SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

M.Sc. PHYSICAL CHEMISTRY
(For students admitted during the academic year 2013-2014)
CURRICULUM AND SYLLABUS

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

M.Sc. PHYSICAL CHEMISTRY
(For students admitted during the academic year 2013-2014)
CURRICULUM AND SYLLABUS

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	Total of L+T+P	C
SEMESTER I						
CHET 401	Analytical Chemistry	4	1	-	5	4
CHET 402	Inorganic Chemistry-I	4	1	-	5	4
CHET 403	Organic Chemistry-I	4	1	-	5	4
CHET 404	Physical Chemistry-I	4	1	-	5	4
CHEP 405	Inorganic Chemistry Practical-I	-	-	6	6	3
CHEP 406	Organic Chemistry Practical-I	-	-	6	6	3
Total		16	4	12	32	22
SEMESTER II						
CHET 408	Inorganic Chemistry-II	4	1	-	5	4
CHET 409	Organic Chemistry-II	4	1	-	5	4
CHET 410	Physical Chemistry-II	4	1	-	5	4
CHET 424	Nanochemistry	4	1	-	5	4
CHEP 411	Physical Chemistry Practical-I	-	-	6	6	3
CHEP 415	Organic Chemistry Practical-II	-	-	6	6	3
Total		16	4	12	32	22

SEMESTER III						
CHET 490	Molecular Spectroscopy	3	3	-	6	4
CHET 491	Thermodynamics	3	3	-	6	4
xxxxxx	Elective-1 (List-I)	3	3	-	6	4
xxxxxx	Elective-2 (List II)	3	3	-	6	3
CHEP 492	Advanced Physical Chemistry Practical	-	-	6	6	3
Total		12	12	6	30	18
SEMESTER IV						
xxxxxx	Elective-3 (List-I)	4	1	-	5	4
CHET 460	Career Comprehensive Course*	2	-	-	2	2
CPR0435	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 of opting specialization : The number of seats in each specialization course would be upto a maximum of 30% of the total eligible candidates.

Note:

* - Continuous Assessment (Full Internals)

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

LIST -I (MAJOR SPECIAL ELECTIVES)

SEMESTER	SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	Total of L+T+P	C
III	CHEE 493	Polymer Chemistry	3	3	-	6	4
	CHEE 494	Nuclear and Radiation Chemistry	3	3	-	6	4
IV	CHEE 495	Advanced Analytical Methods	4	1	-	5	4
	CHEE 496	Photochemistry	4	1	-	5	4

LIST - II (INTERDISCIPLINARY ELECTIVES)

SEMESTER	SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	Total of L+T+P	C
III	CHEE 464	Industrial Chemical Analysis and Quality Control	3	3	-	6	3
	CHEE 465	Environmental Chemistry	3	3		6	3

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
CHET490	Molecular Spectroscopy	3	3	-	6	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 radiation and 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 pre dissociation 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
CHET491	Thermodynamics	3	3	-	6	4
INSTRUCTIONAL OBJECTIVES						
(i)	To learn about the classical mechanics of thermodynamics					
(ii)	To understand and appreciate the concepts of statistical thermodynamics					
(iii)	To apply the concepts of statistical thermodynamics for the study of equilibrium reactions and reaction rates					

UNIT I Chemical Thermodynamics-I

First law of thermodynamics, Concept of work and heat, enthalpy and heat capacities - Second law of thermodynamics: Physical significance of entropy (Direction of spontaneous change and dispersal of energy), Carnot cycle, efficiency of heat engine, coefficient of performance of heat engine, refrigeration and problems. Maxwell relations, thermodynamic equation of state, chemical potential, variation of chemical potential with temperature & pressure. Applications of chemical potential, Fugacity.

UNIT II Chemical Thermodynamics-II

Ideal solutions:Raoult's law, Duhem-Margules equation and its applications to Vapor pressure curves (Binary liquid mixture), determination of activity coefficients from vapor pressure measurements, Henry's law.

Nonidealsolutions: deviations from ideal behaviour of liquid mixtures, liquid vapor compositions, conditions for maximum.

UNIT III Statistical Thermodynamics I

Objectives of statistical thermodynamics - concept of thermodynamics and mathematical probabilities - distribution of distinguishable and non-distinguishable particles. Maxwell - Boltzmann distribution law - Partition function - evaluation of translational, vibrational and rotational partition functions for mono, diatomic ideal gases.

UNIT IV Statistical Thermodynamics II

Thermodynamic functions in terms of partition functions-application of partition function to heat capacity of ideal gases - nuclear partition function - contribution to

heat capacity of ortho and para hydrogen. Heat capacity of solids – Einstein and Debye models.

UNIT V Statistical Thermodynamics III

Fermi - Dirac and Bose - Einstein statistics - comparison with Maxwell -Boltzmann distribution law and their applications - radiation law - electron gas in metals. Irreversible Thermodynamics - Forces and fluxes - linear force, flux relation - phenomenological equations.

Text Books

1. Rao Y. V. C (1993): An Introduction to Thermo-dynamics, Wiley Eastern.
2. Berry, R.S, Rice, S.A and Ross J (2001): Physical Chemistry, Oxford.
3. Sears F. W. &. Salinger G. L (1986): Thermodynamics, Kinetic Theory& Statistical Thermodynamics, Narosa.

References

1. Rajaram and Kuriacose J.C (1986): Thermodynamics For Students Of Chemistry, La INagin Chand, New Delhi, 1986.
2. Gurudeep Raj (2006): Advanced Physical Chemistry, 32nd edition, Goel Publishing House, Krishna Prakashan Media (P) Ltd.
3. Glasstone. S (2012): Thermodynamics for chemists, East West press.

LIST-I (MAJOR SPECIAL ELECTIVES)

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
CHEE493	Polymer Chemistry	3	3	-	6	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 solids 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. Sreedhar Jayadev, 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
CHEE494	Nuclear and Radiation Chemistry	3	3	-	6	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.

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.

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.radiationdosimetry.

Radio isotopes:

Co-precipitation, ion-exchange, solvent extraction - as a tracer, Synthesis of labelled 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, 7th edition, Goel Publishing House Ltd.

References

1. Choppin, G.R(2002):Radiochemistry and Nuclear chemistry
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 III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
CHEP492	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 works.
(iii)	To motivate the students to understand the principles of potentiometric and conductometric titrations.

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.

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**

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

LIST-II (INTERDISCIPLINARY ELECTIVES)

SEMESTER III

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
CHEE464	Industrial Chemical Analysis and Quality Control	3	3	-	6	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, Anamalaya Publishers .
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
CHEE465	Environmental Chemistry	3	3	-	6	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 about various social issues

UNIT I Energy and Environment

Energy resources and their exploitation, Sun as the 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, pathway 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, solar radiation and its spectral characteristics, fossil fuels classification, composition. 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 protection 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, and Kaur 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, S. Chand & Company, New Delhi.

LIST-I (MAJOR SPECIAL ELECTIVES)

SEMESTER IV

Subject Code	Title of the Subject	L	T	P	Total of L+T+P	C
CHEE495	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 BioAssaying 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
CHEE496	Photochemistry	4	1	-	5	4
INSTRUCTIONAL OBJECTIVES						
(i)	To know about the interaction of radiation 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 of photoreactions 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 Processes

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 and Photosensitization- Photosensitized reactions by Mercury, Chlorine and Chlorophyll, Photoinhibition.

UNIT V Industrial Applications of Photochemistry

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

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, 1st edition, 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
CHET 460	Career Comprehensive Course*	2	0	0	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
CPR0435	Project Work	-	-	12	12	12

PURPOSE

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

PROJECT

A student is free to pick up a topic for the project at the beginning of Semester III. The student is expected to complete the major literature survey during the Semester III and present a tentative research plan at the end of Semester III. The candidate will do the experimental work during Semester IV under the supervision of a guide and submit the results in the form of a thesis at the end of Semester IV. The project internally will be evaluated by the concerned guide and the end semester assessment by duly appointed examiner (s).

Assessment Tool Weightage

Review I – 50 Marks

Review II – 50 Marks

Internal Mark Distribution

Attendance	: 5 Marks
Novelty	: 5 Marks
Submission of hard copy	: 15 Marks
Presentation	: 20 Marks
Interactive session	: 5 Marks
Total	: 50Marks

End semester evaluation:

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 project report

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