photovoltaic cell –Transistors–steps in the manufacture of memory chips for computers.

UNIT III Nuclear Chemistry

Radioactive decay – Theories of decay processes – Laws of radioactivity – Detection and measurement of radiations – Nuclear structure – Composition of nuclei –properties of nuclei – nuclear radii, nuclear spin etc – nuclear forces – its characteristics –Meson field theory – nuclear stability – characteristics – nuclear models – liquid drop, shell and collective models. Artificial radioactivity – Nuclear reactions transmutations, stripping and pickup, fission, fusion, spallation and fragmentation reactions – scattering reactions – nuclear cross section. Nuclear reactors – charged particle accelerators – neutron sources – gamma ray and X-ray sources. Applications of nuclear science in agriculture and biology – neutron activation and isotopic dilution analysis.

UNIT IV Spectroscopic Techniques

Infrared and Raman Spectroscopy: Structural elucidation of coordination compounds containing the following molecules/ions as ligands-NH_3,H_2O,CO,NO,OH^-,SO_4^{2-} CN^-,SCN^-,$NO^{2-}$and X^- (X=halogen).

Electron Paramagnetic Resonance Spectroscopy:

EPR of $d^1$and d^9transition metal ions in cubic and tetragonal ligand fields, evaluation of g values and metal hyperfine coupling constants.

UNIT V Studies and Applications of Lanthanides and Actinides

Spectral and magnetic properties, use of lanthanide compounds as shift reagents, Modern methods of separation of lanthanides and actinides, Organometallic chemistry applications of lanthanide and actinide compounds in Industries

Text books

1. Bodie, E. Douglas and Darl H.McDaniel (1970): Concepts and Models in Inorganic Chemistry, Indian Edition, Oxford & IBHPublishing Co, New Delhi.
2. Friedlander,J.W, Kennady and Miller,J.M (1981) :Nuclear and Radiochemistry, 3rd Edition.
3. Cotton and Wilkinson (1988): Advanced Inorganic Chemistry,5thed., John Wiley& Sons, NewYork.

References

1. Kaim,W and Schwederski, B (1994): Bioinorganic Chemistry, Inorganic elements in the Chemistry of Life, John Wiley & Sons, NewYork.
2. James E. Huheey, Ellen A Keiter and Richard L. Keiter (2006):Inorganic Chemistry –Principles of Structures and Reactivity,4thed, Addison-Wesley, NewYork.

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14202	Organic Chemistry– II	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To gain knowledge in the addition reactions and its applications
(ii)	To acquire knowledge about Elimination reactions
(iii)	To understand the rearrangements and its mechanisms
(iv)	To acquire knowledge in photochemistry of organic molecules
(v)	To gain knowledge in pericyclic concerted reactions

UNIT I Addition Reactions

Addition to Carbon - Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals - regio and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds - Hydrogenation of aromatic rings and Hydroboration. Sharpless asymmetric epoxidation.

Addition to Carbon - Hetero Multiple Bonds: Steric course of addition reactions to C=O and C=N, Cram's rule, Aldol condensation, Cannizzaro, Perkin, Knoevenagel condensations, Claisen - Schmidt, Claisen, Dieckman, Benzoin and Stobbe condensations, Wittig, Grignard, Mannich, Michael reaction. Hydrolysis of Carbon-Nitrogen bond, Isocyanates and isothiocyanates.

UNIT II Elimination Reactions, Esterification and Hydrolysis

Elimination Reactions: Types of elimination reactions, Mechanisms, Stereochemistry and Orientation. Hofmann and Saytzeff rules. Syn elimination versus anti- elimination, competition between elimination and substitution, factors influencing elimination and substitution reaction, dehydration, dehydrogenation, dehalogenations, decarboxylative eliminations, pyrolytic eliminations, molecular rearrangement during elimination and Fragmentation reactions.

Esterification and hydrolysis: Mechanism of hydrolysis of Esters, amides and acyl halides, Esterification of acids and trans esterification.

UNIT III Rearrangements

Rearrangement involving migration to electron-deficient carbon

Wagner-Meerwein, Pinacol-Pinacalone, Benzil-Benzilic, Wolf rearrangements.

Rearrangement involving migration to electron-deficient nitrogen

Beckmann, Hofmann, Curtius, Lossen, Schmidt rearrangements

Rearrangement involving migration to electron-deficient oxygen

Baeyer-Villiger oxidation, Hydroperoxide rearrangement.

Rearrangement involving migration to electron-rich carbon

Favorskii, Stevens, Neber rearrangements

UNIT IV Photochemistry

Organic Photochemistry – Fundamental concepts – Jablonski diagram – Energy transfer, characteristics of photoreactions, photoreduction and photoxidation, photoreactions of ketones and enones, Norrish Type I and II reactions. Photochemistry of alkenes, dienes and aromatic compounds, reactions of unactivated centres – Photolytic cycloadditions and photolytic rearrangements –Photosenstitisation – Photoadditions – Barton reaction – PaternoBuchi reaction.

UNIT V Pericyclic Reactions

Concerted reactions – stereochemistry-orbital symmetry and concerted symmetry and correlation diagram –Frontier molecular orbital approach – Woodward and Hoffmann rules – Electrocyclic reactions – cycloaddition reactions – sigmatropic rearrangements – selection rules and examples with simple molecules – 1,3 and 1,5 hydrogen shifts – Cope and Claisen rearrangements.

Text Books

1. March, J (2000): Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 5th edition, Wiley.
2. Morrison, R.T. and Boyd, R.N (1992): Organic Chemistry, 6th edition, Pearson.

References

1. Finar, I.L (1975): Organic Chemistry, Vol.II, 5th edition, ELBS.
2. Bansal,R.K (1975): Organic Reaction Mechanisms, Tata McGraw Hill.
3. CareyF.A and Sundberg,R.J (2002): Advanced Organic Chemistry, Parts A & B, Plenum, 2002

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14203	Physical Chemistry - II	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To have a good foundation in understanding the physical and mathematical aspects of quantum mechanics.
(ii)	To become familiar with the aspects of group theory.
(iii)	To understand and appreciate the concepts of statistical thermodynamics.
(iv)	To know about electrochemical phenomena.

UNIT I Electrochemical Phenomena

Evidences for electrical double layer. Electrocapillary phenomena-Electro capillary curves, Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential. Helmholtz-Perrin, Guoy-Chapmann and Stern models of electrical double layer-Applications and limitations.Kinetics of electrode process. Energy barrier at electrode surface- electrolyte interface, overpotential, Butler – Volmer equation, Tafel equation

UNIT II Chemical Kinetics II

Comparison between gas phase and solution reactions, Cage effect.The influence of the solvent on the reactions between ions and reaction between ions and neutral molecules. Influence of ionic strength on rates of reactions in solution. ARRT to reaction in solution, Significance of volume and entropy of activation.Primary and secondary salt effect.

UNIT III Statistical Thermodynamics

Aims of statistical thermodynamics, definition of state of a system, ensembles (microcanonical and canonical) Boltzmann distribution law and its derivation. Boltzmann-Planck equation: partition functions, thermodynamic properties from partition functions, partition function and equilibrium constant; Quantum statistics-Fermi Dirac and Bose-Einstein statistics, photon gas, electron gas according to such statistics: population inversion, negative Kelvin temperature, Einstein's and Debye's theories of heat capacities of solids. Nuclear spin statistics-statistical basis of entropy

of H_2 gas- ortho and para nuclear states- Calculation of entropy in terms of ortho- para ratio – residual entropy of H_2 at 0 K.

UNIT IV Basics of Group Theory

Symmetry elements and symmetry operations, group and its properties, Multiplication table, point symmetry groups. Schoenflies symbol, representations of groups by matrices, Irreducible representation of groups, the Great Orthogonality theorem, construction of character table (C_{2V}, C_{3v} only). Applications of group theory to normal modes analysis, Selection rules for fundamental vibrational transition – IR and Raman activity of fundamentals in H_2O,BF_3,– The rule of mutual exclusion.

UNIT V Basics of Quantum Mechanics

de-Broglie's concept, experimental verification- Compton effect - Heisenberg's uncertainty principle – derivation of Schrodinger wave equation - requirements of the acceptable wave function. Operators, linear operators, method of getting the following quantum mechanical operators: Position, Momentum, kinetic energy, potential energy, total energy, angular momentum. Hermicity and proving the quantum mechanical operators are Hermitian operation- commutator algebra-evaluation of commutators - eigen functions and eigen values - postulates of quantum mechanics.

Text Books

1. Prasad,R. K (2010): Quantum chemistry, 4th edition, New Age International.
2. Cotton F. A (2004): Chemical applications of group theory, 3rd edition, John Wiley& Sons.
3. Rajaram J (2013): Chemical Thermodynamics: Classical, Statistical and Irreversible, Dorling Kindersley (India)Pvt Ltd.

References

1. Bockris J.O.M and Reddy, A.K.N (2008): Electrochemistry, volumes 1 and 2, Springer.
2. Banwell, C.N (2013): Fundamentals of molecular Spectroscopy, 5thedition., TMH, New Delhi.
3. Gilbert W. Castellan (2004): Physical Chemistry, 4th edition, Narosa Publishing House.

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14204	Analytical Chemistry	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To learn the fundamental principles of analytical chemistry.
(ii)	To understand the difference between accuracy and precision, significance of figures, and be able to apply statistical analysis to rely on or reject results.
(iii)	To understand the different types of titrations and their applications.
(iv)	To understand the different chromatographic methods and their applications.

UNIT I Errors and Evaluations

Systematic and random errors, Effects of errors on analytical results, Accuracy, precision, Absolute and Relative errors, Significant figures, mean, mean deviation and median, standard deviation, variance, confidence limits, application of statistics, Reliability and rejection of results, Q test, Analysis of variance.

UNIT II Types of Titrations

Redox titration: Redox potentials, theory and feasibility of redox titration, calculation of potentials at different stages of titrations, redox indicators, their choice and applications.

Precipitation titrations: Theory and types, Mohr, Volhard and Fajan's methods. Adsorption indicators: theory, choice and applications.

Complexometric titrations: Theory, Stepwise and overall formation constants, Titrations involving chelates (EDTA). Metallochromic indicators: Theory and Choice, Masking and demasking methods and applications.

UNIT III Chromatography

Solvent extraction, principles, types and applications of paper, column, thin layer, gas and ion exchange Chromatographic techniques. Adsorbents, columns, detection methods, estimations, preparative column, GC, MS techniques: methods, principles and uses.

UNIT IV Thermal Methods of Analysis

Thermogravimetric analysis: Principle, Thermal analysis of silver nitrate, methods of obtaining thermograms, TGA, factors influencing the thermogram, Instrumentation, precautions in the use of thermo balance and applications.

Differential Thermo Analysis: Theory, principle, instrumentation and applications, DTA of calcium oxalate monohydrate, thermal analysis of calcium monohydrate.

Thermometric titrations: Theory, instrumentation, technique of thermometric titrations applications of thermometric titrations in complexometric and redox titrations.

UNIT V Electro analytical Techniques

Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Derivation of wave equation, Determination of half wave potential, qualitative and quantitative applications.

Amperometry: Basic principles, instrumentation, nature of titration curves and analytical applications.

Theory of Electrogravimetric analysis, electrode reactions, overpotential, completeness of deposition, electrolytic separation of metals with controlled cathode potential.

Textbooks

1. Skoog, D.A, West,D.M and Holler,F.J and Crouch,S.R (2007): Fundamentals of Analytical Chemistry, 8thEdn., Saunders College Pub.

2. Miller, J.C and Miller, J.N (1988): Statistics for Analytical Chemistry – Ellis Horwood. Chichester..

3.Skoog, Willard and Dean (1988): Instrumental methods of analysis. 8th Edition, East West Press, New Delhi. 1988.

References

1. Christian, G.D and J.E. O'Reilly (1986): Instrumental Analysis, Allyn& Bacon.
2. Sivasankar, B (2012): Instrumental methods of analysis, Oxford University Press
3. Kaur,H (2001): Instrumental methods of Chemical analysis, PragatiPrakashan, 1st Edition, Meerut.

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14205	Organic Chemistry Practical	-	-	5	5	3
INSTRUCTIONAL OBJECTIVES						
(i)	To understand the separation methods of organic mixtures.					
(ii)	To impart knowledge in the synthesis of organic compounds.					

Qualitative Analysis of an organic mixture containing two components.

Pilot separation, bulk separation, analysis, derivatization.

- Detection of elements (N, Cl, S) by Lassaigne's test
- Detection of the following functional groups by systematic chemical analysis: Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), Amido ($-CONH_2$, including imide), Phenolic –OH, Carboxylic acid (-COOH), Carbonyl ($>C=O$); only one test for each functional group is to be reported.

Preparation of Organic compounds (Single stage).

(a) 2,4,6-trinitrophenol(picric acid)from phenol (nitration)
(b) Benzophenoneoxime from Benzophenone (addition reaction)
(c) Benzophenoneoxime to Benzanilide(rearrangement)
(d) 4-nitrobenzoic acid to 4-nitrobenzanilide (Substitution)
(e) o-chlorobenzoic acid from anthranillic acid (Sandmeyer reaction)
(f) p-benzoquinone from hydroquinone (oxidation)
(g) 2,4,6-tribromophenol from phenol (bromination)

General scheme for distribution of marks in practical examination

Time: 6 h (One day Examination) Marks: 50 (External) + 50 (Internal)
Qualitative analysis: 10 Marks
Preparation : 10 Marks
Procedure : 10 Marks
Record : 10 Marks
Viva-Voce : 10 Marks
Internal : 50 Marks
Total : 100

Text Books

1. Vogel (1996): A Textbook of Practical Organic Chemistry, 5th edition, Prentice Hall,
2. Fieser and Fieser (2006): Reagents in Organic Synthesis, Wiley, 2006

References

1. Mann & Saunders (1960): Practical Organic Chemistry, 4th edition, Longmans.
2. Clarke.H. T (1975): A Handbook of Quantitative & Qualitative Analysis, Arnold Heinemann.
3. March,J (2000): Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 5th edition, Wiley.

SEMESTER II

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14206	Physical Chemistry Practical	-	-	5	5	3

INSTRUCTIONAL OBJECTIVES	
(i)	To motivate the students to understand the principles of chemical kinetics, potentiometric and conductometric titrations.
(ii)	To impart knowledge with respect to the phase transformation of different systems.

LIST OF EXPERIMENTS

1. Determination of rate constant of Acid hydrolysis of an ester.
2. Determination of molecular weight of substances by Rast method.
3. Determination of Critical Solution Temperature (CST) of phenol- water system and effect of impurity on CST.
4. Study of phase diagram of two components forming a simple eutectic.
5. Distribution of benzoic acid between water and benzene.
6. Adsorption of oxalic acid/acetic acid on charcoal.
7. Determination of E_a of saponification of Ester by conductometry method.
8. Determination of equivalent conductance, degree of dissociation and dissociation constant of weak acid by conductometry.
9. Determination of relative strength of two acids by conductance measurements.
10. Titration of $AgNO_3$ vs Halide mixture by potentiometry.
11. Redox titrations (MnO_4^- vs I^- / $Cr_2O_7^{2-}$vs Fe^{2+}) by potentiometry.
12. Determination of dissociation constant of weak acids by potentiometry.

General scheme for distribution of marks in practical examination

Time: 6 h (One day Examination) Marks: 50 (External) + 50 (Internal)
Observations including tables and figures: 20 Marks

Procedure	: 10 Marks
Record	: 10 Marks
Viva-Voce	: 10 Marks
Internal	: 50 Marks
Total	**: 100**

Text Books

1. Yadav, J. B (2005): Advanced Practical Physical Chemistry, 22nd edition, Goel publishing House, Krishna Prakashan Media Ltd.
2. Venkatesan, V,Veeraswamy, R and Kulandaivelu, A.R (1997): Basic Principles of Practical Chemistry", 2nd edition, Sultan Chand and Sons Publication, New Delhi.

References

1. Findlay's (1985): Practical Physical Chemistry, Revised and edited by B.P. Levitt 9th edition, Longman, London.
2. Chatwal, G.R. andAnand,S.K (2000): Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Delhi.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14331	Applications of Quantum Mechanics and Group Theory	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To have a good foundation in understanding the physical and mathematical aspects of quantum mechanics.
(ii)	To become familiar with the required mathematics for solving quantum mechanical problems.
(iii)	To understand and appreciate the quantum mechanical approach to the atomic and molecular electronic structure.
(iv)	To know the main applications of group theoretical methods.

UNIT I Application of Quantum Mechanics to Atoms

Particle in a box (1D & 3D), degeneracy and its application to linear conjugated molecular systems, free particle. Bohr's correspondence principle.

Rigid Rotor: wave equation and solution calculation of rotational constants and bond length.

Harmonic Oscillator: wave equation and solution, an harmonicity force constant and its significance.

UNIT II Application of Quantum Mechanics to H-Atom

Schrodinger wave equation for hydrogen atom, separation of variable in polar spherical coordinates and its solution, principle, azimuthal and magnetic quantum numbers and the magnitude of their values, probability distribution function, radial distribution function and shape of atomic orbitals (s, p & d).

UNIT III Application of Quantum Mechanics to Multi - Electron Atoms

Approximation methods applied to many electron atoms and diatomic molecules- Need for approximation methods, Schrodinger equation for He atom, the perturbation theory (first order only), the variation method, secular equation and secular determinants. Hatree-Fock self- consistent method of many electron system and its application to He atom, electron spin and pauli's principle.

UNIT IV Applications of Group Theory to Molecular Vibrations and Chemical Bonding

Symmetry of normal modes of vibrations for NH_3, N_2F_2, HCN. Application to bonding theory – hybridization (AB_3, AB_4)

UNIT V Applications of Group Theory to Molecular Orbital Theory and Electronic Transition

Group theory and quantum mechanics, wave functions as a basis of irreducible representations; HMO theory-HMO calculation and delocalization energy for cyclopropenyl, butane and benzene systems. Electronic transitions for formaldehyde and benzene.

Text Books

1. Prasad,R. K (2010): Quantum chemistry, 4th edition, New Age International Publishers.
2. Chandra, A.K(2002): Introductory quantum chemistry, 4th edition, Tata McGraw – Hill, New Delhi.
3. Raman, K. V (1994): Group Theory and its application to chemistry, Tata McGraw-Hill, New Delhi.

References

1. Ira. N. Levine (2013): Quantum chemistry, 7th edition, Prentice Hall of India Pvt Ltd.
2. Cotton, F. A (2004): Chemical applications of group theory, 3rd edition John Wiley & Sons.
3. Molloy K C (2011), Group Theory for Chemists: Fundamental Theory and Applications, 2nd edition, Woodhead Publishing.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14332	Molecular Spectroscopy	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To know the interaction of electromagnetic radiation with matter and representation of spectra.
(ii)	To understand the mathematical foundations and selection rules of different branches of spectroscopy.
(iii)	To apply the principles of spectroscopy for the structural determination of molecules

UNIT I Physical Principles of Spectroscopy

Introduction to electromagnetic radiationand its interaction with atoms and molecules - Quantization of energy- regions and representation of spectra-Resolution and intensity of spectral transition: signal to noise ratio, width and intensity of spectral lines-selection rules- Einstein absorption and emission coefficient -Fourier transform spectroscopy-Induced emission.

UNIT II Microwave Spectroscopy

Rotational spectra of diatomic molecules - Rigid rotators: rotational energy levels, intensity of spectral lines, selection rules, effect of isotopic substitution-Non-rigid rotators: rotational transitions, centrifugal distortion constant- Rotational spectra of linear and symmetric top polyatomic molecules- Microwave spectrometer-Information derived from rotational spectra.

UNIT III Molecular Vibrational Spectroscopy

Harmonic and anharmonic vibrations: wave functions, selection rules, Morse oscillator-Diatomic vibrating rotator: Born-oppenheimer approximation, vibration-rotation spectra, selectional rules, P, Q, R branches- Vibrational motion in Polyatomic molecules: symmetry and fundamental vibrations, normal modes, overtones, combination, difference bands-Fermi resonance-concept of group frequencies.

Raman spectroscopy: Theories of Raman scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual exclusion principle- Rotation-vibration Raman spectra of diatomic molecules. Molecular structure determination from Raman and Infra-red spectroscopy

UNIT IV Electronic Spectroscopy

Electronic spectroscopy of diatomic and polyatomic molecules- Intensity of vibrational electronic spectra- Franck- Condon principle-rotation fine structure of electronic vibrational spectra- the Fortrat parabola-Dissociation and predissociation spectra.
Photoelectron spectroscopy (PES): principle and techniques of PES, ultraviolet PES, X-ray PES, Auger electron spectroscopy.

UNIT V Spin Resonance Spectroscopy

Spin and an applied field; the nature of spinning particles, interaction between spin and magnetic field, Larmor precession, population of energy levels. Nuclear Magnetic Resonance Spectroscopy: Hydrogen Nuclei-The chemical shift-The coupling constant-Coupling between several nuclei-Analysis by NMR technique.
Electron spin resonance spectroscopy: The theory of E.S.R- The position of E.S.R. absorption-The g factor- The fine and hyperfine structures of E.S.R. absorption-Applications of E.S.R. spectroscopy.

Text Books

1. Banwell, C.N (2013): Fundamentals of molecular Spectroscopy, 5th edition., TMH, New Delhi.
2. Gurudeep Raj (2006): Advanced Physical chemistry, 32nd edition, Goel Publishing House, Krishna Prakashan Media (P) Ltd.
3. Barrow.G.M (1993):Introduction to Molecular spectroscopy, Tata McGraw- Hill Publishers.

Reference

1. Atkins,P. W and De Paula,J. (2002):Physical Chemistry, 7th ed., Oxford University Press, Oxford.
2. Jeanne L. McHale (2008): Molecular Spectroscopy, Pearson(Computing)
3. Drago,R. S(1992) : Physical Methods in Chemistry, 2nd edition, Saunders, Philadelphia

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14333	Advanced Physical Chemistry Practical	-	-	6	6	3

INSTRUCTIONAL OBJECTIVES	
(i)	To motivate the students to understand the principles of potentiometric and conductometric titrations.
(ii)	To impart knowledge with respect to the verification of the laws and apply the principles of conductometric and potentiometric titrations in their future research work.

LIST OF EXPERIMENTS

1. Verification of Onsager equation by conductivity method.
2. Verification of Kohlrausch's law by conductivity method.
   Conductometric titrations:
3. Titration of weak acid against strong base
4. Titration of mixture of acids against strong base.
5. Estimation of CH_3COOH and CH_3COONa in a buffer.
6. Titration of K_2SO_4vs $BaCl_2$
7. Titration of mixture of halides (Chloride + Iodide) vs $AgNO_3$
   Potentiometric titrations:
8. Titration of $AgNO_3$vs Halide mixture
9. Redox titrations
   - MnO_4^- vs I^-
   - $Cr_2O_7^{2-}$vs Fe^{2+}
   - Ce^{4+}vs Fe^{2+}
10. Determination of dissociation constant of weak acids by conductivity and potentiometric methods.
11. Solubility product by conductivity and potentiometric methods.
12. Stability constants of complexes by the use of pH meter, potentiometric method.
13. Determination of pH of a buffer solution using quinhydrone electrode.

References

1. Findlay's (1985) : Practical Physical Chemistry, Revised and edited by B.P. Levitt 9th ed., Longman, London,
2. GurturJ. N. andKapoor, R (1987): Advanced Experimental Chemistry", Vol. I, S. Chand & Co., Ltd, New Delhi.
3. Yadav, J. B (2001): Advanced Practical Physical Chemistry, 20th edition, Goel publishing House, Krishna Pakashan Media Ltd.,
4. Chatwal,G.R and Anand, S.K (2000): Instrumental Methods of Chemical Analysis,Himalaya Publishing House, Delhi

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14305	Applications of Computer in Chemistry	2	1	-	3	2
INSTRUCTIONAL OBJECTIVES						
(i)	To introduce the basics of computers.					
(ii)	To learn C language and its applications in solving problems in Chemistry					

UNIT I Recapitulation of Computer Basics

PC hardware, operating systems, data storage and backup, networks, information technology.Basic operations using windows.

UNIT II Computer Programming

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language.BASIC keywords and commands.Logical and relative operators.Strings and graphics.Compiled versus interpreted languages.

UNIT III Word Processing- I

Handling numeric data: spreadsheet software (Excel), simple calculations, statistical analysis, plotting graphs using a spreadsheet (radial distribution curves for hydrogenic orbitals, gas kinetic theory, spectral data, pressure-volume curves of van der Waals gas, data from phase equilibria studies), graphical solution of equations, solving equations numerically (e.g. pH of a weak acid ignoring/ not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Word Processing- II

Numeric modelling, numerical curve fitting, linear regression (rate constants from concentration- time data, molar exinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric titrations), integration (e.g. entropy/enthalpy change from heat capacity data).Numerical solution of differential equations (e.g. kinetics).

UNIT IV Molecular Modelling

Visualization of 3D structures, calculation of molecular structures and properties (e.g., conformational energies of butane, rotation of 1,3-butadiene, distribution of isomers, energies of orbitals and total energy as a function of bond angle for H_2O, simulation of Diels-Alder reaction, SN_2 reactions).

UNIT V Chemical Information on the Web

Chemical abstracts. Structures and properties.

Software: Microsoft Office, Chem Office, Microcal Origin, Scifinder, scopus, literature search (ACS, RSC, Wiley interscience (Free alternatives: Open Office (www.openoffice.org), ISIS Draw (http://www.mdli.com; registration required), ArgusLab (www.planaria-software.com).

Text Books

1. Noggle, J. H (1985):Physical chemistry on a Microcomputer. Little Brown & Co.
2. Venit, S.M (1996):Programming in Basic: Problem solving with structure and style.Jaico Publishing House, Delhi.

References

1. Engel, T. & Reid, P (2010): Physical Chemistry, 2nd Ed. Pearson.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14306	Mini Project*	2	-	-	2	2

PURPOSE

To under take project in the relevant field of study

The student is free to pickup any topic for the mini project under the supervision of faculty member the project internally will be evaluated by the supervisor and the end semester assessment by duly appointed examiner (s)

Assessment Tool Weightage

Review I – 25 Marks

Review II –25 Marks

Review I & II Mark Distribution

Novelty	-5 Marks
Submission of hard copy	-20 Marks
Presentation	-20 Marks
Interactive session	-5 Marks
Total	- 50Marks
Total	**100 Marks**

LIST-II (INTERDISCIPLINARY ELECTIVES)

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E07	Scientific Research Methodology	3	1	-	4	3

INSTRUCTIONAL OBJECTIVES	
(i)	To know the purpose and importance of research for future development in science.
(ii)	To familiarize the methodology behind the laboratory techniques
(iii)	To learn the ways of carrying out literature review
(iv)	To know the methodology of writing thesis and journal articles.

UNIT I Introduction

Nature and importance of research - aims, objective, principles and problems - selection of research problem - survey of scientific literature - primary and secondary sources - citation index for scientific papers and journals - patents.

UNIT II Conduct of Research Work

Physical properties useful in analysis and methods of separation prior to analysis - Isolation techniques - extraction - Soxhlet extraction, crystallization, sublimation - methods for vacuum sublimation and distillation under reduced pressure.

Chemistry of working with hazardous materials - acid / water sensitive, corrosive, toxic, expolsive and radioactive materials.

UNIT III Data Collection and Analysis

Execution of research –observation and collection of data -Methods of data collection: Experimental data, field data, data from other sources-Sampling method –Data processing and analyzing: Precision and accuracy - Reliability - determinate and random errors - distribution of random errors - normal distribution curve. Statistical treatment of finite samples - the student's t test and F test - Criteria for rejection of an observation - the Q test, significant figures and computation rules - data plotting - least square analysis.

UNIT IV Scientific Writing

Scientific writings: research reports, theses, journal articles, and books.

Steps to publishing a scientific article in a journal: types of publications communications, articles, reviews; when to publish, where to publish, specific format required for submission, organization of the material.
Documenting: abstracts-indicative or descriptive abstract, informative abstract, footnotes, end notes, referencing styles, bibliography-journal abbreviations (CASSI), abbreviations used in scientific writing. Patent writing and filing

UNIT V Computer Usage in Research

Searches of Literature: ASAP Alerts, CA Alerts, SciFinder, ChemPort, ScienceDirectSTN International. Journal home pages.Preparing research papers: Using word processing software – MS office/Latex/others, Drawing graphs and diagrams – Origin/Excel/others. Seminar presentations – Power point for oral and poster presentations. Different file formats particularly useful in research communication (pdf, jpg, jpeg, djvuetc)

Text Books

1. Kothari, C.R (1990): Research Methodology: Methods and Techniques, New Age International.
2. Sinha, S.C. and Dhiman, A.K (2002):Research Methodology, 2 volumes, Ess Publications.
3. Coley, S.M. and Scheinberg, C. A. (1990):Proposal Writing,Sage Publications.

Reference

1. Fink, A (2009): Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
2. Douglas A. Skoog, Donald, M. West, F. James Holler & Stanley R. Crouch (2013): Fundamental of analytical chemistry, 9th Edition, Mary Finch.
3. H. F. Ebel, C. Bliefert and W. E. Russey (1988): The Art of Scientific Writing, VCH, Weinham.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E08	Chemistry of Nanoscience and Technology	3	1	-	4	3

INSTRUCTIONAL OBJECTIVES	
(i)	To understand the basic concept of nano Science and Technology.
(ii)	To acquire knowledge about synthesis, preparation and characterization of nanomaterials
(iii)	To gain knowledge on application of nanomaterials.

UNIT I Basic Aspects of Nanotechnology

Introduction and classification - What is nanotechnology - Classification of nanostructures - Nanoscale architecture - How nanoscale dimensions affect properties - Carbon and inorganic nanostructure - self assembled materials - Making thin organic films –nanopatterning surfaces by self-assembly - Templated nanostructures.

UNIT II Characterization Methods

X-ray diffraction - XPS Working Principle, Instrumentation and Applications.Impedance Analysis - Micro hardness - nanoindentation– Nuclear Magnetic Resonance (NMR). Differential scanning calorimeter (DSC)- Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA)-UV-Visible Spectrophotometer - FTIR – Principle and Applications – Photoluminescence (PL) Spectroscopy.

UNIT III Lithographic Methods

Introduction – Lithography – Photolithography - Phase-shifting photolithography - Electron beam lithography - X-ray lithography - Focused ion beam (FIB) lithography - Neutral atomic beam lithography - Nanomanipulation and Nanolithography - Soft Lithography - Assembly of Nanoparticles and Nanowires Other Methods for Microfabrication.

UNIT IV Sensors

Static and Dynamic Characteristics - Inorganic Nanotechnology Enabled Sensors - Gas Sensing with Nanostructured Thin Films - Nanotechnology Enabled Mechanical Sensors - Nanotechnology Enabled Optical Sensors - Magnetically Engineered Spintronic Sensors - Organic Nanotechnology Enabled Sensors - Surface Materials and Surface Modification.

UNIT V Energy Devices

Nanoscale Electronic and Ionic Transport – Energy Conversion and Storage in Electrochemistry - Overview of the Principles of Operation of Energy Conversion and Storage Devices - Solar Cells -Nanomaterials and Nanostructured Films as Electro active Electrodes - Nanomaterials as Electrolytes - Lithium Ion Batteries - Fuel Cells. Quantum Dot Sensitizers.

Text Books

1. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan (2005): Nanoscale Science and Technology John Wiley & Sons, Ltd., UK.
2. Pradeep,T (2008): Nano: The Essentials: Understanding Nanoscience and Nanotecnology, Tata McGraw-Hill Publishing Company Limited, New Delhi.

References

1. Rao,C. N. R, Thomas,P. J. andKulkarni,G. U (2007): Nanocrystals: Synthesis, Properties and Applications, Springer .
2. Kourosh Kalantar-zadeh and Benjamin Fry (2008): Nanotechnology - Enabled Sensors,Springer.
3. Guozhong Gao (2004): Nanostructures & Nanomaterials: Synthesis, Properties & Applications, ImperialCollegePress .

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E09	Industrial Chemical Analysis and Quality Control	3	1	-	4	3

INSTRUCTIONAL OBJECTIVES	
(i)	To study in detail about toxic and hazardous chemicals
(ii)	To gain knowledge about green chemistry
(iii)	To understand the basics of clinical health and first aid safety

UNIT I Environmental Management of Toxic and Hazardous Chemicals

Introduction to toxic and hazardous chemicals, Procedure for working with substances that pose flammable or explosive hazards, Incineration of hazardous chemicals.Identification, classification and segregation of industrial toxic/hazardous chemicals, Recovery, recycling and reuse of industrially important chemicals.

UNIT II Small Scale Industry and R & D Technology Transfer

Need and scope of small scale, Industry, SSI rules and regulations, Registration, Licensing, Incentives, Factory act, Labor laws, FDA, export-import regulations, and tax benefits, Role of R and D, Functional structure of R&D Unit, Research strategies and manufacturing interface

UNIT III Green Chemistry

Introduction, Twelve principles of Green Chemistry with their explanations and examples; designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, and aromatic amines(4-aminodiphenylamine), benzyl bromide, disodium iminodiacetate (alternative to strecker synthesis), citral, ibuprofen, paracetamol.

UNIT IV Clinical Health and First aid Safety

Definition of Health, WHO standard, Sterilization of surgical instruments.Biochemical analysis of urine and serum. Blood - Composition, grouping and Rh factor. Treatment of shock, haemorrage, cuts and wounds. Burns – classification and first aid. Asbestos,

silica, lead paints, cement, welding fumes and gases - Hazard alert and precautions for safety.

UNIT V Indian Industrial Scenario and Quality Control in Industries

Survey of Indian chemical industries, Indian mineral resources, ferrous metallurgy, heavy chemical industries, nonferrous metals Fine chemicals and pharmaceuticals, natural products and agro-based chemicals, contribution of fertilizers and pesticide, Quality Control Role, Government standards like ISI, MINAS, Agmark, I. P., D. P., U.S.P concepts of quality and quality control.

Text Books

1. Mukharjee,R. R (1984): Elements of Quality Control (Vani Ed Books).
2. Tulsi, S. K (1980): Incentives for Small Scale Industries (ESRS).

References

1. Gerstenfield , A (1980): Effective Management of R & D.
2. Ahluwalia, V.K. &Kidwai M.R (2005): New Trends in Green Chemistry, AnamalayaPublishers.
3. Matlack, A.S. (2001): Introduction to Green Chemistry, Marcel Deckkar

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E10	Environmental Chemistry	3	1	-	4	3

INSTRUCTIONAL OBJECTIVES	
(i)	To study in detail about ecosystem and biodiversity
(ii)	To gain knowledge about the energy resources
(iii)	To discuss in detail the various social issues

UNIT I Energy and Environment

Energy resources and their exploitation, Sun as source of energy- nature of its radiation, Conventional energy sources: coal, oil, biomass and nature gas, non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltaic, solar ponds, nuclear-fission and fusion, magneto-hydrodynamic power (MHD), Energy use pattern in different parts of the world and its impact on the environment. CO_2 emission in atmosphere.

Mechanism of radiation action on living systems- Stochastic and Non-stochastic effects; delayed effects, radioactivity from nuclear reactors, fuel processing and radioactive waste, hazards related to power plants, terrestrial and non terrestrial radiation, dose from environment and nuclear radiations, ultraviolet radiations, pathways analysis and dose assessment, radiologic age dating, radioactivity risk assessment, criterion for safe exposure.

UNIT II Ecosystem, Biodiversity and its Conservation

Biodiversity concepts and patterns, Microbial diversity, Plant diversity, Agrobiodiversity, Soil biodiversity, Economic value of biodiversity, biodiversity losses. Biodiversity hotspots and their characteristic flora and fauna, threatened plants and animals of India, ecosystem people and traditional conservation mechanisms, Biodiversity Convention and Biodiversity Act, IPRs, national and international programmes for biodiversity conservation.

Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act 1972. In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore back, DNA bank.

UNIT III Energy Resources and Maintenance

Renewable and non-renewable energy resources, growing energy need, sun as source of energy, solar radiation and its spectral characteristics, fossil fuels classification, com position. Physico-chemical characteristics and energy content of coal, petroleum and natural gas. Principle of generation and conservation of conventional and non-conventional energy. Energy from biomass and biogas, an aerobic digestion, energy use pattern and future need projection in different parts of the world, energy conservation policies.

UNIT IV Solid and Hazardous Waste Management

Solid wastes: Definition, types, sources, characteristics, and impact on environmental health. Waste generation rates. Concepts of waste reduction, recycling and reuse. Collection, segregation and transport of solid wastes Handling and segregation of wastes at source. Collection and storage of municipal solid wastes. Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery.

Composting, Vermicomposting, Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; secure landfills and landfill bioreactors; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Hazardous wastes: Definition, sources and characteristics: Hazardous waste categorization, generation, collection, transport, treatment and disposal. Legislation on management and handling of municipal solid wastes and hazardous wastes.

UNIT V Social Issues

Urban issues - Energy - water conservation - environmental ethics - global warming - resettlement and rehabilitation issues - environmental legislations - environmental production Act. 1986 - Air, Water, Wildlife and forest conservation Act - Population growth and Explosion - Human rights and Value education - environmental health - HIV/AIDS - Role of IT in environment and human health - Women and child welfare - Public awareness.

Text Books

1. Sharma,B.K. andKaur, H (1996): Environmental Chemistry, Goel Publishing House, Meerut, India.
2. Jadhav,H.V (1992): Elements of Environmental Chemistry, Himalaya.
3.Samir.K.Banerji (1999): Environmental Chemistry,PHI Learning Pvt. Ltd.

References

1. Moore, J. W. and Moore, E. A (1976): Environmental Chemistry, Academic Press, New York.
2. Lunn, G. and Sansone,E.B (1990): Destruction of hazards chemicals in the laboratory,Wiley, New York.
3. Dara, S.S (2005): A Text book of Environmental Chemistry and Pollution Control 8thEdn, Publisher, S. Chand & Company.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E11	Industrial Chemistry	3	1	-	4	3

INSTRUCTIONAL OBJECTIVES	
(i)	To study in detail about the raw materials and energy required for the chemical industry
(ii)	To gain knowledge about the surfactants, pesticides and explosives
(iii)	To gain in depth knowledge about the various spectroscopic techniques used in industrial analysis of samples.

UNIT I Raw Materials and Energy for Chemical Industry

Raw materials – Characteristics of raw materials and their resources – methods of raw material concentrations–integral utilization of raw materials.

Energy for chemical industry–Fuels–classification of fuels–coal–fuel gases and liquid fuels–petroleum–cracking–Octane number–cetane number–composition and uses of coal gas, water gas, producer gas, oil gas and gobar gas.

UNIT II Surfactants, Explosives, Pesticides

Surfactants: Classification with examples, Adsorption and micelle formation, Manufacture of anionic, cationic, zwitterionic and nonionic detergents, Applications in industries Applications as Foaming agent, Wetting agent, Dispersant, Solubilizers, Emulsifiers and Rheology modifiers, Detergent formulations, Detergent biodegradation, Biosurfactants.

Explosives: Classification, characteristics, preparation of nitrocellulose-T.N.T, Picric acid, Dynamite-cordite and Gunpowder, Dynamite, HMX, PETN, Cyclonite, plastic explosives, gelatin, RDX, cordite and seismic explosives, propellants-manufacture of liquid and solid propellants-hydrazine, incendiaries and smoke screens. Industrial applications.

Pesticides: Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, malathion, carbaryl) compounds family, Plant pesticides, Pesticide formulations.

UNIT III Cement, Ceramics, Polymeric Materials, Glass, Paints and fertilizers

Cement: Manufacture – Wet Process and Dry process. Types, Analysis of major constituents, setting of cement, reinforced concrete. Cement industries in India.

Ceramics: Important clays and feldspar, glazing and verification.

Polymeric Materials: Industrial polymers (Thermoplastics polymers and thermosetting Polymers) and composite materials–their constitutions, chemical and physical properties, Industrial applications.

Glass: Types, Composition, manufacture of Optical glass, colored glasses, lead glass and neutron absorbing glass.

Fertilizers: Fertilizer industries in India, Manufacture of ammonia, ammonium salts, urea, superphosphate, triple superphosphate and nitrate salts.

Paints: Components of paints,pigments, thinner, binder, types of paints, water based paints, drying of paints

UNIT IV Industrial Chemical Analysis

Sampling procedures, sampling of bulk materials, techniques of sampling–solids, Liquids and gases. Collection and processing of data.

Chromatography: Principles, working and applications of paper chromatography, TLC, GLC, HPLC.

Particle size determination, rheological properties of liquids, plastics and their analysis. Modern Instrumental Methods of analysis–UV-visible spectroscopy-IR spectroscopy and non-dispersive IR- Raman spectroscopy-NMR Spectroscopy-Electron spin resonance spectroscopy-Atomic absorption spectroscopy-Flame photometry-Neutron diffraction-X-ray fluorescence-Ion chromatography

UNIT V Industrial Hygiene and Chemical Safety

(a) Industrial hygiene: Concept, air and biological monitoring, occupational disease, operational control measures, personal protective equipments; (b) Industrial hazards and Safety: Process hazards checklists, hazard surveys, safety program, Hazop safety reviews. c) Industrial pollution: Classification of hazards chemicals, storage, transportation, handling, risk assessments, challenges/solutions (d)Eco-friendly effluents disposal: Water pollutants, health hazards, sampling and analysis of water, water treatment, different industrial and domestic effluents and their treatment and disposal, advanced waste water treatment, effluent quality standards and laws, chemical industries, tannery, dairy, textile effluents, common treatment.

Text Books

1. Mukhlyonov (ed.) (1979): Chemical Technology ,Vol.1, 3rd Edition, Mir publication, Moscow.
2. De.,A.K. (1989): Environmental Chemistry,WileyEasternLtd.,11th edn., Meerut.
3. Sharma, B.K (1997): Industrial Chemistry, Goel publishing house.

References

1. Norris Shreve, R. and J.A.Brink (1977): Jr. Chemical Process Industries. 4thedn.McGrawHill, Tokyo.
2. Chakrabarty, B.N (1981): Industrial Chemistry, Oxford & IBH Publishing Co., New Delhi.

LIST (1B) ELECTIVES

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E03	Polymer Chemistry	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To know about the basic concepts of polymer science
(ii)	To envision the importance of polymers.
(iii)	To identify various mechanism of polymerization.
(iv)	To set research goals in the highly topical areas of research in polymer chemistry.

UNIT I

Basic concepts of Polymer Science: Molecular forces and chemical bonding in polymers – Classification of polymers – Chain polymerization – Step polymerization – polymerization techniques.

Molecular weight and size: Number average, Weight average, Sedimentation and Viscosity average molecular weight – Degree of polymerization – size of polymer molecule.

UNIT II

Kinetics of Polymerization: Free radical polymerization- Cationic polymerization - Anionic polymerization - Poly condensation.

Glass transition temperature: Definition - Factors influencing glass transition temperature - Relationship between glass transition temperature and molecular weight, Plasticisers and melting point – importance of glass transition temperature.

UNIT III

Crystalline Nature: Crystalline soils and their behaviour towards X-rays – Polymers and X-ray diffraction – Degree of crystallinity – crystallites –factors affecting crystallinity, Helix structures.

Copolymerization: Free radical copolymerization – Ionic copolymerization – Copolycondensation – Individual polymers: Polyethylene, polypropylene, polystyrene, poly acrylonitrile, polymethyl methacrylate, polyesters, polycarbonates, polyamides, polyurethanes, polyvinyl acetate, polyvinyl chloride, poly isoprenes, silicone polymers.

UNIT IV

Polymer degradation: Types of degradation, thermal and mechanical – photo degradation – oxidative and hydrolytic degradation. Polymer reactions – Hydrolysis, acidolysis, aminolysis, hydrogenation, addition and substitution reactions – cyclisation, cross-linking reactions – Graft and Block copolymers.

UNIT V

Experimental methods: Polymer synthesis, isolation and purification of polymers – Fractional - Molecular weight determination – Molecular weight distribution curve – determination of glass transition temperature. Elastomeric materials – Fibre forming materials – Plastic material Rheology of polymeric materials – compounding and processing techniques.

Text Books

1. SreedharJayadev, Vishwanathan,N.V, Gowarikar,V.R (2006): Polymer Science, New Age International Pub, USA.
2. Fred W. Billmeyer, (2008): Text Book of Polymer Science, 3rd edition, Wiley India.

References

1. Saunders,K. J (1988): Organic Polymer Chemistry, 2nd edition, Chapman and Hall.
2. Charles E. Carraher, Jr. (2003): Polymer Chemistry, 6th edition,Marcel Dekker Inc., New York and Based.
3. Kumar Gupta (1997): Fundamentals of Polymer Science and Engineering, 1st edition, Tata McGraw Hill.
4. Paul C Painter, (1998): Fundamentals of polymer science, 2nd edition, CRC Press INK.

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E04	Nuclear and Radiation Chemistry	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To gain knowledge about the fundamentals of nuclear structure, stability and radiations
(ii)	To familiarize about the types of nuclear reactions, nuclear sources and nuclear reactors.
(iii)	To have a wide knowledge about the radioisotopes, detection and applications.
(iv)	To equip the students for their future career in nuclear industry

UNIT I

Structure of nucleus

Composition of the nucleus-nuclear size, shape and density- nuclear moment: nuclear angular momentum, nuclear magnetic dipole moment, electric quadrupole moment - NQR- nuclear models: liquid drop model, nuclear shell model, fermi gas model.– nuclear configuration- parity and its conservation-mass defect and binding energy-nuclear forces theory.

UNIT II

Radioactive decay

Group displacement law-decay series-rate of disintegration-half life-average life-units of radioactivity-secular and transient equilibria -theories of alpha decay, beta decay, gamma emission, positron decay, nuclear isotherm, internal conversion and electron capture-Auger effect.

Radiation detection and measurement- Counters: Geiger counters, scintillation counters, proportional counters ,semiconductor detectors.

UNIT III

Nuclear fission and fusion:

Bethe's notation of nuclear process-nuclear reaction energies (Q value)- fission-energy release in nuclear fission-mass distribution of fission products-theory of nuclear

fission-fissile and fertile isotopes-energy from nuclear fusion- thermonuclear reactions in stars-classification of reactors-power nuclear reactor-breeder reactor- nuclear reactors in India.

Nuclear Resources in India:

Uranium and Thorium resources in India and their extractions, Heavy water manufacturing in India.

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UNIT IV

Radiation Chemistry

Sources of high energy radiation, Interaction of high energy radiation with matter, radiolysis of water – definition of G – value – mode of reactions of hydrated electrons.radiation dosimetry.

Radio isotopes: Co-precipitation, ion-exchange, solvent extraction - as a tracer, Synthesis of labeled compounds (any two), isotopic dilution and radiopharmaceuticals. Neutron activation analysis, positron annihilation and autoradiography.

UNIT V

Applications of radioisotopes

Characteristics of tracer isotopes - General principles of using radioisotopes, applications of radiotracers in physicochemical constants - diffusion coefficient, surface area, solubility, stability constant. Chemical pathways - kinetic studies, inorganic reactions, organic reactions, biosynthesis,polymerization. Trace analysis of elements and compounds - neutron activation analysis. Biological effects of Radiation-waste disposal.

Text Books

1. Gopalan, R. (2000): Elements of nuclear chemistry, Sultan Chand, Delhi,
2. Sharma, B.K. (2001): Nuclear and Radiation Chemistry, Goel Publishing Houses Ltd., 7th edition,.

References

1. Choppin, G.R (2002): Radiochemistry and Nuclear chemistry, 3rd edition, Butterworth Heinemann.
2. Arnikar, W.J (1995): Essentials of Nuclear Chemistry, 4thedition, New Age International Pvt. Ltd.
3. Friedlander, G, Kennedy, T. W and E. S. Macias and J. M. Miller, (1981).Introduction of Nuclear and Radiochemistry, 3rd Edition, John Wiley,

SEMESTER IV

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E53	Advanced Analytical Methods	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To know the principle and applications of electrochemical techniques.
(ii)	To elucidate the molecular structure by applications of chemical spectroscopy.
(iii)	To understand the basic concepts in surface imaging
(iv)	To know about biochemical analysis and the applications of sensors.

UNIT I Advanced Electrochemical Techniques

Principles, Instrumentation-Electrochemical scanning tunneling microscopy and Electrochemical Atomic force microscopy. Spectro-electrochemistry - Principle, applications. Impedance measurements, Chronomethods - Principles, Chrono-potentiometric –amperometric and coulometric measurements - Instrumentation and Applications.

UNIT II Applications of Chemical Spectroscopy

Infrared Spectroscopy: Fourier Transform infrared spectroscopy - Applications. Combined Applications - UV, IR, NMR and Mass in the elucidation of molecular structure.Chemical Analysis- Non-destructive techniques- Wavelength and energy dispersive X-ray fluorescence spectroscopy (WDS and EDS)-X-ray absorption spectroscopy (XANES and EXAFS)-Destructive technique- inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

UNIT III Surface Analytical Techniques

Basic concepts in surface imaging - Electron Spectroscopy for Chemical Analysis (ESCA): Principles, Instrumentation, and Analytical Applications. Auger electron spectroscopy: Principles, Instrumentation, Applications. Surface enhanced Raman Spectroscopy (SERS): Principles, Instrumentation, Nanoparticulate SERS substrates, Surface enhanced resonance Raman scattering (SERRS), SERRS of Ag and Au metal colloids, Thin solid films, Langmuir-Blodgett Monolayers, SERRS mapping and imaging, Applications.

UNIT IV Chemiluminescence

Introduction, principle, types. Measurement of chemiluminescence, Instrumentation quantitative chemiluminescences.Gas phase chemiluminescence'sanalysis.Electro-chemiluminescence.

UNIT V Bioanalytical Chemistry

Relevance of Bioa ssaying and Biochemical Analysis-Spectroscopic methods and fluorimetric methods-Quantitation of Enzymes and Optical Methods of Detection of Enzymes, Immobilization Methods, Mass Spectrometry of Biomolecules, Matrix-assisted laser desorption/ionization (MALDI); Electrochemical Sensors and Biosensors in Bioanalysis-Immunoassaying.

Text Books

1. Sharma, Y. R. (2007): Elementary Organic Spectroscopy-Principles and Applications, 5th Edition S. Chand Publishers.
2. Kamalesh Bansal, (2009): Analytical spectroscopy, Campus Book International.

References

1. Fritz Scholz, (2010):Electroanalytical Methods: Guide to Experiments and Applications, 2nd Edition, Springer,.
2. D J O'Connor, Brett A Sexton, Roger S C Smart (Eds) (2010): Surface Analysis Methods in Materials Science, 2nd Edition, Springer,.
3. John F Watts, John Wolstenholme, (2011): An Introduction to Surface Analysis by XPS and AES, 2nd Edition, Wiley VCH.
4. Susan R. Mikkelsen and Eduardo Cortón, (2004): Bio Analytical Chemistry, John Wiley & Sons Inc.

SEMESTER IV

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14E54	Photochemistry	4	1	-	5	4

INSTRUCTIONAL OBJECTIVES	
(i)	To know about the interaction of radiations with matter and photochemical laws.
(ii)	To classify various photochemical processes.
(iii)	To know about the kinetics of photochemical reactions.
(iv)	To equip the students for their future career in industries

UNIT I Basics of Photochemistry

Interaction of electromagnetic radiations with matter, types of excitations, Distinction ofphotoreactions from thermally initiated reactions and from high energy radiation reactions, absorption and emission of radiation - Franck - Condon Principle - decay of electronically excited states - Grothus& Draper law, law of photo chemical equivalence and law of absorption (Lambert Beer's law) and its limitation.

UNIT II Photochemical Process

Different types of molecular orbitals and electronic states, Intensities and selection rules for spectral transitions, types of electronic transitions in organic molecules, Jablonski diagram - radiative and non radiative processes - fluorescence and phosphorescence, Chemiluminescence - spin forbidden radiative transition - internal conversion and intersystem crossing - energy transfer process.

UNIT III Kinetics of Photochemistry

Kinetics of unimolecular and bimolecular photophysical processes - excimers and exciplexes - static and dynamic quenching - Stern-Volmer analysis. Experimental methods - quantum yield and life time measurements- Stopped Flow techniques, Flash photolysis - steady state principle - quantum yield and chemical actinometry. Kinetics of photochemical reactions: hydrogen and halogen reactions.

UNIT IV Photochemical Cells and Photosensitization

Photoelectric effect , photovoltaic cells, photogalvanic cells, photoelectrochemical cells and photo assisted electrolysis of water, aspects of solar energy conversion, Photosensitization- Photosensitized reactions by Mercury, Chlorine and Chlorophyll, Photoinhibition.

UNIT V Industrial Applications of Photochemistry

Technical applications, application of luminscence phenomena to optical bleaching oftextiles and papers. Rapid radiationless transition to ground state. Applications of electron and energy transfer processes, Photofragmentations used in photochemical synthesis of detergent andInsecticides

Text Books

1. Rohtagi-Mukherjee,K. K. (2014): Fundamentals of Photochemistry, 3rd edition, New Age International, New Delhi.
2. Atkins, P. W. (2002): Physical Chemistry, 7thEdition, Oxford University Press, New York.
3. Levine,I. N. (2002.) :Physical Chemistry, 5thEdition,Tata McGraw Hill Pub. Co. Ltd., New Delhi.

References

1. Wayne,R. P. (1988): Principles and Applications of Photochemistry, 2nd edition, Oxford University Press.
2. Turro.N.J, Scaiano.J.C, Ramamurthy.V. (2008): Principles of Molecular Photochemistry: An introduction, 1stedition, University Science Books, Sausalito Calif.
3. Gilbert,A. &Baggott,J.(1991):Essentials of Molecular Photochemistry, CRC Press.

SEMESTER IV

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14402	Career Comprehensive Course*	2	-	-	2	2
INSTRUCTIONAL OBJECTIVE						
(i)	To evaluate the subject knowledge and presentation skill of the candidate and to train them for their employability					

Courses covered under the syllabus from First Semester to Fourth Semester (including electives) will form the basis for Career Comprehensive Course.

SEMESTER IV

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
PCY14403	Project Work	-	-	12	12	12

PURPOSE

To undertake research in an area related to the program of study.

INSTRUCTIONAL OBJECTIVE

M.Sc. projects should be socially relevant and research oriented ones.

Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester.

The project internally will be evaluated by the concerned guide.

The student shall be capable of identifying a problem related to the program of study and carry out wholesome research on it leading to findings which will facilitate development of a new/improved product, process for the benefit of the society.

Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project.

The method of assessment for both Phase I and Phase II is shown in the following table:

Assessment Tool Weightage

Review I : 40 Marks

Review II : 40 Marks

Review I & II Mark Distribution

Attendance	: 5 Marks
Novelty	: 5 Marks
Submission of hard copy	: 15 Marks
Presentation	: 10 Marks
Question session	: 5 Marks
Total	**40Marks**

Seminar- 20 Marks from III semester

Report evaluation	: 70 Marks
Viva	: 30 Marks
Total	**200 Marks**

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for

presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.