DEPARTMENT OF PHYSICAL AND NUCLEAR CHEMISTRY AND CHEMICAL OCEANOGRAPHY
SCHOOL OF CHEMISTRY
ANDHRA UNIVERSITY

# M.Sc.(Final) Physical Chemistry
# (Syllabus for 2005 admitted batch onwards)

## Third Semester – Paper – I
## ADVANCED CHEMICAL KINETICS AND PHYSICAL CHEMISTRY OF POLYMERS

### UNIT – I

Theories of reaction rates – Potential energy surfaces – reaction Co – ordinate – Reactions in solutions – Kinetic isotope effect – solvent isotope effects – Chain reactions $H_2$-$Cl_2$, $H_2$-$Br_2$ and $H_2$ – $O_2$ reaction – explosion limits. Linear free energy relationships – Hammett equation – Okamato – Brown equation – Taft equation. Quantitative structure activity relationships in kinetics – Topological and quantum chemical descriptions – prediction of rate constants.

### UNIT – II

Complex reactions – Consecutive – Parallel and opposing reactions – Equilibrium and steady state technique – Michalies – Menten Models. Flow and relaxation Technique for fast reactions – NMR methods determining exchange rates.

### UNIT – III

Physical Chemistry of Polymers: Characteristics of macro molecules (addition and condensation of polymerization), degree of polymerization. Shapes of macro – molecules, bulk, solution and emulsion polymerisation – co – polymeisation, block and graft copolymers, Ziegler matta catalysis. The structure and properties of polymers - crystallinity, Glass-transition temperature, Rheology and solubility of polymers, processing of polymers – Additives.

## UNIT – IV

Interaction of polymers and liquids – Flory – Huggins treatment and its limitations, Fractionation, viscosities of polymer solutions, synthesis and properties of polyesters, polylamides polyurethanes, polystyrene and bakelite. Determination of molecular weights of polymers by osmometry, light scattering, Ultra centrifuge and Viscometry.

**Suggested books:**


1. Chemical Kinetics by Laidler
2. Physical Organic Chemistry by Wiberg
3. Kinetics and Mechanism by Frost and Pearson
4. Molecular connectivity in Chemistry and Drug Research L.B.Kier and L.H.Hall Academic press,1976.
5. Chemical Kinetics – The study of Reaction Rates in solution – Kenneth A.CONNORS-VCH Pubishers.
6. An introducer to polymer Chemistry – W.R.Moore.
7. Introduction to polymer Chemistry – R.B.Seymour.
8. Fundamentals of Polymer Science and Engineering – Anil Kumar And S.K.Gupta.

DEPARTMENT OF PHYSICAL AND NUCLEAR CHEMISTRY AND CHEMICAL OCEANOGRAPHY
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# M.Sc.(Final) PHYSICAL CHEMISTRY

## III SEMESTER

### PAPER: II QUNATUM CHEMISTRY – II AND CHEMICAL APPLICATIONS OF SYMMETRY AND GROUP THEORY

## QUANTUM CHEMISTRY

### UNIT 1:

Review of postulates and Theorems of quantum mechanics Discussion of solutins of the Schrodinger equation of some model system Viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom. Tunnelling phenomenon. Approximation methods. Variation method, linear variation function. Perturbation method. (Time independent and non – degenerate Time dependent perturbation Theory)

Many electron atom. Independent electron model. Antisymmetric wave function. Slater's determinant. Hartree self consistant field method. Hartree-fock self cnsistent Field methods. Toothans equations. Basis functions. Electronic configruration vector model of the atom. Multiplet structure. Spin orbit interaction, parity of atomic states.

### UNIT II

Diatomic molecules: Mercular orbital (MO) theory valence Bond (VB) Theory. Electronic structure of molecules. Hartree – fock methods. Roothan's procedure. Basis Functions Minimal Basis set, extended Basis set, Condon-slater rules. Correlation diagrams for Homonuclear and Hetreronuclear diatomics. Virial theorem and its application. Improvement of SCE wave functions configuration Interaction, MCSCF, MRCI methods, Review of results.

## CHEMICAL APPLICATIIONS OF SYMMETRY AND GROUP THEORY

### UNIT III :

Representations – reducible and irreducible representatives – Orhogonality theorem and its consequences – Constructions of Character tables for $C_{2V}$ and $C_{3V}$ point groups – wave functions as bases for irreducible representations – Direct Product

Application to Chemical bonding:

Hybridization scheme for $AB_n$ type of molecules $AB_3$, $AB_4$, $AB_5$ and $AB_6$ under point groups $D_{3h}$, $D_{4h}$, $T_d$, $C_{4v}$ and $O_h$

Ligand field theory: Splitting of d – orbitals under $D_{4h}$, $T_d$, $C_{4v}$ and $O_h$ environments.

Construction of molecular orbital correlation diagram (1) for σ bonds in octahedral environment and (2) for $H_2O$ molecule.

**UNIT IV:**

Application to Molecular Vibrations:

Symmetry selection rules for i.r. and Raman activity – transition moment integral – application of direct product.

Determination of symmetries of total degrees of freedom: Calculation of Character per Un-shifted atom for different symmetry operations and evaluation of $T_{3N}$.
Determination of symmetries of i.r. and Raman active vibrational modes for Accidental degeneracy and Fermi Resonance.

Recommended Text Books:


1. Chemical Applications of Group Theory, F.A.Cotton Wiley Eastern Limited, New Delhi.
2. Group Theory and its Applications to Chemistry, K.V.Ramana, Tata McGraw –Hill Publishing Company Limited New Delhi.
3. Introductory Quantum Chemistry, A.K.Chandra, TATA MCGRAW-HILL Publishing Company Ltd., New Delhi.
4. Quantum Chemistry, Iran Levine, Pearson Education.
5. Theoretical Chemistry, S.Glastone.

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# M.Sc. (Final) PHYSICAL CHEMISTRY

## IV SEMESTER

### PAPER II: QUANTUM CHEMISTRY-III, NUMERICAL METHODS FOR CHEMISTS AND ADVANCED COMPUTER PROGRAMMING

## QUANTUM CHEMISTRY:

### UNIT I:

Polyatomic molecules: Abinitio methods: Commutation of symmetry elements with Hamiltonian. Symmetry based terms. Hartree-Fock methods, Different Basis Functions Configuration Interaction. Introductory treatment of coupled cluster method.

Symmetry Applications: Symmetry adapted molecular orbitals. Calculation in $H_2O$, $NH_3$, $CH_4$ etc, Use of symmetry in Hyckel theory. The direct product and its importance, determination of selection rules for electronic transitations in the case of HCHO.

### UNIT – II

Semiemperial methods: Huckel theory of planar conjugated systems. Bond order, electron density and free valency calculations. Application to ethylene, butadiene cycopropenyl system, cyclobutadiene etc.Introduction to extended Huckel theory. PP treatments, ZDO approximation, CNDO and INDO Introduction to AMI method. Introduction to AMPAC Package.

### UNIT III: NUMERICAL METHODS:

Precision and Accuracy, Determinate and indeterminate errors, computational errorstruncation and rounding off errors, algorithm errors-absolute and relative errors-Error propagation. Measures of Dispersion – range, arithmetic mean, mean deviation variance and standard deviation – movements – skewness and kurtosis.

Interpolation: interpolation for linear fit, linear interpolation in non-linear fit6, polynomial interpolation – Lagrange interpolation formula – Application to complex equilibria.

Numerical techniques of solving ordinary first order differential equations:- Euler's method, Predictor-corrector method, Rungae Kutta method-application to chemical kinetics.

**UNIT IV:**

Fortan programming: Concepts of Alogrithms and flow-charts, logical variables and logical expressions, order of evaluation of logical expressions, logical assignment statements, logical if and block if statements, computer GO TO statement, writing a decision, chain of decisions, arrays-one dimensional and two dimensional arrays. DO loop and its application in Input and Output statements. Statement Function, Function and Subroutine sub-programs.

Application to Chemical Problems:

Flowcharts and Programs for

1. Calculation of skewness and kurtosis of replicate measurements.
2. Polynomial interpolation using Lagrange interpolation formula
3. Euler's step by step iteration method for solving ordinary first order differential equation.
4. Calculation of first order rate constant of acid catalyzed hydrolysis an ester, using a subprogram for the calculation of slope by linear least-squares method.

RECOMMENDED TEXT BOOKS:


1. Introductory Quantum Chemistry, A.K.Chandra, TATA McGRAW-HILL Publishing company Ltd., New Delhi.
2. Quantum Chemistry, Iran Levine, Pearson Education.
3. Theoretical Chemistry, S.Glastone
4. Computer programming in Fortan-IV by V.Rajaraman, Prentice-Hall of India Pvt. Ltd., New Delhi.

# M.Sc.(Final) PHYSICAL CHEMISTRY

## (Syllabus for 2005 Admitted Batch onwards)

## Third semester – Paper III:

**STATISTICAL THERMODYNAMICS AND SOLUTION EQUILIBRIA OF PROTON LIGAND COMPELXES**

### UNIT – I

Statistical mechanics: Ensembles (Canonical and micro canonical) – Basic deifinition distribution and microstates, thermodynamic probability. The classical distribution law. The Maxwell – Boltzmann distribution law, method of lagranigan multipliers, indistinguishable particles, quantum statistics – Bose – Einstein and Fermi Dirac Statistics, Conditions for the applicability of Maxwell – Boltzmann statistics, Bose-Einstein statistics and radiation, extreme gas degeneration, degenerate electron gas.

### UNIT – II

Statistical thermodynamics: Partition functions. Thermodynamics functions from partition functions for multiple degree of freedom, theories of heat capacities of solids, statistical evaluation of entropy, comparision of statistical values with third law entropies (thermal entropies)

### UNIT – III

Correlation factors for $p^H$ meter-Gran analysis of acid base titrations-nbarh and number of moles of alkali per ligand plots-stability constant of proton ligand complexes-successive approximation-half nbarh method – predicition of stability constants by quantum chemical/molecular mechanics.

### UNIT – IV

Simulation of proton ligand complexes – effect of solvent on stability – Abrahma multi layer model – LD model – components of expert system – knowledge base inference engine and use interface.

**Suggested Books**


1. M.T. Beck, Complex Equilibria, 1991
2. Alcock, solution Equilibria, 1992
3. Richard E. Dickerson, Molecular Thermodynamics
4. S.Glasstone, Theoretical Chemistry
5. S.Glasstone, Thermodynamics for Chemists
6. C.Andrews, Equilibrium Statistical Mechanics
7. Davies, Thermodynamics
8. Yeremin, Thermodynamics
9. J. Rajaram, and T.C. Kuriacose, Thermodynamics for student of chemistry.

## M.Sc.(Final) PHYSICAL CHEMISTRY
## (Syllabus for 2005 Admitted Batch onwards)

### Third Semester – Paper IV

### INSTRUMENTATION
**(Common for Physical, Nuclear Chemistry and Chemical Oceanography)**

### UNIT – I

Spectrophotometry – deviations from Beer – lamberts law instrumentation – Errors in Spectrophotometry – Photometric titrations – composition and stability constants of mononuclear complexes by linear extrapolation methods – order of data and instruments – elementary principles – kinetic spectrum, time delay – excitation emission spectra.

### UNIT – II

Chromatrographic methods – Ion exchange chromatography separation of transition metal ion – solvent extraction – partition coefficient – distribution ratio – classification of solvent extraction systems and evaluation of formation constants and applications Gas liquid Chromatography – Principal – Instrumentation – retention time – retention volume – Multi component – Multi variate analysis – Matrix notation – Elementrary principles of HPLC – ICP and hyphenated instruments.

### UNIT – III

Techniques and instrumentation of IR, Microwave, Raman ESR, NMR. Limits of detection, limits of quantification and sensitivity – Laboratory management, GLP, GMP. Atomic absorption spectroscopy – elementary principles of laser mass spectrometry. Theories of over voltage – applications decomposition potential concentration over voltage – kinetic over voltage.

## UNIT – IV

Polarogrphy – Introduction – types of currents – qualitative and quantitive aspects of polarography – analytical applications to organic and inorganic compounds – Evaluation of stability constants by deford and hume method – amperometric titrations. Principles of thermo gravimetry – Apparatus and working, differential methods of analysis – principle factors affecting DTA curve. Application of DTA.

### Suggested Books


1. Quantitative Analysis – R.A. Day and A.L.Underwood
2. Quantitative Inorganic Analysis – A.I.Vogel
3. Spectroscopy S.Walker and Straw, Volumes I, II and III
4. Instrumental Methods of Chemical Analysis – Kudesia Snwheny (Pragati Prallesan Meerut) 1988.
5. Instrumental Techniques for Analytical Chemistry – Frank settle (Pearson Edition) 2004.

## M.Sc.(Final) PHYSICAL CHEMISTRY

## (Syllabus for 2005 Admitted Batch onwards)

## Fourth Semester – Paper I:
## ADVANCED CHEMICAL KINETICS AND PHOTO CHEMISTRY

### UNIT – I

Correlation analysis – Marcus Theory of electron transfer adiababatic and non adiabatic electron transfer – outer and inner speher mechanism – effect of solvent on rates – effect of dielectric constants on ion – ion, ion – molecule, molecule – molecule reations – Enzyme catalysis – BET isotherm determination of surface area – semiconductor catalysis – Homogeneous catalysis – acid base and redox catalysis.

### UNIT – II

Correlation of rate with $H_o$, $H_R$, acidity functions and their use in the illustration of mechanism in acid base catalysis – catalysis by transition metal ions and their complexes – Indistrially important processes – electron transfer reactions – Marcus theory – Application – substitution reaction in Octahedral complexes.

### UNIT – III

Photochemistry : Absorption Excitation – photochemical laws – quantum yield of electronically exicted states – measurements of life times – Flash photolysis – Stopped flow Techniques: energy dissipation by radiative and non – radiative processes, absorption spectra – Franck – condon principles. Photochemical stages – Primary processes and secondary processes – Rate constants and life times of reactive excited states.

### UNIT – IV

Properties of excited states : structure, dipole moment acid base strengths – reactivity, kinetics of bimolecular processes – quenching, Stern – Volmer equation. Photoreduction and oxidation. Cyclo addition reactions, Wood – ward –Hofmann's rules.

**Suggested Books**


1. Chemical kinectics by Laidler
2. Physical Organic Chemistry by Wiberg
3. Kinetics and mechanism by Frost and Pearson
4. Techniques in Organic Reaction Mechanism by Zuman and Patel.
5. Chemical kinetics – The study of Reaction Rates in solution – Kenneth A. CONNORS – VCH Publishers.
6. Fundamentals of photochemistry – k.k.Rohatgi – Mukherjee
7. Photochemistry – cox and kemp
8. Photochemistry – Calvert by Pitts,

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# M.Sc. (Final) PHYSICAL CHEMISTRY

## IV SEMESTER

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## QUANTUM CHEMISTRY:

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Interpolation: interpolation for linear fit, linear interpolation in non-linear fit6, polynomial interpolation – Lagrange interpolation formula – Application to complex equilibria.

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Flowcharts and Programs for

5. Calculation of skewness and kurtosis of replicate measurements.
6. Polynomial interpolation using Lagrange interpolation formula
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8. Calculation of first order rate constant of acid catalyzed hydrolysis an ester, using a subprogram for the calculation of slope by linear least-squares method.

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6. Quantum Chemistry, Iran Levine, Pearson Education.
7. Theoretical Chemistry, S.Glastone
8. Computer programming in Fortan-IV by V.Rajaraman, Prentice-Hall of India Pvt. Ltd., New Delhi.

# M.Sc. (Final) PHYSICAL CHEMISTRY
# (Syllabus for 2005 Admitted Batch onwards)

## Fourth Semester – Paper III
### ADVANCED THERMODYNAMICS AND SOLUTION EQUILIBRIA OF METAL-LIGAND COMPLEXES

### UNIT – I

Thermodynamics and phase changes – Free energy and meaning of phase changes, calculation of phase equilibrium curves, Pressure as a measure of escaping tendency, single components phase diagrams, free energy diagrams and the critical point, frist and second order transitions, partial molar quantities and their determination, chemical potential and phase rule. Thermodynamics of chemical reactions, Real gases and fugacity an its determination from PVT data.

### UNIT – II

Thermodynamics of living systems: Simultaneous coupled reactions, coupled reactions and metabolism free energy utilization, free energy utilization in metabolism, citric acid cycle, Terminal oxidation, Chain aerobic metabolism. Elementary aspects of non equilibrium thermodynamics conservation of mass and energy – entropy production and flow in open system – Onsagar theory – principles of microscopic reversibility.

### UNIT – III

Calvin Wilson Titration Techniques for metal ligand complexes – hydroxylated complexes stability constant by martell method – Laden procedure. Solution of a non – linear function of two variables – Algorithm of MINIQUAD programme – criteria of best fit model input/output.

### UNIT – IV

Prediction of metal ligand stability constants – Irwing and William order. Neural networks – Processing element, Transfer function, Training algorithm – BFGS, MAFQUARDT and back propagation. Multi layer perception and radial basis function NN's. Features of Trajan software – Input Output – Intelligent problem solver.

**Suggested Books**


1. M.T.Beck, complex Equilibira, 1991
2. Alcock, Solution Equilibria, 1992
3. Neural Networks systems Techniques and Applications – Ciornelices T. leondes; Vol.1:Algorithms and Architectures.
4. J.Zupan, Neural Network for Chemists, VCH,1992
5. Richard E.Dickerson , molecular Thermodynamics
6. S.Glasstone, Theroretical Chemistry
7. S.Glasstone, Thermodynamics for chemists
8. C.Andrews, Equilibrium Statistical Mechanics
9. Davies, Thermodynamics
10. Yeremin, thermodynamics
11. J.Rajaram, and T.C.Kuriacose, Thermodynamics for students of chemistry.

## M.Sc.(Final) PHYSICAL CHEMISTRY
## (Syllabus for 2005 Admitted Batch onwards)

## Fourth Semester – Paper IV
## SPECTROSCOPY

### UNIT – I

Rotational (Microwave) Spectroscopy – The rotational energies of polyatomic molecules – Rotational selection rules for linear molecules – symmetric top – Asymmetric top molecules – degeneracy of rotational energy levels – The stark effect in molecular rotational spectra – Molecular Rotation – Nulcear spin coupling – Application of Rotation Sepctra – Determination of Inter Nuclear distance – Moment of Inertia and Dipolemoment. The vibrations of polyatomic molecules infrared spectroscopy – simple harmonic and anharmonic vibrations Born – open himer approximation – Normal modes of vibrations – fundamental modes – vibration coupling – over tones and combination bands – interpretation of infrared spectra group frequencies - applications of infrared studies to organic and Inorganic compounds in the liquid state.

### UNIT – II

Rotation vibration spectra – selection rules and transitions for the rigid rotator – harmonic oscillator model – parallel and perpendicular bands of linear and symmetric top molelcules – Raman active fundamental – Criterian for their appearance – Rotational and vibrational Raman and Infrared studies – $AB_2$, $AB_3$ type molecules – correlation of infrared and Raman spectra.

### UNIT – III

ESR spectroscopy – the resonance condition – anisotropy in g-factor due to spin-orbit coupling – Theory and applications of ESR method – Crystallin solids – free radicals in solutions – other aspects of ESR studies – Interpretation of ESR spectra of typical radicals and ion like $Mn^{+2}$, $Cr^{+3}$, $Zn^{+2}$, $CU^{+2}$ photolysis of water – alcohol system – nitrobenzene, etc. Hyperfine interactions in the following systems. P-Benzoquinone – (semi) napthline radical anion and anthracene radical anion.

## UNIT –IV

NMR spectroscopy – Introductory principles – Types of environmental effects – chemical shifts and shielding – effect of chemical exchange on spectra – some application of NMR spectra – Determination of quadrupole interactions – Nuclear spin – spin interaction by means of bonding electrons – an elementary study of isotopes other than proton – Fluroine -19, phosphorous-31, Carbon-13, Boron-11.

## Suggested Books


1. Spectroscopy S.Walker and straw, volumes I, II and III
2. Molecular Spectroscopy, - Gordon M.barrow
3. Fundamentals of Moelcular Spectroscopy – Banwell
4. Spectroscopy – B.K.Sharm – Goel Publishing House Meerut. 1990.

## SYLLABUS FOR
## M.Sc.CHEMISTRY (NUCLEAR CHEMISTRY SPECIALISATION)

## III SEMESTER

### Paper – I Nuclear Theory and Nuclear Reactions

1. Radioactive decay processes – decay chains and their quantitative treatment – general equation – radioactive equilibria – successive decays – branching decay – natural radioactive series – experimental methods for determination of half-lives of short and long lived isotopes.
2. Decay systematics – alpha decay – beta decay – gamma decay – decay schemes – theories of alpha, beta and gamma decays – K-capture – internal conversion – Auger electrons – nuclear isomerism – isomeric transition.
3. Nuclear reactions – notation – comparison with chemical reactions – nuclear reactions induced by neutrons and charged partices – fluex and cross sections – energeitcs and kinetics – potential barrier – reaction threshold and excitation functions – compound nucleus mechanism – Ghoshal's experiment – photonuclear reactions – stripping and pick-up reactions – Oppenheimer – Phillip's process – fragamentation and spallation reactions.
4. Nuclear fission – general features – charge and energy distribution – mass yield curves – prompt and delayed neutrons – fission cross-section – fissible and fissionable nuclides – critical energy – theory of fission process – spontaneous fission.

**Books Recommended:**


1. Nuclear and Radiochemistry by G.Friedlander, J.W.Kennedy, E.S.Macias and J.M.Miller, Wiley – Interscience, New York (1981)
2. Essentials of Nulcear Chemistry by H.J.Arnikar, New Age international Private Limited, New Delhi(1997)
3. Nuclear Physics, I.Kaplan, Addision –welsely, reading(Mass), 1963, Narosa Publishing House, New Delhi (1998)

4. Principles of Radiochemistry, H.A.C. Mckay, Butterworths, London (1971)
5. Nulcear chemistry and its applications M.Haissinsky, Addision – Wesley, Reading (Mass) (1964)
6. Source Book on Atomic Energy – S.Glasstone, D.Van Nostrand, New York, 1987 (Affiliated East-West press, New Delhi, 1969).

## III SEMESTER

## PAPER – II NUCLEAR DETECTION TECHNIQUES

1. Interaction of Particles and radiations with matter – processes responsible for energy loss – conservation laws – range and energy relationships – determination of range and energy of particles and radiations – Feather analysis method for determination of energy of beta particles – specific ionization – stopping power – straggling – breamsstrahlung – absorption of beta particles – back scattering – half thickness – various absorption coefficients.
2. Detection of radiations – types of measuring instruments – Principles of operation and uses – G.M. tubes and their characteristics – gas multiplication factor – quenching – resolving time – recovery time – dead time - efficiency of G.M.Counter – Statistics of counting – bionomial distribution for radioactivity – Poisson distribution – normal distribution – accuracy of counting measurements.
3. Ionization chambers – proportional counters – Scintillation counters – solid state detectors – Cherenkov detectors – calibration of counting equipment – determination of absolute disintegration rate – nuclear emulsion techniques and autoradiography – neutron detection methods.
4. Radiation Protection – hazards associated with various types of radiatios – radiation shielding dosage – biological effects of radiation. Radioactive waste disposal and waste treatment – basic principles of handling and disposal of radioactive wastes.

**Books Recommended:**


1. Nuclear Radiation Detection, W.J.Price, Second Edition, McGraw Hill Book
2. Company, New York (1968)

3. Essentials of Nuclear Chemistry by H.J.Arnikar, Fourth Edition, New Age International private limited, New Delhi (1997)

4. Introduction to Nuclear Physics and Chemistry – B.G.Harvey, Pentice-Hall of India (Private) ltd., New Delhi (1965)

5. Nuclear Chemistry and its applications – M.Haissinsky, Translated from French by D.G.Tuck, Addison – Wesely Publishing Company, Inc., London (1964)

## III SEMESTER

## Paper – III RADIATION CHEMISTRY

1. Elements of radiation chemistry – chemical and physical effects of nuclear radiations of matter – units for measuring radiation absorption – linear energy transfer – Bethe's equation – radiation dosimetry – physical and chemical dosimetry – Glass, Fricke's and ceric sulphate dosimeters.
2. Radiolysis of water and some aqueous solutions – solvated electron – identification reactions of solvated electrons – Hart and Boag's experiment – properties of solvated electrons – pulse-radiolysis. Free radicals – radiation induced colour centres in crystals – storing and release of energy – free radical induced chemical effects – radiation tracks – spurs, delta rays – steady state concentration of radicals in bulk.
3. Radiation effects on solids – radiation induced polymerization and irradiation of polymers – cross linking – degradation – graft polymerization – radiation sources – industrial applications of radiation sources – radiation sterililzation – chemical synthesis.
4. Hot atom chemistry – Szilard – Chalmers process – retention of activity – effect of various factors on rentention – retention in oxygenated anions – reactions of recoil atoms – mechanisms in reactions of recoil atoms – synthesis of labeled compounds by hot atom chemistry – chemical changes in isomeric transitions.

**Books recommended:**


1. An introduction to Radiation Chemistry, J.W.T.Spinks and R.J.Woods, Jhon Wiley and Sons, New York (1964)
2. Radiation Chemistry, G.Hughes – Oxford Chemistry Series, Editors P.W.Atkins, J.S.EHolker and A.K.Holiday, Clarendon press, Oxford (1973)
3. Nuclear Radiation Detection, W.J.Price, Second Edition, McGraw Hill Book Company, New York (1968)
4. Essentials of Nuclear Chemistry by H.J.Arnikar, Fourth Edition, New Age International Private Limited, New Delhi (1997)

**SYLLABUS FOR**

**M.Sc.CHEMISTRY (NUCLEAR CHEMISTRY SPECIALISATION)**

**IV SEMESTER**

**PAPER – I – NUCLEAR REACTORS**

1. Neutrons – neutron sources – neutron moderation – nuclear reactors – multiplications and critically factors – moderators, coolants, cladding and structural materials – control materials
2. Homogenous and hertrogenous reactors – types of reactors – power reactors – boiling water reactors – pressurized water reactors – fast breeder reactors – research reactors – reactors for special purpose.
3. General equations for growth and decay of fission products – neutron poisons – neutron poisoning ratio – separation of fission products – Sr-90 and Cs-137. Preparation and isolation of Co-60, P-32, I-131, Mn-54, Cr-51 and Fe-55
4. Isotopic Effects – Theory of isotope effects in chemical equilibrium and chemical kinetics – calculation of isotope effects in simple reactions – Separation of isotopes of Uranium – gaseous diffusion and thermal diffusion separation process – preparation of heavy water by electrolytic and chemical exchange methods.

**BOOKS RECOMMENDED:**


1. Chemistry of the Actinide Elements by Katz and Seabrog
2. Nuclear Chemistry and its applications – M.Haissinsky, Translated from French by D.G. Tcuk, Addison – Wesely Publishing company Inc., London (1964)
3. Radio Chemistry, An.N.Nesmeyanov, Mir Publishers, Moscow (1974)

## IV SEMESTER

## Paper – II ADVANCED COMPUTER PROGRAMMING, NUMERIC METHODS, NUCLEAR FUSION AND NUCLEAR MODELS

1. Fortran programming: concepts of Algorithms and flow - charts - logical variables and logical expressions – order of evaluation of logical expressions – logical assignment statements – logical if and block if statements – computed GO TO statement – writing a decision – chain of decisions – arrays – one dimensional arrays – DO statement – nesting of do loops – implied DO loop and its applications in Input and Output statements – statement function – function and subroutine sub-programs

Applications to Chemical problems:

Flowcharts and Programs for

a) Calculation of skewness and kurtosis of replicate measurements
b) poly-nomial interpolating using Lagrange interpolation formula
c) Euler's step by step iteration method for sloving ordinary first order differential equation
d) Calculation of first order rate constant of acid catalyzed hydrolysis of an ester using a subprogram for the calculation of slope by linear least-square method.

2. Precision and accuracy – determinate and indeterminate errors – computational errors – truncation and rounding off errors – algorithm errors – absolute and relative errors – error propagation. Measures of dispersion – range, arithmetic mean, mean deviation, variance and standard deviation – moments – skewness and kurtosis. Interpolation for linear fit and linear interpolation in non-linear fit – polynomial interpolation – Lagrange interpolation formula – application to complex equilibria – numerical techniques of solving ordinary first order differential equations – Euler's method – Predictor-corrector method – Rungae Kutta method – application to chemical kinetics.

3. Nuclear fission – energy production in stars – proton-proton chain – carbon – nitrogen cycle – stellar evolution – controlled thermonuclear reactions – genesis of chemical elements – element and isotope abundance.
4. Nuclear Models – liquid drop model – semi-empirical mass equation and its applications – shell model – development and description of the model – prediction of nuclear properties like spin and parity on the basis of this model.

**BOOKS RECOMMENDED:**


1. Fortran 77 – Elements of programming style, W.M.Fouri, S.Goughram, L.Gioia and M.Fouri, CBS Publishers & Distributors New Delhi (1987).
2. Nuclear Physics, I.Kalpan, Addision-Wesley, reading (Mass),1963, Narosa Publishing House, New Delhi(1998)
3. Nuclear and Radiochemistry by G.Friedlander, J.W.Kennedy, E.S.Macias and J.M.Miller, Wiley-Interscience, New York (1981)

## IV SEMESTER

## PAPER – III – PROCESS CHEMISTRY OF REACTOR MATERIALS

1. Preparation, separation and chemistry of actinium and protactinium – chemistry involved in Th-Pa-U breeder cycle – Thorax process.
2. Chemistry and extraction of thorium and uranium – separation of uranium, plutonium and fission products from the spent fuel by redox, purex and TTA chelation processes – U-235-hexone process-U-235-TBP process
3. Preparation of americium, curium and all trans-curium actinides – comparison of properties of actinides and lanthanides. Synthesis of elements 104 to 111. Super heavy elements – electronic configuration – prediction of stability, synthesis, search in natural sources.
4. Elementary aspects of non-aqueous and high temperature separation processes of importance in nuclear technology. Chemistry of beryllium, Zirconium and hafnium and their importance in nuclear technology.

**BOOKS RECOMMENDED:**


1. Nuclear Chemical Engineering, M.Benedict and T.Pigford, McGraw Hill Book Company, New York (1968)
2. Chemistry of the actinide elements, J.J.Katz and G.T.seaborg, First Edition, Methen & Co.Ltd., London (1957)

## IV SEMESTER

## PAPER –IV –APPLIED RADIOACTIVITY

1. Radioisotope tracer methodology – problems of experimental design – radio analytical techniques – radiometric analysis – solubility measurements – various types of isotope dilution techniques – radio activation analysis including non-destructive analysis
2. Isotopic analysis exchange reactions – quantitative rate law – application of radioisotopes in the study of isotopic exchange and electron – transfer reactions – reaction kinetics and molecular rearrangements and reaction mechanism. Use of radionuclide in diffusion studies, surface area phenomena and catalysis. Applications of radionuclide for therapeutic and diagnostic purposes.
3. Nuclear Processes as chemical probes – Mossbauer effect – positron annihilation – dating techniques – radiocarbon dating – determination of age of earth and minerals by various dating techniques.
4. Radioactivity in the environment – natural radioactive nuclides and their distribution in the environment, nuclear process in the atmosphere and the radioactivity in the environment – contributions from nuclear tests. Nuclear reactors and other nuclear establishments like fuel – reprocessing plants, waste management of certain elements like Cs-137, I-131, H-3, Ra-226 and plutonium isotopes in the environmental samples.

**BOOKS RECOMMENDED:**


1. Principles of Radiochemistry, H.A.CMcKay, Butterworths, London(1971)
2. Nuclear Chemistry and its applications – M.Haissinsky, Translated from French by D.G.Tuck, Addision – Wesely Publishing Company Inc., London (1964)
3. Nuclear and Radiochemistry by G.Friedlander, J.W.Kennedy, E.S.Macias and J.M.Miller, Wiley- Interscience, New York (1981)
4. Radio Chemistry, An.N.Nesmeyanov, Mir Publishers, Moscow(1974)

**Syllabus of M.Sc. Chemistry (Marine Chemistry)**

**III Semester**

**Paper I: Chemical Oceanography-I**

Unit I Salinity and Chlorinity Chlorosity Physical Properties – electrical Conductivity, specific gravity, compressibility and refractive index. Equation of state of sea water. Marcet's Principle. Conservative and Non-conservative behaviour of major and minor elements. Residence Time – its computation, variability and importance. Surface residence time Geochemical balance of oceans. Mass balance calculations – sodium balance. Excess volatiles. Radioactive elements in the sea.

Unit II Gas Exchange at surface. Reactive and non – reactive gases – sources and fluxes. Argon as a reference gas Distribution of $N_2$ and He.

Dissolved Oxygen, A.O.U. Anoxic environments. $H_2S$ and alteration of associated elemental chemistry. Carbon dioxide System. Alkalinity Calcium Carbonate Saturation and Compensation Depths.

Unit III Micronutrient elements – N, P and Si – their budgets and cycles. Nitrogen imbalance and denitirfication. Trace metals (Cu, Zn, Co, Ni, V, Cr,Mo, Sn, Mn, Fe and Cd) – their origin, distribution and fate. Water Mass indentification using T-S diagrams, PO and NO plots. Inter – element relationships and ratios.

Unit IV Dissolved Organic Matter and Particulate Organic Matter. Their Origin, Elemetal and chemical composition, distribution and fate. Ectocrines. Extra cellular Metabolites and humic substances.

Inputs, formation and fate of suspended particles. Morphology and composition. Stokes law of falling particles and its application in the sea. Degradation of organic matter under aerobic and anaerobic conditions.

**Text and Reference Books**


1. The oceans : Their Physics, Chemistry and General Biology, by H.U.Sverdrup, M.W.Jhonson, and R.H.Fleming Asia Publishing House, Bombay,1961.

2. Introduction to Marine chemistry by J.P.Riley Academic Press London(1969)

3. Chemical Oceanography, by J.P.Riley and G.Skirrow (Editors), 2nd Edition Vols, 1 And 2, Academic Press London, 1975. Relevant Chapters (6,7,8,9,11,12,13,14, And 18, 37).
4. The Indian Ocean – A perspective, By R.Sen Gupta and E.Desa (Editors), Oxford & IBH(Pub), New Delhi, 2001, Chapter 4.

**M.SC. chemistry (Marine Chemistry)**
**Paper – II: Organic Spectroscopy**
**III SEMESTER**

Unit I **Infra Red Sepctroscopy in structure elucidation:** Infra Red – units of frequency. Molecular vibrations. Factors influencing vibrational frequencies. The IR Sepctrophotometer. Sampling techniques. Characteristics frequencies of Organic molecules and interpretation of spectra with special reference to marine natural products

Unit II **Ultra violet Spectroscopy in structure elucidation:** Ultra violet – absorption laws. Measurements of the Spectrum. Chromophores. Group frequencies and rules of summation. Interpretation of spectra with special reference to marine natural products.

Unit III **NMR Spectroscopy in structure elucidation: NMR –** measurement of spectra. Chemical Shift, Intensity of **NMR** signals and integration. Factors affecting chemical shifts. Anisotropy. Spin-spin coupling. Some simple $^{1}H$-$^{1}H$ coupling constants. Pulse experiment & FT NMR Spectroscopy. Spin decoupling. Nulcear Overhauser effect. $^{13}C$ NMR Spectra. Interpretation of spectra with special reference to marine natural products.

Unit III **Mass spectroscopy in structure elucidation : Mass –** principles and instrumentation. Isotopic abundances. Molecular ion. Metalstable ions. Cleavges; Fragmentation associated with functional groups. Mc Lafferty and RDA (Retro-Deals Alder) Rearrangements. Interpretation of spectra with special reference to marine natural products.

**TEXT and Reference Books**


1. Organic spectroscopy by W.Kemp, Macmillan, 3rd Edition, 1991
2. Spectometric Identification of Organic compounds by R.m.Silverstein and F.X.Webster, Jhon Wiley & sons(Pub), New York, 1998.

**M.Sc. (CHEMISTRY)**
**III SEMESTER**
**PAPER: III CHEMICAL METHODS IN MARINE CHEMISTRY**

**UNIT 1** Errors in ananlytical measurements –Propagation of errors. Accuracy and precision. Standard deviation. Coefficient of Variation and Confidence limit. Calibration – linear and multi-linear least squares. Detection and determination limits. Good Laboratory Practices. Control Charts-Shewhart charts. R Charts.

**UNIT 2** sampling: General methods of collection, preservation, pretreatment and post treatment of water (including sewage and effluent); sediment and biological samples. Criteria of an ideal filtering medium – glass fibre, membrane and nucleopore filters. Digestion methods. Sequential extractions.

**UNIT 3** Matrix effects. Interference effects. Preconcentration methods – co-precipitation, co-crystallisation, floatation, ion exchange, solvent extraction their principles and applications.

**UNIT 4** Chemical methods of analysis of marine samples by volumetric, gravimetric and Complexometric methods- their principles and major applications to sea water analysis. Methods of estimation of salilnity, major elements, dissolved oxygen, nutrients, trace metals and organic constituents.

**Text and reference books:**


1. Chemical Oceanography, Vol.3 by J.P.Riley and G.skirrow (editors), Academic press London(1975).
2. Instrumental Methods of Analysis by H.H.Willard, L.L.Merrit, Jr.J.H.Dean and F.A.Settle, Jr.,CBS(pub), Delhi, $6^{th}$ Edition, 1986,
3. Vogel's Text Book of Quantitative Chemical Analysis Jhon Wiley & Sons Inc., New York, 1999.

**M.Sc. (CHEMISTRY)**
**IV SEMESTER**
**Paper I: Chemical Oceanography – 2**

**UNIT I** Development and scope of Oceanography Contributions of Challenger and International Indian Ocean Expeditions and GEOSECS programme. Major oceanographic institutions in the world and India. International Collaboration in Marine Science Antarctica and Polymetallic nodule Programmes of India Law of the Sea

**UNIT II** Elementary principles only of physical Oceanography. Water circulation Important Water Masses Upwelling and Sinking. Temperature structure of the water column Air-Sea interaction and heat budget of oceans. Ocean physiographic features – shelf, slope, Deep, Ridges, Canyons, Trenches, Submarine Volcanoes. Estuaries, Fjords and Deltas. Geological time scale and calendar of major geological events Eustatic Sea level changes.

**UNIT III** A typical conditions under which major elements are not conservative. Oceanography of coastal environments. Esturaried lagoons and land –locked basins and hydrothermal solutions Bay of Bengal and Arabian Sea.

Elementary principles only of Biological Oceanography Primary productivity and factors affecting it. Common tropical phytoplankton and zooplankton species Bacteria and its importance Benthos. Foraminifera Ecological considerations.

**UNIT IV** Sediment organic matter – its composition and early diagenesis Geochemistry of sediment Trap material Major contributions of the Deep sea drilling Project Ocean Drilling Progrmme Diagenesis of porphyrins, steroids terpenes, hydrocarbons and Carotenoids Biomakers amino acid dating. Applications of organic Geochemistry in paleoceanography

Theories of pertroleum formation – diagenesis categensis and metagenesis Kvenolden diagram. Kerogen Immature and mature organic matter and pertroleum Biomakers of petroleum.

**Text and Reference BOOKS:**


1. The oceans : Their Physics, Chemistry and General Biology, by H U Sverdup, M.W. Jhonson, and R.H.Fleming, Asia Publishing House, Bombay, 1961
2. Introduction to marine chemistry by J.P.Riley, Academic Press. London (1969)
3. Chemical Oceanography, by J.P.Riley and G.Skirrow (Editors), 2nd Edition Vols. 1 And 2, Academic Press London. 1975 Relevant Chapters (6,7,8,9,11,12,13,14 and 18, 37)
4. The Indian Ocean – A perspective, by R.Sen Gupta and E.Desa (Editors), oxford & IBH (Pub), New Delhi, 2001,chapter 4
5. Petroleum formation and occurrence : A new approach to oil and gas exploration By B P Tissot and D.H.Welte , Springer – Verlang, Berlin 1978.

**M.Sc. (CHEMISTRY)**

**IV SEMESTER**

**PAPER – II NATURAL PRODUCTS**

| | |
|---|---|
| **UNIT I** | Phylogenetic Tree and chemical elaboration by marine life forms General methods of extraction and purification of marine natural products. Seaweeds in industry Isolation, chemistry and applications of agar, alginate and Carragements. |
| **UNIT II** | Chemistry of chlorophylls, phycocyanobilins. Cartotenoids and their functions chemistry of β-carotoene and zeamanthin chemistry of vitamins $B_1$, $B_{12}$ and vitamin C. Algal Natural products: Kainic acid, domoic acid |
| **UNIT III** | Tyrian purple caulepine, pahutoxin, nereistoxin, anabaseine, surugatoxin, aplysin, oroidin, ara A and ara B Cypridina and watassena luciferins and mechanism of bioluminescence. |
| **UNIT IV** | Usual and unusual sterols of the marine environment. Saxitoxin, tetrodotoxin and holotoxins. Paralytic shellfish poisoning. Marine ecological chemistry and chemical interactions Antibiotic property of seawater. Present status of drugs from the sea |

**TEXT AND REFERENCE BOOKS:**


1. CHEMICAL OCEANOGRAPHY, Vol 4 by J.P.Riley and G. Skirrow (editors) Academic Press, London, 1975 Relevant Chapters (21, 22, 23, 31, 37, 39)

2. Marine Natural products Chemical and Biological Perspectives Volumes 1 to Volume 5 Academic Press, New York 1983, Relevant Chapters.

**MARINE CHEMISTRY**

**IV SEMESTER**

**PAPER: III HYDROCHEMISTRY, ATMOSPHERIC CHEMISTRY AND INORGANIC CHEMICAL RESOURCES**

UNIT 1 Chemical equilibria in natural waters. Acid – Base equilibria in natural waters. Carbonate and orthophosphate systems. $P^H$ and Buffer capacity of sea water. Redox equilibria. $P^H$ – $E_H$ diagrams. Chemical speciation and influence on equilibria of Fe, Mn, organic matter. S and Mo. Master variables. Species evaluation. Complexation ability of natural waters and metal – organic interactions. Organic and inorganic species as major ligands of sea water. Concepts of stability constants and metal detoxification.

Unit 2, Colloids clay minerals and their structural characteristics. Their importance in the sea. Adsorption in the marine environment and electrical double layer. Specific and non – specific adsorption. Origin of charge. Corrosion –its mechanism. Various forms of corrosion and the effect of environment factors. Corrosion prevention..

Unit 3. Chemical composition of the atmosphere. Global change and its influence on oceans. Greenhouse gases: $CO_2$, $NO_X$, $CH_4$ and oxides of sulfur. Anti-greenhouse gas: $(CH_3)_2S$. Marine aerosols – their transportation and composition. Sea water micro layer. One box and two box models of sea water mixing. Modeling of the marine environment – principles and applications.

Unit 4: Inorganic chemical resources: Fresh water recovery by various methods of desalination including evaporation /distillation, hydrate formation, electro dialysis and reverse osmosis. Manufacture of salt and major minerals of water Mg, K and Br.

**TEXT AND REFERENCE BOOKS:**


1. Marine chemistry by R.A.Horne, Wiley interscience, New York 1999.
2. Aquatic Chemistry by Stumm and Morgan
3. Equilibrium Concepts in Natural water systems Advances in chemistry series 67 by R.R.Gould American Chemical Society Washington 1967.
4. The Geo chemistry of Natural waters by J.I.drever, Prentic Hall Inc., Englewood Cliffs, 1982
5. Marine Corrosion by F.L.Laque Jhon Wiley & Sons 1975
6. Fundamentals of Water Desalination by E.D.Howe Marcel Dekker Inc.,New York! 1974.
7. Chemical Oceanography by J.P.Riley and G.Skirrow (editors) Vol4 Academic Press 1975

**M.Sc. (CHEMISTRY)**

**MARINE CHEMISTRY**

**IV SEMESTER**

**PAPER IV: MARINE SEDIMENTS AND MARINE POLLUTION**

| | |
|---|---|
| **UNIT 1** | Flux of materials across the sea water – sea bed interface. Fick's laws of diffusion and their applications in the flux calculations. Marine sedimentary processes. Classification of sediments. Characteristics of near shore and Deep sea sediments. Sediment texture and triangular plot of sand-silt-clay. Composition and distribution of nitrogenous, biogenous, hydrogenous and cosmogenous components. Their evaluation by sequential extractions. Major element chemistry of marine sediments and crystals earth. Trace metal enrichment before particle deposition. |
| **UNIT 2** | Early and late diagensis of sediments in oxic and anoxic environments. Elemental ratio as guide to sediment dieagensis. Pore water chemical equilibria in sub/anoxic environments. Occurrence and chemistry of clay and heavy minerals. Mechanism of formation, chemistry and distribution of ooids and authigenic deposits- phospeties, ferromanganese nodules and metalliferous deposits on the seafloor. Their crystal structure and identification. Geochrononology of marine sediments. |
| **UNIT 3** | Marine pollution dynamics – inputs, monitoring, fate and modeling Eutrophichation and Biochemical Oxygen Demand. Toxic effects and health hazard. Sewage, petroleum hydrocarbons, pesticides, metal and radioactive pollution. Major industrial polluants abnd treatment of effluents. |
| **UNIT 4** | Criteria for waste disposal and management of marine pollution. Case study of Visakhapatnam Harbour. National and International legislation on environmental pollution / protection. Principles of coastal zone management. |

TEXT AND REFERENCE BOOKS


1. INTRODUCTION to Marine chemistry by J.P.Riley and R.Chester Academic Press London1969.
2. Marine Chemistry by R.A.Horne, Wiley Inter Science, New York 1999.
3. Chemical Oceanography by J.P.Riley and G.Skirrow Vols. 5 & 6, Academic Press 1975.
4. The Health of the Oceans by E.D.Goldberg, The UNESCO Press 1976.
5. Chemical Oceanography, Vol.3 by J.P.Riley and G.Skirrow (editors) Academic Press London, 1975
6. Marine Pollution by E.D. Goldberg, academic Press, 1975.

DEPARTMENT OF PHYSICAL AND NUCLEAR CHEMISTRY AND CHEMICAL OCEANOGRAPHY
SCHOOL OF CHEMISTRY
ANDHRA UNIVERSITY

## Paper – IV: PHYSICAL CHEMISTRY- I

### M.Sc I SEMESTSER

| | | |
|---|---|---|
| Unit 1 | States of Matter | Transport properties of Gases – Thermal Conductivity Diffusion. Theories of liquid structure; Calculation of collision numbers. |
| | Solids | X – Ray diffraction studies: Bragg's equation – Crystal structure determination, lattice type and lattice dimensions – crystal defects – Band theory of solids – Semiconductors - Theories of specific heats of solids. |
| Unit 2 | Thermodynamics | Free energy, entropy and enthalpy – chemical equilibrium – Thermodynamic criteria of the chemical equilibrium – effect of temperature on equilibrium constant – Vant Hoff isochore – Maxwell relations – Gibbs-Duhem equation; Duhem – margules equations; Classius-Clapeyron equations – Nernst heat theorem. Third law of thermodynamics and determination of absolute entropy – limitation of third law of thermodynamics. |
| Unit 3 | Kinetics I | Theories of Reaction rates – Collision theory – limitation; transition state theory – effect of ionic strength – Debye-Huckel theory – primary and secondary salt effects – effect of dielectric constants of solvent-ion-ion interaction; solvent models – Born-Abraham. Langevin dipole model. |
| Unit 4 | Kinetics II | Effect of substituent – Hamett equation – limitations – Taft equation – prediction of rate constant of a reaction; consecutive reactions, parallel reactions, opposing reactions (unimolecular steps only – no derivation) – specific and general acid-base catalysis – Skrabal diagram – fast reactions – flow systems – temperature and pressure jump methods – relaxation. |

**Books suggested:**

For Units 1 and 2

1. Physical Chemistry by Glasstone
2. Physical Chemistry by Moore
3. Physical Chemistry by Castallan

For Units 3 and 4

1. Physical Chemistry (7$^{th}$ edition, 2002) by Atkins and Paule.

DEPARTMENT OF PHYSICAL AND NUCLEAR CHEMISTRY AND CHEMICAL OCEANOGRAPHY
SCHOOL OF CHEMISTRY
ANDHRA UNIVERSITY

## Paper – IV: PHYSICAL CHEMISTRY- II

## M.Sc II SEMESTSER

| | | |
|---|---|---|
| **Unit 1** | **Physical methods of molecular structure elucidation** | **Magnetic properties of molecules theories of magnetic susceptibility – measurement of magnetic susceptibility. Principle and theory of NMR spectroscopy – Nature of spinning particle and its interaction with magnetic field – chemical shift and its origin – spin-spin interaction experimental methods – applications of NMR studies in structural elucidation – structure of ethanol, dimethyl formamide, styrene and acetophenone.** |
| **Unit 2** | **Electron spin resonance** | **Principle and experimental technique – g-factor, line shapes and line widths – hyperfine interaction – application of ESR studies to the structure of free radicals, metal complexes and biological systems.** |
| **Unit 3** | **Photochemistry** | **Fluorescence – delayed fluorescence, E(osime) and P(yrin) type – phosphorescence – Jabanowski diagram - photophisical process – intersystem crossing or internal conversion, derivation of Stem-Volmer equation – Quantum yield – Quenching effect – Photochemical equilibrium.** |
| **Unit 4** | **Electrochemistry** | **Electrochemical cell – Galvanic and electrolytic cell concentration cell with and without transference – effect of complexation on redox potential – ferricyanide/ ferrocyanide couple, Iron(III) phenanthroline couple Determination of standard potential, activity coefficients from EMF data.** |

**Books Suggested:**

**For Units 1 and 2**

1. **Fundamentals of Molecular Spectroscopy by Banwell.**
2. **Spectroscopy by Straw & Walker**

**For Units 3 and 4**

1. **Physical Chemistry (7th edition, 2002) by Atkins and Paule.**
2. **Physical Chemistry by Glasstone.**

**Paper – IV: PHYSICAL CHEMISTRY- I**

**M.Sc I SEMESTSER**

**PRACTICAL IIIP: PHYSICAL CHEMISTRY PRACTICAL –I**

1. Critical Solution Temperature of partially miscible liquids phenol-water System.
2. Effect of electrolyte (NaCl) on miscibility temperature.
3. Determination of cell constant.
4. Determination of Pk, value of acetic acid by conductometric method.
5. Conductometric titration of strong acid with strong base (HCL vs NaOH)
6. Conductometric titration of a weak acid strong base (HOAc vs NaOH)

**Books suggested:**


9. Practical Experiments in Physical Chemistry by Alexander Finallay.
10. Experiments in Chemistry by D.V. Jahagirdan. Himalaya Pub. House, 2003.
11. Physical chemistry experiments by P. Ghosh.


**M.Sc II SEMESTSER**

**PRACTICAL IIIP: PHYSICAL CHEMISTRY PRACTICAL – II**

1. Determination of composition of cuprammonium cation.
2. Determination of equilibrium constant of the reaction: $KI + I_2 = KI_3$
3. Conductometric titration of mixture of a strong acid and weak acid weak acid with a strong base (HCl + HOAc) vs NaOH.
4. Potentiometric titration of iron (II) with $K_2Cr_2O_7$
5. Determination of relative strength of acids (HCl) by ester hydrolysis
6. Polarimetric determination of relative strength of acids by hydrolysis of sucrose.

**Books suggested:**


1. Practical Experiments in Physical Chemistry by Alexander Finallay
2. Experiments in Chemistry by D.V. Jahagirdan. Himalaya pub. House, 2003.
3. Physical chemistry experiments by P. Ghosh.