

M. Phil Chemistry
(Course of studies)

Paper I: Research Methodology, Quantitative Techniques and Computer Applications

100 marks

UNIT I

Research-Definition-Importance and Meaning of Research-Characteristic of Research-Types of Research-Steps in Research-Identification, selection and formulation of research problem-Research Design, Conclusion of Research-Formulation of Hypothesis, Research Reports ; Types of Reports-contents-styles of reporting-Steps in drafting reports-Editing the final draft- Evaluating the final draft.

Statistics in Research-Hypothesis-Fundamentals of Hypothesis testing-Standard Error-Point and Interval estimates-Important Non-Parametric tests:Sign, Run, Kruskal-Wallis tests and Mann-Whitney test-Parametric tests:Testing of significance-Mean, Proportion, Variance and Correlation-testing for Significance of difference between Means, Proportions, Variances and Correlation coefficient. Chi-square tests-ANOVA-One way and Two way.

UNIT II

Fundamental Laboratory Techniques, Basic principles, working with liquids, Basic laboratory procedures, Principles of solution chemistry, pH and buffer solutions, Instrumental standardization, optimization of procedures.

Introduction, classification of Analytical methods, Types of Instrumental methods, Instruments for analysis. Analog & Digital signals, Planning for laboratory automation. An overview of automatic instruments and instrumentation. Flow Injection Analysis, Discrete Automatic systems.

The investigative approach: Making and recording measurements, SI units and their use, Scientific method and design of experiments for Project work. Analysis and presentation data: Using graphs, presenting data in tables, Descriptive statistics, Statistical tests, Drawing chemical structures, Elementary ideas of chemometrics, Chemo informatics and Computational chemistry

UNIT III

Chemical safety and Disaster Management: Emergency response: chemical spills, radiation spills, biohazard spills, leaking compressed gas cylinders, fires, medical emergency accident reporting, Use of sensors technology for disaster management

General safety: safety equipments, personal protective equipments, compressed gas safety, safety practices for broken glass wares, centrifuge safety, treated biomedical wastes and scientific ethics.

Isolation and Purification of compounds, Solvents for recrystallization, Sublimation, Fractional/vacuum/steam distillation, Limit tests, Sources of errors in observations

Basic principle, operating method, sample size, sampling and calibration of frequently used laboratory instruments, Chemical analysis based on various techniques of spectrometry, chromatography etc., Quality control and quality assurance in chemical Industries.

UNIT IV

General approach to method development and validation, Study of validation parameters, Accuracy, Precision, Linearity, Range, Limit of detection(LOD), Limit of quantification(LOQ), System suitability, Stability, Ruggedness, Robustness

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Introduction, fundamentals, principle, instrumentation and applications of gas chromatography, HPLC and other hyphenated Techniques: LC-MS, GC-MS, IC-MS, HP-TLC, and ICP-MS Spectroscopy
Separation Methods: Theory and applications of separation methods in analytical chemistry: solvent extraction, ion exchangers including liquid ion exchangers.

UNIT V

Literature Searching: On-line searching, Database, Scifinder, Scopus, CA on CD, Locating research article, Citation Index, Impact Factor

Writing scientific report: Planning, preparation, draft, revision and refining; writing project proposal to funding agency, Paper writing for International Journals, submitting to editors. Conference presentation, preparation of effective slides and presentation.

Introduction to Internet and its applications: web browsers – World Wide Web, Search Engines, e-journals, literature Survey in Chemistry, Popular journals and websites in Chemistry, Databases in Chemistry, literature searching and collection using e-journals.

Preparing presentations: i) Research papers : Using word processing software – MS Word/Latex/others, Drawing graphs and diagrams – Origin/Xmgrace/Excel/others. ii) Seminar presentations – Power point for oral and poster presentations

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Paper II:

Spectral and Analytical Chemistry

100 marks

Unit I

IR and Raman spectroscopy, Instrumentation, preparation of samples and pellet making

Molecular vibrations, selection rules, force constant - band assignments, applications, organic structures, fingerprinting, identification of common functional groups, applications.

Combined uses of IR and Raman spectroscopy in structural elucidation of simple molecules like N_2O , ClF_3 , NO_2 , and ClO , Predicting IR bands for simple organic molecules, effect of coordination on ligand vibrations, uses of group vibrations in the structural elucidation of metal complexes of urea, thiourea, cyanide, thiocyanate, nitrate, sulphate and dimethyl sulfoxide, effect of isotopic substitution on the vibrational spectra of metal carbonyls with reference to the nature of bonding, geometry and number of C-O stretching vibrations (group theoretical treatment).

Raman spectroscopy: Stokes and anti-Stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy, Selection rules, Polarization of Raman lines, Applications of Raman Spectroscopy, Photo electron spectroscopy-principle and applications, Auger electron spectroscopy, electron spectra in chemical analysis.

UNIT II

NMR spectroscopy Bloch equations, the quantum mechanical description of the NMR experiment, transition probabilities, Fourier transform NMR, Relaxation effects, measurements of T1 and T2. Second order spectra, Quantum mechanical treatment of coupling, effect of relative magnitudes of J on the spectrum of an AB and ABX molecules, double resonance experiment. Spectral simplification and determination of signs of coupling constants. Examples for different spin systems, chemical shifts and coupling constants (spin-spin coupling) involving different nuclei (1H , ^{19}F , ^{31}P , ^{13}C), elementary aspects of Solid State NMR.

Sampling techniques, factors influencing both internal and external quantitative studies, hydrogen bonding (intermolecular and intramolecular) conformational aspects in cyclic 1,2 diols and 1,3 diols, 1H NMR spectroscopy, coupling constant, first order and second order splitting spin, spin splitting, dependence of J on dihedral angle, vicinal and geminal coupling constants, Karplus equation, long range coupling constants, influence of stereo chemical factors on chemical shift of protons, simplification of complex spectra, double resonance techniques, shift reagents, chemical spin decoupling of rapidly exchangeable protons (OH, SH, COOH, NH, NH_2), an elementary treatment of NOE phenomenon, 2D technique (COSY, NOESY and ROSY)

^{13}C NMR spectroscopy. Basic theory of FT NMR, Relaxation, broad band decoupling. Off resonance decoupling and chemical shift correlations (CH , CH_2 , CH_3 , $=CH_2$, $=C$, aromatic). NMR in medicine

EPR spectroscopy - Factors affecting the magnitudes of g and A tensors in metal species, Zero field splitting and Kramer's degeneracy, spectra of V(II), Mn(II), Fe(II), Co(II), Ni(II) and Cu (II) complexes- applications of EPR to a few biological molecules containing Cu(II), Fe(II) and Fe(III) ions, spin densities and McConnell relationship, Applications of EPR to some simple systems

UNIT III

UV Visible spectroscopy, Electronic excitation, origin of different bands, intensity of bands, selection rules - laws of photometry, correlation of electronic absorption with Molecular structure, chromophoric groups, conjugated systems, systems of extended conjugation, aromatic systems, empirical rules, experimental methods, photometric titrations.

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Photo Electron Spectroscopy: X-ray photoelectron spectroscopy (ESCA): X-ray photoelectron spectra of atoms - Ar, Kr and Xe. Applications of ESCA in quantitative analysis.

Valence Electron photoelectron spectroscopy (UV- PES): UV-PES spectra of F_2 , Cl_2 , Br_2 , I_2 , CO, HF, NH_3 and H_2O . Comparison of bonding capabilities of CO, N_2 and CS towards metals. Comparison of binding energies in isoelectronic series- Ne, HF, H_2O , NH_3 and CH_4 . Photo electronic spectra of transition metal carbonyls and metal halides. Koopmans' theorem.

Jablonskii diagram, Fluorescence and phosphorescence and factors affecting these, Calculation of excited state life-times from absorption data, Quenching of fluorescence, Stern-Volmer equation.

UNIT IV

Diffraction Methods, Atomic scattering factors, Scattering by a small crystal, Direct and reciprocal lattice, Miller indices, Bragg's law and Laue's equations, Structure factors, application to some common metal and metal salt structures (rock salt, zinc blende), Space groups, Glide planes and screw axes, Structure determination for organic crystals like naphthalene, Fourier series, Patterson's functions, Heavy atom method, Comparison of X-ray method with electron and neutron diffraction methods.

Electron diffraction - Basic principles, Weirl equation and application to simple molecules. Electron energy loss spectroscopy (EELS), EXAFS AND SEXAFS

UNIT V

Mass Spectrometry Principles, Instrumentation, Different ionizing techniques (EI, CI, FD, FAB, ESI, MALDI) - Various analysers (Magnetic sector, Quadrupole, Ion trap, ToF), Factors affecting fragmentation, ion analysis. Ion abundance, Analysis of mass spectrum, simple cleavage - β cleavage - allylic cleavage, benzylic cleavage, Factors affecting fragmentation pathways - Mc-Lafferty rearrangement, ortho effect, Fragmentation patterns of common organic compounds. Problems based on UV, IR, NMR and Mass spectral data.

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UNIT I

Drug Design- Development of new drugs, procedures followed in drug design, structure- activity relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery. Factors affecting bioactivity. QSAR, LD-50, ED-50

UNIT II

Principles of Green Chemistry and its applications-solvent free reactions-microwave assisted synthesis- role of ionic liquids in green chemistry-cleaner technology with super critical fluids-catalytic approach to green chemistry(use of zeolites, clays, mesoporous materials)- waste water treatment by oxidation technology at ambient conditions-remediation methods for textile effluents, green chemistry bio catalytic reactions. Biotransformations: Classification of enzymes, advantages and disadvantages, applications in organic synthesis; Principles of ultrasound and microwave assisted organic synthesis.

UNIT III

Retrosynthesis and its strategies- Synthones and Types - Synthetic Equivalent - Target Molecule , Functional Group Inter conversion. Guidelines to a Good Disconnection-Order of Events ,1,2 - 1,3 -1,4 - 1,5 and 1,6 Difunctional Disconnections- Chemo selectivity , Regioselectivity , Protecting groups , Use of aliphatic nitro compounds in organic synthesis , A high light on the use of acetylenes in the synthetic chemistry- Retro synthetic analysis of organic molecules.

Enolates, Thermodynamic versus Kinetic enolates, enolate equivalents and enamines: Applications in carbon-carbon bond formation and related reactions. Applications in chiral synthesis.

Umpolung reactions (sulphur compounds, nitro compounds, lithiated ethers and related compounds).

UNIT IV

Optical isomerism, cause of optical activity, molecular dissymmetry, relative and absolute configurations, nomenclature of optical isomers, Sequence rule, Principles of Optical rotatory dispersion and circular dichroism: Phenomena of ORD and CD. Classification of ORD and CD Curves; Cotton effect curves and their application to stereochemical problems; the Octant rule and its application to alicyclic ketones Application of ORD, MORD and MCD. Optical activity in the absence of chiral carbon (biphenyls, spiranes, allenes and helical structures). Stereochemistry of Silicon, Germanium, Selenium and Tin compounds

UNIT V

Reagents and reactions

Functional group transformations, Reagents for the inter conversion of various groups, Special and specific oxidizing agents, reducing agents and organo metallic compounds for the inter conversions, The survey of reactions and reagents, Gilman's reagent, LDA, DCC, 1,3-dithiane, Trimethyl silyl iodide, Wilkinson's catalyst, DDQ.

Reduction, Use of NaH, LiAlH₄, Tri-tertiary butoxy Aluminium Hydride, NaCNBH₃, SiMe₃H, Alkali metal in Acidic, Basic, Neutral solvents, Hydrazines. Oxidation- OsO₄, CrO₂Cl₂, O₃, HIO₄, Dioxane, lead tetra acetate, SeO₂.

Catalytic hydrogenation and dehydrogenation, DMSO either with Ac₂O or Oxalyl chloride, Dess-Martin reagent. LDA, Phase transfer catalysis (PTC), Merrifield resin, Baker's yeast.

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UNIT I

Organometallic chemistry General introduction, Structure and bonding, Survey of organometallic complexes according to ligands. π bonded organometallic compounds including carbonyls, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds and their M.O. diagrams. Metal-carbon multiple bonds. Fluxional organometallic compounds including π -allyl complexes and their characterization. Futuristic aspects of organotransition metal chemistry. Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxoreaction), activation of C-H bond.

UNIT II

Fundamentals of inorganic biochemistry, geo-chemical effects on life systems, essential and non-essential elements in bio-systems.

Bioinorganic Chemistry of Toxic Metals- Detoxification by Metal Chelation-Drugs which add by binding at the metal sites of Metalloenzymes- Radiation risks and medical benefits- Natural and Man made Radio isotopes- Bio inorganic chemistry of Radio Pharmaceuticals, Platinum Complexes in Cancer Therapy- Cisplatin and its mode of action, Gold containing Drugs as Antirheumatic Agents and their mode of action, Lithium in Pschycopharmacological Drugs. Futuristic aspects of organo transition metal complexes as catalysts and in bio-inorganic chemistry.

UNIT III

Synthesis of Novel Coordination Compound

Design and Synthesis of macrocyclic Ligands - Synthetic Procedures - Direct Macrocyclic synthesis, Microwave assisted synthesis - Metal ion template synthesis, Macrocyclic systems

Macro cycles with pendant functional group - Catenands, Cage macrocycles, Cryptands and Crown Polyethers - Binucleating macrocycles, Compartmental Ligands. Natural macrocycles - Host-guest chemistry- macrocyclic host and non metallic guests.

Analytical techniques to determine the nature of the complexes. Elemental analysis, Estimation of metal ions, Conductivity and magnetic measurements.

UNIT IV

Inorganic Nanomaterials and Their Applications:

Introduction to nanomaterials, Physicochemical properties of nanomaterials (Optical, Electrical, Electronic Redox, Mechanical, Magnetic and catalytic). Synthesis and Preparation of nanostructured oxides and chalcogenides. Influence of nanomaterials on health, communication, energy, environment, safety, security and defence. Special applications of nanomaterials, sensor, energy storage, nanoelectronics and computing structural materials (Nanocomposites) catalysis communication, nanomedicine. Advanced nanomaterials Si, C, Ag, Au, Pt nanoparticles.

UNIT V

Thermal methods of analysis:

Thermogravimetry, Differential Thermal Analysis and Differential Scanning Calorimetry, instrumentation. Methodology of TG, DTA and DSC. Thermomechanical analysis, Dynamic mechanical analysis. Application of TGA, study of oxalates and chromates. Determination of Glass transition, Heat capacity determination, Characterization of polymer blends. Problems of based on decomposition path way and % composition. Thermometric titrimetry - theory, instrumentation, applications.

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Unit I

Concepts and Language

Properties of covalent bonds-bond length, inter-bond angles, force constant, bond and molecular dipole moments. Molecular and bond polarizability, bond dissociation enthalpy, entropy. intermolecular forces, hydrophobic effects. Electrostatic, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects. Hydrogen bond.

Unit II

Molecular recognition

Molecular receptors, design and synthesis of receptors and coreceptor molecules Multiple recogn Molecular devices ition, Principle of molecular association and organizations, utilization of H bonds to creat supramolecular structures and crystal engineering, Novel liquid crystals, Fullerenes, Dendrimers, Cation and anion binding hosts, binding of neutral molecules and organic molecules. Transport processes and carrier design, Ion Channels

Unit III

Molecular devices and sensors

Principle and types- Electronic Photonic and Ionic devices, Chemical sensors, Glass membrane sensors, Polymer membrane chemical sensors(Ca^{2+} , K^+ , F^- , NO_3^- Ion sensors) Biosensors Glucose and cholesterol biosensor, Biosensor to determine the freshness of fish, Implantable electrodes.

Unit IV

Nanotechnology

Concept and future prospects, elementary idea of miniaturized total analysis system (μTAS), Preparation of nano particles -various methods- RF plasma, chemical methods, thermolysis, pulsed laser methods, optical and electrical properties of nanoparticles. Characterization of nano particles-experimental methods-powder X-ray diffraction, transmission electron microscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy(AFM).

Reduced dimensionality in solids – zero dimensional systems, quantum dots. Optical properties of quantum dots. One dimensional systems, carbon nano tubes, electric, mechanical and other properties.

Unit V

Smart Materials and Nanomedicine

Calixarenes, Catenanes, Rotaxanes, Drug Encapsulation, functional drug carriers, Smart materials, smart instruments, surgical robots, Tissue Regeneration Scaffolds, Imaging devices

Applications of nano particles in – photocatalysis, laser and light emitting diodes, optical filters, optical band gap materials. Use of carbon nano tubes in fuel cells and catalysis.

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Text Books

- Practical Skills in Chemistry, J. R. Dean, A. M. Jones, D. Holmes, R. Reed, J. Weyers and A Jones, Pearson Education Ltd. [Prentice Hall] (2002)
- OSU safety Manual 1.01.
- Research Methodology. Methods and Techniques : C. R. Kothari,
- Tests, Measurements and Research Methods in Behavioural Sciences : A. K. Singh
- Physical Method in Chemistry, R.S.Drago, Saunders College Publishing.
- Computers and Common Sense R. *Hunt and Shelley*, Prentice Hall, New Delhi (1998)
- Computer Programming in Fortran-90 V. *Rajaraman*, Prentice Hall, New Delhi (1990)
- Computer and Chemistry: introduction to programming and numerical methods T. *R. Dickson*, Freeman (1968)
- Computer programs for chemistry D. F. *Detar* W. A. Benjamin Inc, New York Vol. 1-3 (1968-69)
- Instrumentation to modern chromatography by L.R.Snyder and J.J.Kirkland (John wiley and sons, Inc) II Edition.
- Analytical Method development and validation by Michael Swatz & Iras.Krull.
- Analytical Instrumentation performance characteristic and quality by Graham Currell.
- Organic Chemistry (VI edition) - R.T Morrison, R.N. Boyd. Prentice Hall of India Pvt Ltd, (2003)
- Organic Chemistry - I.L. Finar, 6th Edition (Low price) Pearson Education, 2003
- Organic Chemistry- (V edition) - John Mc Murry), Asian Book Pvt Ltd, New Delhi
- Advanced organic chemistry (IV edition) - Jerry March
- Reaction Mechanisms and Problems in Organic Chemistry–P.Chattopadhyay, Asian Book Pvt Ltd, New Delhi (2003)
- Reactive Intermediates in Organic Chemistry-J. P. Trivedi, Univ. Granth Nirman Board
- Principles of Reaction Mechanism in Organic Chemistry - Parmar-Chawla
- A text book of Organic Chemistry, - Raj K. Bansal, New Age International (P) Ltd. 4th Edition 2003
- Organic Chemistry, T.W. Graham Solomn, Craig B. Fryble, Low Price 8th Edition, John Wiley & Sons, Inc.
- Organic Chemistry, V. K. Ahluwalia & Madhuri Goyal, Narosa Publishing House, (2000).
- Molecular Orbital Theory for Organic Chemists, A. Streitweiser, Jr, Wiley International (1961) and Subsequent Edition
- Fundamentals of analytical chemistry - D. A. Skoog, D. M. West, F. J. Holler and Crouch.
- Analytical Chemistry - G. D. Christian.
- Analytical Chemistry - Principles – J. K. Kennedy and W. B. Saunders.
- Instrumental Methods of Chemical Analysis – B. K. Sharma.
- Food Analysis – S. N. Mahindru.
- Instrumental Methods of Chemical Analysis – Willard, Merit and Dean.
- Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et. al. ELBS.
- Ecology of Polluted water and Toxicology – K. D. Mishra.
- Environmental Guidelines and Standards in Indian - P. K. Goel & K. P. Sharma.
- Enzyme Biotechnology – G. Tripathi.
- Industry, Environment and Pollution – Arvind Kumar and P. K. Goel.
- Manual on water & waste water analysis - Neeri
- Water Pollution - Dr. V. P. Kudesia.
- Basic concepts of Environmental Chemistry - Des W. Connel.

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- Manual on Water and Wastewater analysis - Dr. B. B. Sundarsan.
- Liquid waste of Industry: Theories Practices and Treatment by Nelson L. Nemerow.
- Principle and Application of Organotransition Metal Chemistry, Collman & Hegsdus, University Science Books.
- The Organometallic Chemistry of the Transition Metals ,R.H. Crabtree, John Wiley.
- Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
- Principle of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
- The Inorganic Chemistry of Biological Processes, M.N. Hughes, John Wiley & Sons.
- Bioinorganic Chemistry, G.R. Chatwal and A.K. Bhagi, Himalaya Publishing House.
- Modern Spectroscopy, J.M. Hollas, John Wiley.
- Textbook of Inorganic Chemistry Vol.I &II, A.Singh & R.Singh, Campus International Publication
- Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley
- Separation Chemistry, R. P .Budhiraja, New Age International
- A First Course in Polymer Chemistry, Mir Publishers, Moscow.
- Physical Chemistry of Polymers, A Tager, Mir Publishers, Moscow.
- Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.
- Polymer Chemistry, Bruno Vollmert. Springer, New York.
- Principles of Polymer Systems, F. Rodriguez, McGraw Hill.
- Polymer Science, V. R. Gowariker, N. V. Vishwanathan and J. Shreedhar, Willey Eastern Ltd., New Delhi.
- Physical Chemistry of Macromolecules, D. D. Deshpande, IIT, Bombay
- Polymer Chemistry An Introduction, Malcolm P. Stevens, Addition-Wesley Publishing Company, Inc.
- Spectrometric identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
- Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
- Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
- Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.
- Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Ltd.
- Modern Spectroscopy, J.M.Hollas, John Wiley
- Physical Methods in Chemistry , R.S.Drego , Saunders Collge
- Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill
- Structural methods in Inorganic Chemistry, Ebsworth & Rankin, ELBS
- Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley
- Introduction to Megnetic Resonance, Carrington and Maclachalan, Harper &Row
- Chemical Application Of Group Theory, F.A.Cotton, W E S Wiely
- Principle of Bioinorganic Chemistry, S.J.Lippard and J.M.Berg, University Science Books.
- The Inorganic Chemistry of Biological Processes, M.N.Hughes, JohnWiley & Sons.
- Bioinorganic Chemistry, G.R.Chatwal and A.K.Bhagi, Himalaya Publishing House.
- Inorganic Biochemistry vols. I and II ed., G.L.Eichhorn, Elsevir.
- Advance Inorganic Chemistry, Cotton & Wilkinson, Weily Elsevier.
- Principle and Application Of Organotransition Metal Chemistry, Collman & egsdus, University Science Books.
- The Organometallic Chemistry of the Transition Metals ,R.H. Crabtree, John Wiley.
- Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
- Metallo-Organic Chemistry, A.J. Pearson, Wiley.

- Designing organic synthesis - S. Warren, Wiley.
- Some modern methods for organic synthesis - W. Carruthers.
- Principles of organic synthesis - R. Norman & J. M. Coxon.
- Advanced organic chemistry Part B – F.A. Carey & R. J. Sundberg.
- Organic synthesis - concept, methods & starting materials – J. Fuhrhop.
- Modern synthetic reactions - H.O. House, W.A. Benjamin.
- Disconnection approach – Warren
- Organic chemistry, Vol 2., - I.L. Finar.
- Stereoselective synthesis: A practical approach - M. Nogradi.
- Chemistry, Biological and Pharmacacological properties of medicinal plants from the Americas - Ed. Kurt. M. P. Gupta and A. Marston.
- New trends in Natural product chemistry – Alta – Ur- Rahman and M.I. Choudhary.
- Chemistry or Natural Products, Krishnasamy N.R, 1999, , Hyderabad, University Press.
- Modern Experimental Biochemistry, II Ed Boyer RF, 1993,, California, The Benjamin /Cummings publishing company Inc.
- Liquid Crystals and Plastic Crystals, Vol. 1, W. Gray and P. A. Windsor Ch.4.1 and 4.2
- Elements of X-ray Crystallography, L. V. Azaroff, Mc Graw-Hill N.Y.
- Physical Chemistry, P. C. Rakshit.
- Physical Chemistry, Danial Alberty, Mc Graw-Hill.
- Text book of Physical Chemistry, S. Glasstone, Macmilan.
- Principles of the Solid State, H. V. Keer, New Age, New Delhi.
- Nuclear Chemistry and its applications – By. Haissionsky – Addison Wesley
- Nuclear and Radio Chemistry – By. G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller – A Wiley – Interscience Publication, John Wiley and Sons –III rd Edition.
- Radio Chemistry – By An. N. Nesmeyanov, Mir Publishers.
- Artificial Radioactivity – By. K. Narayana Rao and H. J. Arnikaar – Tata McGraw Hill Publishing Company Ltd. New Delhi
- Modern methods of organic synthesis, William Carruthers and Iain Coldham, Cambridge University press, Fourth Ed. 2004.
- Experiments and Techniques in organic chemistry, D Casto, C Johnson and M. Miller, Prentice-Hall.
- Practical Pharmaceutical Chemistry, CBS Publishers ND Fourth Ed. In Part I& II, By A H Beckett and J B Stenlake.
- Elementary Practical organic chemistry Part I, II, II, Arthur I. Vogel. (2nd edition) CBS Publishers & Distributors.
- Vogel's Text book of Quantitative analysis, Revised by J Bassett, R C Denney, G H Jeffery, and J Mendham, ELBS.
- Synthesis and Characterization of Inorganic Compounds, W L Jolly, Prentice Hall.
- Microscale and Miniscale Organic Chemistry Laboratory Experiments, McGraw Hill, By A M Schoffstall, B A Gaddis, and M L Druelinger.
- Statistics for Analytical chemists, First Ed. 1983, By R Caulcutt and R Boddy, Chapman & Hall.
- Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
- Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
- Inorganic Biochemistry vols I and II. Ed. G.L. Eichhorn, Elsevier.
- Introduction to nanotechnology. Charles P. Poole Jr, F.J. Owens, Wiley India Pvt. Ltd

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- Solid state chemistry and applications. A.R.West
- New directions in solid state chemistry. CNR Rao and Gopalakrishnan
- Principles of the Solid State, H. V. Keer, New Age International
- Material Science and Engineering – An Introduction, William D. Callister, Jr., John Wiley & Sons
- Materials Science & Engineering – A First Course, V. Raghavan, Prentice Hall
- Nanostructured Materials and Nanotechnology, edited by Hari Singh Nalwa, Academic Press
- Self Assembled Nanostructures, Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen & Gang-Yu-Liu, Kluwer Academic/Plenum
- Nanotechnology: A Gentle Introduction To The Next Big Idea, Ratner and Ratner
- Membrane mimetic chemistry: characterizations and applications of micelles, microemulsions, monolayers, bilayers, vesicles, host-guest systems, and polyions , Fendler
- Advances in Nanoscience & Nanotechnology, Ashutosh Sharma, Jayesh Bellare, Archana Sharma
- Principles of Nanotechnology: Molecular-Based Study of Condensed Matter in ... , G. Ali Mansoori
- BioNanotechnology, Elisabeth S. Papazoglou, Aravind Parthasarathy