DEPARTMENT OF CHEMISTRY

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY,

(MUST) Mirpur

Scheme of Studies

MPhil and PhD Chemistry

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY (MUST), MIRPUR

AZAD JAMMU & KASHMIR

SCHEME OF STUDIES FOR MASTER OF PHILOSOPHY IN CHEMISTRY

Duration:	**4-8 Semesters**
Courses:	**24 credits**
Thesis:	**06 credits**
Seminar:	**01 credits**
Total:	**31 Credits**

Courses

I. Physical Chemistry

CHM-701 Physical Chemistry of Polymers (Cr. 3)

CHM-702 Advanced Quantum Chemistry (Cr. 3)

CHM-703 Electrode Process (Cr. 3)

CHM-704 Magnetic Resonance Spectroscopy (Cr. 3)

CHM-705 Advanced Chemical Kinetics (Cr. 3)

CHM-706 Advanced Molecular Spectroscopy (Cr. 3)

CHM-707 Advanced Photochemistry (Cr.3)

CHM-708 Advanced Surface Chemistry (Cr. 3)

CHM-709 Advanced Solution Chemistry (Cr. 3)

CHM-710 Chemistry of Advanced Materials (Cr. 3)

CHM-711 Advanced Statistical Mechanics (Cr. 3)

CHM-712 Solid State chemistry (Cr. 3)

CHM-713 Colloid Chemistry (Cr. 3)

CHM-714 Advanced Nuclear and Radiation Chemistry (Cr. 3)

CHM-715 Applied Chemical Thermodynamics (Cr. 3)

CHM-716 Electroanalytical Methods and Techniques (Cr. 3)

CHM-717 Synthesis of Nanomaterials by Chemical and Physical Routes (Cr. 3)

CHM-718 Physical Chemistry of Environment (Cr.3)

CHM-719 Special Topics in Physical Chemistry (Cr. 3)

CHM-720 Polymer Physics (Cr. 3)

II. Inorganic Chemistry

CHM-721 Multinuclear NMR Spectroscopy (Cr. 3)

CHM-722 Inorganic Electronic Spectroscopy (Cr. 3)

CHM-723 Kinetics and Mechanisms of Inorganic Reactions (Cr. 3)

CHM-724 Organo-transition Metal Chemistry (Cr. 3)

CHM-725 Bio-Inorganic Chemistry (Cr. 3)

CHM-726 Physical Methods in Inorganic Chemistry (Cr. 3)

CHM-727 Inorganic Material Chemistry (Cr. 3)

CHM-728 Catalysis (Cr. 3)

CHM-729 Special Topics in Inorganic Chemistry (Cr. 3)

CHM-730 Advanced Material Chemistry (Cr. 3)

CHM-731: Advanced Polymer Science
CHM-732: Computational Chemistry
CHM-733: Chemistry of Composite Materials
CHM-734: Materials Science I
CHM-735: Materials Science II
CHM-736: Solid State Electronic Devices
CHM-737: Physics of Semiconductors and Devices
CHM-738: Characterization Techniques in Materials

CHM-739 Electronic Materials Processing
CHM-740 Advanced Energy Conversion Devices (Cr. 3)

III. Organic Chemistry

CHM-741 Protecting Groups in Organic Synthesis (Cr. 3)

CHM-742 Organic Synthesis-Retrosynthetic Approach (Cr. 3)

CHM-743 Advanced Stereochemistry (Cr. 3)

CHM-744 Physical Organic Chemistry (Cr. 3)

CHM-745 Nuclear Magnetic Resonance in Organic Chemistry (Cr. 3)

CHM-746 Advances in Chromatographic Techniques (Cr. 3)

CHM-747 Chemistry of Isoprenoids and Steroids (Cr. 3)

CHM-748 Chemistry of Glycosides (Cr. 3)

CHM-749 Biosynthesis of Natural Products (Cr. 3)

CHM-750 Chemistry of Organometallic Compounds (Cr. 3)

CHM-751 Reactive Intermediates in Organic Chemistry (Cr. 3)

CHM-752 Advanced Heterocyclic Chemistry (Cr. 3)

CHM-753 Advanced Mass Spectrometry (Cr. 3)

CHM-754 Organic Photochemistry (Cr. 3)

CHM-755 Organic Polymer Chemistry (Cr. 3)

CHM-756 Pericyclic Reactions (Cr. 3)

CHM-757 Advanced Stereoselective Synthesis (Cr. 3)

CHM-758 Modern Name Reactions in Organic Synthesis (Cr. 3)

CHM-759 Special Topics in Organic Chemistry (Cr. 3)

CHM-760 Advanced Natural Product Chemistry (Cr. 3)

IV. Analytical Chemistry

CHM-761 Frontiers Nanomaterials for Bio-applications (Cr. 3)

CHM-762 Advanced Analytical Instrumental Techniques (Cr. 3)

CHM-763 Advanced Thermal Analysis (Cr. 3)

CHM-764 Water and Soil Chemistry (Cr. 3)

CHM-765 Analysis and Characterization of Polymers (Cr. 3)

CHM-766 Advanced Atomic Spectroscopy (Cr. 3)

CHM-767 Atmospheric Chemistry (Cr. 3)

CHM-768 Chromatographic Methods of Analysis (Cr. 3)

CHM-769 Diffraction Methods of Analysis (Cr. 3)

CHM-770: Experimental Techniques in Nanotechnology

CHM-771 Applied Industrial Processes (Cr. 3)

CHM-772 Special Topics in Analytical Chemistry (Cr. 3)

V. Biochemistry

CHM-781 Biochemistry of Disease (Cr. 3)

CHM-782 Advances in enzyme structure and function (Cr. 3)

CHM-783 Fermentation and Biotransformation(Cr. 3)

CHM-784 Fundamentals of Molecular Biology (Cr. 3)

CHM-785 Metabolomics (Cr. 3)

CHM-786 Metabolic regulations (Cr. 3)

CHM-787 Biological Oxidations (Cr. 3)

CHM-788 Lab Techniques in Biochemistry (Theory + Lab Work) (Cr. 3)

CHM-789 Biostatistics (Cr. 3)

CHM-790 Research Methodology and scientific writing (Cr. 3)

CHM-791 Techniques in Molecular Biology (Cr. 3)

CHM-792 Special Topics in Biochemistry (Cr. 3)

CHM-793 Forensic Chemistry (Cr. 3)

CHM-794 Drug Designing (Cr. 3)

7. Dissertation/Research/Seminar (For M.Phil. Students)

CHM-798 Seminar (Cr.01)
CHM-799 Thesis (Cr. 06)

Course Contents of MPhil Courses

Physical Chemistry

CHM-701 Physical Chemistry of Polymers (Cr. 3)

Polymer interactions: Molecular forces and chemical bonding in polymers; configuration and conformation of polymer chains. Dimensions of polymer chain; RMS un-perturbed end-to-end displacement length. Polymer .solutions: Expansion factor in solutions; physical parameters affecting the chain dimensions; theta conditions. Theories of polymer solutions; phase separation and fractionation; solubility parameters; criteria for solubility. Plasticisation. Molecular weights of polymers: Molecular size measurement. Techniques for measuring: number-average; weight-average; z-average and viscosity-average molecular mass; universal curve. Spectroscopic analysis: UV, FTIR and NMR techniques. Thermal analysis: TGA; DSC; DMA; glass transition temperature. Morphology: Amorphous and crystalline structures; semicrystalline nature; viscoelasticity; models and predictions; time-temperature dependency; polymer reheology; electrical and magnetic properties of polymers.

Recommended Books

1. A. Ravve, Principles of Polymer Chemistry, 2nd ed., Plenum Publishers, New York (2000).
2. F.W. Billmeyer, Jr., Textbook of Polymer Science, John Wiley & Sons, New York (1994).
3. J.R. Fried, Polymer Science and Technology, Prentice Hall/PTR (1995).
4. C.E. Carraher, Seymour/Carraher's Polymer Chemistry, 5th ed., Marcel Dekker, New York (2000).
5. J. Furnkaw, Physical Chemistry of Polymer Rheology, Springer-Verlag, Berlin (2003).
6. C. Tanford, Physical Chemistry of Macromolecules, John-Wiley and Sons, New York (1961).

CHM-702 Advanced Quantum Chemistry (Cr. 3)

A brief overview of basic concepts and solution of four representative systems: Particle in a box, simple harmonic oscillator, rigid rotor and hydrogen atom. Appropriate methods: Variation and perturbation methods; application of variation method to molecular orbitals. Many electron atoms: Slater's determinants, electron spin and spin orbit interaction. Molecular orbital (MO) and valence bond (VB) theory: Homonuclear and homonuclear diatomic molecules. Semiempirical and ab-initio: MO treatment of molecules.

Recommended Books

1. I.N. Levine, Quantum Chemistry, 5th ed., Prentice Hall, New Jersey (2000).

2. A. Szabo, Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, Revised 1st ed., McMillan, New York (1996).

3 A. Szabo and N.S. Ostund, Modern Quantum Chemistry, McMillan, New York (1982).

CHM-703 Electrode Process (Cr. 3)

Overview of electrode processes: Kinetics of electrode reactions. Mass transfer by migration and diffusion. Electroanalytical techniques: potential step and potential sweep methods. Electrochemical impedance spectroscopy: Effects of solution resistance and double layer capacitance. Electrode reactions with coupled homogeneous chemical reactions. Industrial electrochemistry: Corrosion study: detection, measurement, monitoring and remedial. Energy conversion systems: fuel cells and batteries. Digital simulation of cyclic voltammograms.

Recommended Books

1. A.J. Bard and L.R. Faulkner, Electroanalytical Chemistry, Marcel Dekker (1993).

2. D. Pletcher and F.C. Walsh, Industrial Electrochemistry, 2nd ed., Blackie Academic & Publisher (1993).

3 J.O'M. Bockriss, A.K.N. Reddy, and M.F. Gomboa, Modern Electrochemistry: Electrodes in Chemistry, Engineering, Biology and Environmental Science, 2nd ed., Springer (2000).

4 M. Mohammad and M. Amjad, Principles of Electrode Kinetics, Rooha Printers, Lahore (2000).

Item 1: 5 P.H., Reiger, Electrochemistry, Chapman and Hall, New York (1994).

CHM-704 Magnetic Resonance Spectroscopy (Cr. 3)

Introduction to magnetic resonance: Principles of magnetic resonances spectroscopy; physical basis of nuclear magnetic resonance (NMR) spectroscopy; pulsed NMR methods. NMR spectral parameters: Chemical shift spin-spin coupling and its various types, treatment and analyses of AX_n, AMX and AB systems. NMR of nuclei other than ^1H and ^{13}C. NMR relaxation: Mechanisms and their applications. Other applications: Dynamic NMR; two-dimensional NMR spectroscopy and its various types. NMR applications in structure elucidation. Electron Spin Resonance (ESR) spectroscopy: Principles; applications to solids and solutions.

Recommended Books

1. H. Friebolin, One- and Two-Dimensional NMR Spectroscopy, VCH, Weinheim (1993).

2. J.K.M. Sanders and B.X. Hunter, Modern NMR Spectroscopy, 2nd ed., Oxford University Press, UK (1993).

3. R.S. Alger, Electron Paramagnetic Resonance, John Wiley, New York (1968).

4. E.D. Becker, High Resolution NMR: Theory & Chemical Applications, New York, Academic Press (1980).
5. W.R. Groasmun and R.M.K. Carlson, Two Dimensional NMR Spectroscopy, VCH Publishers, New York (1987).
6. J.A. Pople, High-Resolution Nuclear Magnetic Resonance, McGraw-Hill, New York (1959).
7. C.P. Pople, Electron Spin Resonance, John Wiley, New York (1967).
8. P.B. Ayscough, Electron Spin Resonance in Chemistry, Methuen & Co., London (1967).

CHM-705 Advanced Chemical Kinetics (Cr. 3)

Reactions in solutions: Diffusion-controlled reactions; applications of transition state theory; solvent effects on polar and ionic reactions; salt effects on reactions. Kinetic isotope effects. Chain reactions: Features of chain mechanisms; branching chain and oscillating reactions. Determination of reaction orders: Methods when the infinity reading is unknown; 0^{th}-order or fractional order reactions with respect to a single concentration; rate expression and method of flooding; reactions with complex dependence on a single concentration variable. Product catalyzed reactions: Dual solution in consecutive reactions; series reaction with reversible step; prior-equilibrium and improved steady-state approximation. Concentration-jump methods for opposing reactions. Methods of data analysis: Linear free energy relation (LFER). Hammett co-relation; acid-base catalysis; the Bronsted catalysis law; mechanisms of acid-base catalyzed reactions, reactivity-selectivity principle and iso-selectivity rule; intrinsic barrier and Hammond's postulate. Marcus equations and its applications.

Recommended Books

1. J.H. Espenson, Chemical Kinetics and Reaction Mechanisms, 2^{nd} ed., McGraw-Hill, Singapore (1995).
2. A.A.M. Frost and R.G. Pearson, Kinetics and Mechanism, 3^{rd} ed., Butterworths, London (1969).
3. R.A. Alberty and R.J. Silby, Physical Chemistry, John Wiley, New York (1995).

CHM-706 Advanced Molecular Spectroscopy (Cr. 3)

General: Introduction of molecular spectroscopy; molecular symmetry and group theory. Vibrators: Rigorous treatment of microwave and IR spectra of non-rigid and polyatomic molecules. Raman spectroscopy: Principles; applications to diatomic and simple molecules; normal coordinate analysis. Electronic spectroscopy: Introduction to theories of molecular bonding; classification of molecular orbitals and electronic transitions; selection rules; electronic spectra of diatomic and simple polyatomic molecules; dissociation and dissociation products; the Birge-Sponer method for characterization of the excited species; high resolution electronic spectra and rotational energy interaction; the Fortrat diagram and application.

Recommended Books

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 3rd ed., McGraw-Hill, UK (1983).
2. J.D. Graybeal, Molecular Spectroscopy, International Edition, McGraw-Hill Book Company, New York (1988).
3. J.M. Hollas, High Resolution Spectroscopy, 2nd ed., Wiley, USA (1998).

CHM-707 Advanced Photochemistry (Cr.3)

Principles of photochemistry: Primary and secondary chemical processes. Electron transfer in photochemistry: Collisional and coulombic modes; effect of temperature; eximers and exiplexes, the SET photochemistry, quantum yields. Kinetics and energetic of photochemical reactions: Mechanism of photochemical reactions; intersystem crossing; flash photolysis; mass spectrometric methods. Experimental methods in photochemistry: Low, medium and high pressure mercury lamps; resonance lamps; actinometers, phototubes; sources of high intensity flashes of light; laser and synchrotron radiations. Photolytic studies: Aqueous and non aqueous systems; effects of radiations on solids. Applications in daily life and industry: Picosecond and femtosecond flash photolysis, Supramolecular photochemistry.

Recommended Books

1. P. Suppan, Chemistry and Light, The Royal Society of Chemistry, London (1994).
2. R.P. Wayne, Principles and Applications of Photochemistry, Oxford University Press (1988).
3 J.G. Calvert, and J.N. Pitts, Photochemistry, John Wiley and sons Inc. New York (1966).
4 A. Cox and T.J. Kemp, Introduction of Photochemistry, McGraw-Hill, London (1971).

CHM-708 Advanced Surface Chemistry (Cr. 3)

Solid-liquid interface: Wetting; heat of wetting; thermodynamic description of an interface; Gibbs-Duhem equation for an interphase, Gibbs adsorption isotherm, adsorption from solutions (dilute, liquid mixtures, non-electrolytes, electrolytes, etc.) at solid-liquid interface; detergency and flotation. Study of liquid interfaces: Kelvin's and Laplace equations. Technical catalysis: Catalyst preparation techniques; catalytic reactors; supported metal catalysts; industrial applications of heterogeneous catalysts. Catalysis for steam-reforming, CO- & CO_2-methanation; water-gas shift; Fischer-Tropsch synthesis reactions. Catalysts for syntheses of: ammonia; nitric acid; chemical fertilizers etc.

Recommended Books

1. S.J. Gregg and K.S.W. Sing, Adsorption, Surface Area and Porosity, 2nd ed., Academic Press, London (1982).
2. G.C. Bond, Heterogeneous Catalysis: Principles and Applications, 2nd ed., Clarendon Press, Oxford (1987).
3. M.J. Jaycock and G.D. Parfitt, Chemistry of Interfaces, Ellis Harwood Ltd, Chichester, UK (1981).

CHM-709 Advanced Solution Chemistry (Cr. 3)

Solutions: Classification; their importance in chemistry, industry and life science. Interactions in solutions: Concept of solute and solvent; multicomponent systems; preferential solvation. Solvents: Their characterization; microscopic structure of solvent and solvates; pair distribution function (PDF) and its determination using different techniques (spectroscopy and diffraction). Molecular dynamics and microscopic structure; different techniques of molecular dynamical calculations. Theories and laws related to solutions. Macroscopic properties of solutions: Transport properties; thermodynamics of solution; equilibria in solutions.

Recommended Books

1. C. Reichhardt, Solvents and Solvent Effects in Organic Chemistry, 2nd ed., VCH, Weinheim, Germany (1988).
2. J.H. Hildebrand, J.M. Prausnitz and R.L. Scott, Regular and Related Solutions, Van Nostrand Reinhold Company, New York (1970).
3. O. Popovych and R.P.T. Tomkins, Nanoaqueous Solution Chemistry, John Wiley & Sons, New York (1981).
4. D. Tabor, Gases, Liquids and Solids, 3rd ed., Cambridge University Press, UK (1993).
5 R.C. Reid and T.K. Sherwood, The Properties of Gases and Liquids, McGraw-Hill Book Company, New York (1986).
6. K. Shinoda, Principles of Solution and Solubility, Marcel Dekker, Inc., New York (1988).
7 H.J. Butt, G. Graf and M. Kappl, Physics and Chemistry of Interfaces, John Wiley-VCH, Weinheim (2003).

CHM-710 Chemistry of Advanced Materials (Cr. 3)

Introduction: Definitions and classification; natural composites; property enhancement by reinforcement and orientation; matrix interface; synthetic fibers; processing of composites. Examples: Metallic; ceramic and polymeric matrices; interface reactions. Properties: Mechanical and thermal properties of composite materials; stress relaxation and creep studies; dynamical mechanical properties, toughening mechanisms and mechanical failure in polymeric composites.

Recommended Books

1. F.L. Mathews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman and Hall (1994).
2. R.E. Shalin, Polymer Matrix Composites, Chapman and Hall (1995).
3 R.S. Scifullon, Physical Chemistry of Inorganic Polymeric and Composite Materials, Ellis Harwood (1992).

CHM-711 Advanced Statistical Mechanics (Cr. 3)

Introduction: Statistical mechanics and its significance for chemical systems. Ensembles: microcanonical, canonical and grand canonical. Probability: Discrete states; continuously varying probabilities. Average values: concepts of number average and time average, fluctuations and standard deviations. Partition functions: Concept; different types; their determination for diatomic and polyatomic molecules. Partition functions of the systems of very large number of particles. Relationship between partition function and thermodynamic functions. Statistical mechanical treatment: Chemical equilibria and chemical reactions; imperfect gases; liquid state; dilute solutions: perfect crystals. Applications of Ferm-Dirac and Bose-Einstein statistics and their mutual comparison with Boltzman Maxwell statistics.

Recommended Books

1. F. Reif, Statistical Physics (Berkeley Physics Course), McGraw-Hill, New York (1965).
2. N. Davidson, Statistical Mechanics, McGraw-Hill, New York (1962).
3. T.L. Hill, Statistical Mechanics, McGraw-Hill, New York (1956).
4. J.G. Aston and J.J. Fritz, Thermodynamics and Statistical Thermodynamics, John-Wiley, New York (1959).
5. J.M. Seddon and J.D. Gale, Thermodynamics and Statistical Mechanics, RSC Publishers (2001).

CHM-712 Solid State Chemistry (Cr. 3)

Electronic structure of solids and band theory: Band structures of metals, insulators and semiconductors. Intrinsic semi-conduction and conductivity; controlled valency semiconductors; influence of temperature; dopant content, etc. Applications of semiconductors, p-n junctions. Band structure and color of inorganic solids. Thermoelectric (Thomson, Peltier, Seebeck) effects: Thermocouples. Hall effect, dielectric materials; ferroelectricity; pyro-electricity; piezo-electricity – their mutual relationships and applications. Behavior of substances in magnetic field: Effect of temperature: Curie and Curie-Weiss laws; calculation of magnetic moments; mechanism of ferro- and antiferro-magnetic ordering; super-exchange magnetic materials. Characterization techniques.

Recommended Books

1. W.D. Callister, Jr., Material Science and Engineering, 6th ed., John Wiley, New York (2003).
2. A.R. West, Solid State Chemistry, 2nd ed., John Wiley, Singapore (2002).
3. R.H. Bube, Electrons in Solids, 3rd ed., Academic Press, San Diego (1992).
4. J.R. Christman, Fundamentals of Solid State Physics, John Wiley, New York (1988).
5. K. Seeger, Semiconductor Physics, 6th ed., Springer-Verlag, Berlin (1997).
6. R.F. Pierret and K. Harutunian, Semiconductor Device Fundamentals, Addison-Wesley Longman, Boston (1996).
7. R.E. Hummel, Electronic Properties of Materials, 3rd ed., Springer-Verlag, New York (2000).

CHM-713 Colloid Chemistry (Cr. 3)

Liquid interfaces: Surface tension; capillarity. Young's and Kehrin equations. Spreading phenomenon; work of adhesion and cohesion; adsorption from solution; Gibbs-adsorption equation. Organized molecular assemblies: Insoluble surface monolayers, Langmuir Blodget films, surface presence-area diagrams. Surfactants: micellar structures and properties; micellar catalysis; bilayers and vesicles; membranes; micro- and macroemulsions; colloidal dispersions. Colloids: Colloidal stability and DLVO theory. Electrokinetics-zetapotenital and electrophoresis. Light scattering techniques; coagulation and flocculation.

Recommended Books

1. D.F. Evans, The Colloidal Domain, VCH, Weinheim (1994).
2. P.C. Hiemenzt and R. Rajagopalan, Principles of Colloid & Surface Chemistry, 3rd ed., Marcel Dekker, Inc., New York, Basel, Hong Kong (1997).
3. M.J. Rosen, Surfactants & Interfacial Phenomena, Marcel Dekker, Inc., New York (1989).
4. A.W. Adamson, Physical Chemistry of Surfaces, John Wiley & Sons Inc., New York (1990).
5. A.K. Arora and B.V.R. Tata, Ordering and Phase Transitions in Charged Colloids, VCH, Weinheim (1996).
6. A.G. Volkov, Liquid Interfaces in Chemical, Biological and Pharmaceutical Application, Marcel Dekker Inc., New York (2001).
7. M. Antonietti, Colloid Chemistry, Springer Verlag, Berlin ISBN: 3540004157.

G.L. Gains Jr., Insoluble Monolayers at Liquid-Gas Interface, John Wiley & Sons Inc., New York (1966).

CHM-714 Advanced Nuclear and Radiation Chemistry (Cr. 3)

Basic principles: Sources of nuclear radiation, radioactivity, nuclear-structure, models and stability, nuclear reactions. Nuclear track detectors: Kinetics and mechanism of track etching, tracers. Nuclear waste and its management: Nuclear hazards and benefits, transuranium elements and nuclear series, theoretical aspects of reactions, sources, absorption of radiations. Dosimetry: Categories, theoretical and experimental aspects, dose and dose rate. Radiolysis: Kinetic studies of radiolytic processes, radiolytic studies of: gaseous, aqueous and organic systems. Applications: Nuclear chemistry, radiobiology, analytical uses of radiation absorption.

Recommended Books

1. G. Choppin, J. Liljenzin and J. Rydberg, Radiochemistry and Nuclear Chemistry, 3rd ed., BH Publishers (2002).
2. K.H. Lieser, Nuclear and Radiochemistry, 2nd revised ed., Wiley-VCH (2001).
3. G. Friedlander and J.W. Kennedy, Nuclear and Radiochemistry, 3rd ed., Wiley, New York (1981).

4. W.J. Cooper, R.D. Curry and K.E. O'shea (Eds.), Environmental Applications of Ionizing Radiations, Wiley-IEEE (1998).

5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th ed., Wiley Eastern Ltd., New Delhi (1995).

6. A. Vertes and S. Nagy, Handbook of Nuclear Chemistry, Springer Verlag, Berlin (2003).

7. F. Aziz and M.A.J. Rodges, Radiation Chemistry, VCH, Weinheim (1987).

8. J.W.T. Spinks and R.J. Woods, An Introduction to Radiation Chemistry, 2nd ed., John Wiley, New York (1976).

9. R.J. Woods and A.K. Pikaev, Applied Radiation Chemistry: Radiation Processing, Wiley-IEEE (1993).

CHM-715 Applied Chemical Thermodynamics (Cr. 3)

Basic thermodynamics: Energy balance; entropy balance. Thermodynamic properties interrelations: Maxwell's equations; flow of fluids. Power production: The Rankine cycle, Brayton's cycle; fuel cells and batteries; internal combustion engine; compression and refrigeration. Vapor compression evaporation; vapor compression refrigeration, liquefaction of gases. Phase equilibrium: Non-ideal gas and liquid mixtures; chemical reaction equilbria.

Recommended Books

1. J. Winnik, Chemical Engineering Thermodynamics, John Wiley & Sons, Inc., New York (1997).

2. I.N. Levine, Physical Chemistry, McGraw Hill, New York (2002).

3 B.G. Kyle, Chemical and Process Thermodynamics, Printice Hall International, London (1999).

4 T. Letcher (Ed.), Chemical Thermodynamic for Industry, Royal Society of Chemistry, ISBN: 0854045910 (2004).

CHM-716 Electroanalytical Methods and Techniques (Cr. 3)

Basics of the instrumentation: Controlled potential techniques; controlled current techniques. Designing of electrochemical cells: Fabrication of electrodes; micro and ultra-microelectrodes; chemically modified electrodes. Solvents and supporting electrolytes. Electrocoupled methods: Electroorganic synthesis, photo-electrochemistry, spectro-electrochemistry. Voltammetric analysis: Normal pulse analysis; differential pulse analysis; squarewave analysis, AC voltammetry; chronomethods; stripping analysis. Bulk electrolysis: Electrogravimetric analysis; electroseparation techniques; coulometric analysis. Write up of experimental instrumentation and procedure.

Recommended Books

1. P.T. Kissinger and W.R. Heineman, Laboratory Techniques in Electroanalytical Chemistry, 2nd revised ed., Marcel Dekker Ltd., New York (1996).

2. A.J. Bard and L.R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd ed., Wiley (2001).

3. P.M.S. Monk, Fundamentals of Electroanlytical Chemistry (Analytical Techniques in Science), John Wiley & Sons (2001).

V.S. Bagotski, Elementals of Electrochemistry, 2nd ed., Wiley, New York (2005).

CHM-717 Synthesis of Nanomaterials by Chemical and Physical Routes (Cr. 3)

Introduction, requirements for energy applications, bottom-up and top-down approaches, solid, liquid and vapor phase synthesis, sol gel, precipitation and hydrothermal growth, zero-dimensional nanostructures, one-dimensional nanostructures, physical chemistry of solid surfaces (topics including surface energy, chemical potential, electrostatic and steric stabilization). Two experimental projects.

Vacuum technology, chemical vapor deposition, physical vapor deposition, sputter deposition, special deposition technology, thin films formation mechanism, fundamentals of microfabrication, synthesis of special nanomaterials (topics including carbon fullerenes and nanotubes, micro and mesoporous materials etc.) Two experimental projects.

Recommended Book:

1. Nanostructures and Nanomaterials Synthesis: Properties and Applications by Guo Zhong Cao, (Imperial College Press, 2004).

CHM-718 Physical Chemistry of Environment (Cr. 3)

Course Contents:

Environment and its resources:

Resource depletion and environmental pollution; green house effect; green house gases; mechanism of reactions causing pollution; interaction of pollutants with materials; noxious emission from industrial processes; aerosol production. **Chemistry of pollutants:** Nuclear waste and its management. Kinetic and thermodynamic aspects of atmospheric phenomena. Clean energy for future. **Experimental techniques for environmental monitoring.**

Recommended Books:

1. W.W. Eckenfelder, Jr., Industrial Water PollutionControl, McGraw-Hill International Edition (2000).

2. J.O.M. Bockris, Environmental Chemistry, Plenum Press, New York (1992).

3. S.E. Manahan, Environmental Science and Technology, Lewis Publishers, New York (1997).
4. J. Colls, Air Pollution-An Introduction, SPON Press, Taylor & Francis Group, London (1997).
5. R. Miroslav and N.B. Vladimir, Practical Environmental Analysis, The Royal Society of Chemistry, UK (1999).
6. J.H. Seinfeld, Atmospheric Chemistry and Physics of Air Pollution, John Wiley & Sons, New York (1986).
7. J.H. Seinfeld and S.N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley & Sons, New York (1998).
8. WHO, Guidelines for Air Quality, World Health Organization, Geneva (2000), (wwwwhoint/environmental information/Air/Guidelines/aqguide7pdf)
9. P. Patnaik, Handbook of Environmental Analysis, CRC Press Inc., Florida, USA (1997).
10. S.T. Holgate, J.M. Samet, H.S. Koren and R.L. Maynard, Air Pollution and Health, Academic Press, New York (1999).
11. R.A. Bailey, H.M. Clark, J.P. Ferris, S. Krause and R.L. Strong, Chemistry of the Environment, 2nd ed., Academic Press, London (2002).
12. R.M. Harrison, An Introduction to Pollution Science, The Royal Society of Chemistry, UK (2006).

CHM-719 Special Topics in Physical Chemistry (Cr. 3)

CHM-720 Polymer Physics (Cr. 3)

Course Contents:

Introduction of polymer materials, thermodynamics, weight, size and conformation of polymers, amorphous vs crystalline state of polymer, and methods of its determination, liquid crystalline state of polymer, mechanical behavior of polymer, effect of fillers on mechanical behavior of polymers, thermal behavior of polymer, effect of filler on thermal behavior of polymer, polymer modification and blending, modern topics in polymer physics.

Recommended Books:

1. M. J. Bowden, in Electronic and Photonic Applications of Polymers,M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society, Washington, DC, 1988.

2. D.Williams, in Electronic and Photonic Applications of Polymers, M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society,Washington, DC, 1988.
3. D. J.Williams, ed., Nonlinear Optical Properties of Organic and Polymeric Materials, ACS Symposium Series No. 283, American Chemical Society,Washington, DC, 1983.
4. N. A. Plate, R.V.Talroze, and V. P. Shibaev, in Polymer Yearbook 3, R. A. Pethrick and G. E. Zaikov, eds., Harwood, London, 1986.
5. P. Georlette, J. Simons, and L. Costa, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
6. J. Green, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
7. J.M. J. Fréchet and D.A.Tomalia, eds., Dendrimers and Other DentriticPolymers,Wiley, Chichester, England, 2001.

Inorganic Chemistry

CHM-721 Multinuclear NMR Spectroscopy (Cr. 3)

Introduction: Basic principle of NMR, instrumentation, sample preparation. Chemical shifts: ^{1}H, ^{13}C, ^{15}N, ^{31}P, ^{29}S and ^{11}B chemical shifts, factor affecting chemical shifts. Spin-spin coupling: Coupling constant, spin systems, H,H-coupling, C,H-coupling, C,C-coupling constants and chemical structures. NMR Experiments: Spin decoupling in ^{1}H and ^{13}C NMR, H,H-COSY, H,C-COSY, NOE and other experiments.

Recommended Books

1. H. Friebolin, Basic One- and Two-Dimensional NMR Spectroscopy, 4th ed., VCH Publishers, New York (2005).
2. A. Rehman, Nuclear Magnetic Resonance Spectroscopy, Press Manager, UGC Print Shop, Islamabad (1989).
3. J.K.M. Saunder, Modern NMR Spectroscopy, Oxford University Press, London (1989).
4. R.S. Macomber, A Complete Introduction to Modern NMR Spectroscopy, John-Wiley and Sons (1998).
5 T.D.W. Claridge, High Resolution NMR Techniques, Elsevier Science, Amsterdam (1999).
6 R.J. Abraham, J. Fischer and P. Lotus, Introduction of NMR Spectroscopy, Wily Chichester, USA (1988).

CHM-722 Inorganic Electronic Spectroscopy (Cr. 3)

Term symbols, Russel Saunders, coupling scheme, development of correlation and Tanabe-Sugano diagrams, crystal field diagrams. Energy level calculations; selection rules, band intensities and band assignments. Interpretation of crystal field and charge transfer spectra. Spectra of low symmetry complexes. Application of group theory to vibrational spectra of simple and coordination compounds.

Recommended Books

1. A.B.P. Lever, Introduction to Electronic Spectroscopy, Elsevier, Amsterdam (1968).
2. J.P. Facler, Symmetry in Coordination Chemistry, Academic Press, New York (1971).
3. Alan and Vincent, Molecular Symmetry and Group Theory, John Wiley, London (1977).
4 F.A. Cotton, Chemical Applications of Group Theory, 3rd ed., John Wiley, New York (1990).
5 J. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Addison-Wesley, Reading/Singapore (1993).

CHM-723 Kinetics and Mechanisms of Inorganic Reactions (Cr. 3)

Principles of kinetics. Steady state approximation. Determination of rate law. Inert and labile complexes. Substitution reactions of octahedral, square planer and tetrahedral complexes. Oxidation-reduction reactions of metal ions. Organo-transition metal compounds. Free radical reactions.

Recommended Books

1. D. Benson, Mechanisms of Inorganic Reaction in Solution: An Introduction, McGraw-Hill, London (1968).
2. F. Basolo and R.G. Pearson, Mechanisms of Inorganic Reactions: A Study of Metal Complexes in Solutions, 2nd ed., John Wiley, New York (1967).
3. D. Katakis and G. Gordon, Mechanisms of Inorganic Reactions, Wiley-Interscience, New York (1987).
4. S.R. Logan, Fundamentals of Chemical Kinetics, Longman, London (1996).
5. J.O. Edwards, Inorganic Reaction Mechanism: An Introduction, W.A. Benjamin, New York (1965).
6. R.C. Henderson, The Mechanisms of Reactions of Transition Metals, 5th ed., Oxford University Press (1993).

CHM-724 Organo-transition Metal Chemistry (Cr. 3)

Classification of organometallic compounds; transition metal to carbon sigma bonded compounds, complexes with metal-carbon pi bonds such as η^2–η^7. Synthesis, properties and nature of bonding in pi complexes. Complexes of molecular nitrogen, oxygen and carbon disulphide. Fundamental

processes in organometallics, fluxional and dynamic equilibrium, oxidative addition and reductive elimination, insertion and deinsertion, reactions of coordinated ligands. Catalysis by oraganometallic (stoichiometric and catalytic processes) compounds. Polymerization and oligomerization, synthesis with CO hydrogenation of olefin etc.

Recommended Books

1. A. Yamamoto, Organotransition Metal Chemistry Fundamental Concepts and Applications, John Wiley & Sons (1986).
2. M.L.H. Green, G.E. Coates and K. Wades, Organometallic Compounds, Methuen & Co. Ltd., (1968).
3. M. Bochmann, Organometallic 1 and 2, Oxford Science Publications (1994).
7. F.A. Cotton, G. Wilkenson, Advanced Inorganic Chemistry, 6^{th} Ed. John Wiley & Sons, (1999).

CHM-725 Bio-Inorganic Chemistry (Cr. 3)

Introduction: Development and importance of bio-inorganic chemistry. Metals and Complexes: Metals of biological importance. Function of metals in enzyme catalysis. Metalloproteins and enzymes containing a transition metal centre at their active site. Oxygen carriers; uptake and transport activation and utilization; synthetic dioxygen carriers; nitrogen fixation; vitamin B_6 and B_{12}. Importance of nonmetals in biological systems. Metal ions and chelating agents in biological systems.

Recommended Books

1. S.J. Lippard and J.M. Berg, Principles of Bioinorganic Chemistry, Panima Publishing Corporation, New Delhi (1997).
2. R.W. Hay, Bioinorganic Chemistry, Ellis Horwood, London (1984).
3. I. Bertim, H.B. Gray, S.J. Lippard and J.S. Valentine, Bioinorganic Chemistry, Viva Book Private Ltd. New Delhi (1998).
4. B.K. Keppler, Metal Complexes in Cancer Chemotherapy, VCH, Weinheim (1993).
5. M.F. Gielen, Metal Based Anti-tumor Drugs, Freund Publishing House Ltd. London (1988).

CHM-726 Physical Methods in Inorganic Chemistry (Cr. 3)

Infrared and Raman spectroscopy and their applications. Group theory and vibrational analysis. Application of ORD, CD, NMR, ESR and Mass Spectrometry to inorganic systems.

Recommended Books

1. J.B. Lambert and E.P. Mazzola, Nuclear Magnetic Resonance Spectroscopy, Prentice Hall, New Jersey, (2003).

2. D.L. Pavia, G.M. Lamp and G.S. Kriz, Introduction to Spectroscopy, 3rd ed., Thomson Learning, Inc., U.K. (2001).

3. R. Davis, M. Frearson, Mass Spectrometry, Analytical Chemistry by Open Learning, John Wiley and Sons, New York (1987).

3. C.G. Herbert, R.A.W. Johnstone, Mass Spectrometry, Basics, CRC Press London (2002).

4. M. Yonus, Organic Spectroscopy, AHP International (Pvt.) Ltd. Lahore, (1998).

CHM-727 Inorganic Material Chemistry (Cr. 3)

Introduction to inorganic materials, Application and interpretation of powder X-ray diffraction data of materials, The synthesis of inorganic materials – Solid state reactions, Precursor, solution and sol-gel methods, Solid-gas reactions, Hydrothermal method, CVD, Aerosol process, Low temperature method, Transition metal oxides, Electronic, magnetic and optical properties of inorganic materials, Nonstoichiometric compounds, Zeolites, intercalation in layer materials and solid electrolytes, Some recent developments in inorganic material chemistry.

Recommended Books

1. M.T. Weller, Inorganic Material Chemistry, Oxford University Press, Inc., New York (1994).

2. L. Smart and E. Moore, Solid State Chemistry, 2nd ed., Chapman & Hall (2004).

3. A.R. West, Basic Solid State Chemistry, 2nd ed., John Wiley & Sons, Ltd. (2000).

CHM-728 Catalysis (Cr. 3)

Physical adsorption, Chemisorption of gases on metals and metal oxides, textural and structural characterization of catalysts, Synthesis of porous solids, Kinetics of catalytic reactions, Catalysis and theoretical concepts, Catalytic process such as oxidation reactions, production of petrochemicals, environmental catalysis, polymerization and photocatalysis, Catalyst deactivation, Fuel cells.

Recommended Books

1. B. Viswanath, S. Sivasanker and A.V. Ramaswamy, Catalysis Principles and Applications, Narosa Publishing House, New Delhi, India (2006).

2. J. Hagen, Industrial Catalysis: A Practical Approach, 2nd rev. ed., Wiley-VCH, Weinheim, Germany (2006).

3. R. Richards, Surfaces and Nanomolecular Catalysis, CRC, Taylor/Frances, Boca Raton (2006).

4. K. Bucholz and V. Kasche, Biocatalysis and Enzyme Technology, Wiley-VCH, New York (2005).

5. I. Chorkendorff and J.W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, Wiley-VCH, Weinheim, Germany, New York (2003).

6. A. Weichkowski et al., Catalysis and Electrocatalysis at Nanoparticles Surfaces, Marcel Dekker, New York (2003).
7. B.K. Hodnett, Heterogeneous Catalysis Oxidation, John Wiley and Sons, New York (2000).
8. S. Bhaduri and D. Mukesh, Homogenous Catalysis: Mechanisms and Industrial Applications, John Wiley-Interscience, New York (2000).
9. J. Tsuji, Transition Metal Reagents and Catalysis: Innovation in Organic Synthesis, John Wiley and Sons, Chichester/New York (2000).
10. S.M. Robert, Biocatalysts for Fine Chemical Synthesis, John Wiley and Sons, Chichester (1999).
11 B.C. Gates, Catalytic Chemistry, John Wiley & Sons, New York (1992).
12. Bond, Heterogeneous Catalysis: Principles and Applications, Clarendon Press, Oxford (1986).
13. J.M. Thomas and R.M. Lambert (Eds.), Characterization of Catalysis, John Wiley & Sons, Chichester (1980).
14. G.C. Bond, Catalysis by Metals, Academic Press, London (1962).

CHM-729 Special Topics in Inorganic Chemistry (Cr. 3)

Topics under recent investigation and of current interest (the choice will depend upon the interests of the teacher giving this course).

CHM-730 Advanced Material Chemistry (Cr. 3)

Course Content:

Introduction of material chemistry, solid state chemistry, metal materials, semi conducting materials, organic soft materials, smart and peizo electric material, Structural Comparison, Synthetic Approaches; CVD, Sole Gel Method, Solvothermal Method, Electro Deposition, etc in each case, and material characterizations.

Recommended Books:

1. Flegler, S. L.; Heckman, J.W.; Klomparens, K. L. Scanning and Transmission Electron Microscopy: An Introduction, W. H. Freeman: New York, 1993.
2. Williams, D. B.; Carter, C. B. Transmission Electron Microscopy: A Textbook for Materials Science, Plenum Press: New York, 1996.
3. Egerton, R. F. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer: New York, 1986.

4. Goldstein, J.; Newbury, D.; Joy, D.; Lyman, C.; Echlin, P.; Lifshin, E.; Sawyer, L.; Michael, J. Scanning Electron Microscopy and X-Ray Microanalysis, 3rd ed., Kluwer: New York, 2003.
5. Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Brundle, C. R.; Evans, C. A.; Wilson, S. eds., Elsevier: New York, 1992.
6. Campbell, D.; Pethrick, P. A.; White, J. R. Polymer Characterization, 2nd ed., Stanley Thornes: Cheltenham, UK, 2000.
7. Criddle, W. J.; Ellis, G. P. Spectral and Chemical Characterization of Organic Compounds: A Laboratory Handbook, 3rd ed., Wiley: New York, 1990.
8. Dinardo, N. J. Nanoscale Characterization of Surfaces and Interfaces, 2nd ed., Wiley: New York, 2004.
9. Surface Characterization: A User's Sourcebook, Brune, D.; Hellborg, R.; Hunderi, O. eds., Wiley: New York, 1997.
10. Beam Effects, Surface Topography, and Depth Profiling in Surface Analysis (Methods of Surface Characterization), Czanderna, A. W.; Madey, T. E.; Powell, C. J. eds., Plenum Press: New York,1998.
11. Ion Spectroscopies for Surface Analysis (Methods of Surface Characterization), Czanderna, A. W.; Hercules, D. M. eds., Springer: New York, 1991.
12. Brandon, D. D.; Kaplan, W. D. Microstructural Characterization of Materials, Wiley: New York, 1999.
13. Pecharsky, V.; Zavalij, P. Fundamentals of Powder Diffraction and Structural Characterization ofMaterials, Springer: New York, 2005.
14. Concise Encyclopedia of Materials Characterization, 2nd ed., Cahn, R. ed., Elsevier: San Diego, CA, 2005.

CHM-731 Advanced Polymer Science (Cr.3)

Functional Polymer, functionality and latent functionality, statistical distribution and analysis: weight, size, shape and conformation of polymers. Ideal Solution of polymers, Application of Colligative Properties for weight, size and shape determination, derivation of principles of light scattering, viscometery, size exclusion chromatography. Conformational and configurational effect on polymer dimension (radius, gyration), nature and elastomeric character (relation with ideal gas), amorphous vs crystalline state of polymer (relation with temperature and stress), mechanical behavior of polymer (relation with nature, molecular weight, siz and shape of polymer), themomechenical character.

Recommended Books:

1. M. J. Bowden, in Electronic and Photonic Applications of Polymers,M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society, Washington, DC, 1988.
2. The Element of Polymer Science and Engineering by Alferd Rudin, Academic Press, Elsevier, San Diego, USA
3. D Campbell, RA Pethrick, JR White (2000) Polymer Characteriation, Taylor and Francis, Newyork, USA.
4. D.Williams, in Electronic and Photonic Applications of Polymers, M. J. Bowden and S. R.Turner, eds., Advances in Chemistry Series No. 218, American Chemical Society,Washington, DC, 1988.
5. D. J.Williams, ed., Nonlinear Optical Properties of Organic and Polymeric Materials, ACS Symposium Series No. 283, American Chemical Society,Washington, DC, 1983.
6. N. A. Plate, R.V.Talroze, and V. P. Shibaev, in Polymer Yearbook 3, R. A. Pethrick and G. E. Zaikov, eds., Harwood, London, 1986.
7. P. Georlette, J. Simons, and L. Costa, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
8. J. Green, Fire Retardancy of Polymeric Materials, A. F. Grand and C. A.Wilkie, eds., Marcel Dekker, New York, 2000.
9. J.M. J. Fréchet and D.A.Tomalia, eds., Dendrimers and Other DentriticPolymers,Wiley, Chichester, England, 2001.

CHM-732 Computational Chemistry (Cr. 3)

Overview of Computational Chemistry, Population analysis, transition states, reaction paths, Molecular Dynamics. Classical Simulation Methods. QM/MM, Post-Hartree-Fock methods, Electron correlation, Semiempirical methods. Excited states (including time-dependent DFT (TD-DFT)), Spectroscopic observables, Solvation models, Potential energy surface (PES), Atomic charges, Analysis tools, AIM (Bader) analysis, NBO etc., Performance of Computational Chemistry softwares, Skills training in reading and understanding computational chemistry articles.

Recommended Books:

1. Frank Jensen, Introduction to Computational Chemistry, 2nd Edition (Wiley)
2. C.J. Cramer, Essentials of Computational Chemistry (Wiley).
3. Andrew Leach, Molecular Modelling: Principles and Applications (2nd Edition), Prentice Hall.

CHM-733 Chemistry of Composite Materials (Cr. 3)

Introduction: Definitions and classification; natural composites; property enhancement by reinforcement and orientation; matrix interface; synthetic fibers; processing of composites. Examples: Metallic; ceramic and polymeric matrices; interface reactions. Properties: Mechanical and thermal properties of composite materials; stress relaxation and creep studies; dynamical mechanical properties, toughening mechanisms and mechanical failure in polymeric composites.

Recommended Books

1. F.L. Mathews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman and Hall (1994).
2. R.E. Shalin, Polymer Matrix Composites, Chapman and Hall (1995).
3 R.S. Scifullon, Physical Chemistry of Inorganic Polymeric and Composite Materials, Ellis Harwood (1992).

CHM-734 Materials Science-I (Cr. 3)

Materials Science, Types of Materials, Structure-Property-Processing Relationship; Atomic Arrangement in Materials; Structural Imperfections, Atomic Movement; Physical and Mechanical Behavior of Materials; Deformation, Cold Working, Work Hardening, Annealing, Hot Working; Phase Diagrams, Solidification, Cast structure; Phase Diagrams, Solid State Transformations; Heat Treatment; Material deterioration and its prevention; Failure of Materials; Ceramics, Polymers, Composites

Recommended Book:

1. The Science and Engineering of Materials, by Donald R. Askeland, Pradeep P. Fulay, and Wendelin J. Wright (Cengage Learning, 2010).

CHM-735 Materials Science-II (Cr. 3)

Introduction, Structural Features, Strengthening Mechanisms; Characterization of Materials; Physical, Chemical, Mechanical; Non-Ferrous Materials-I, Aluminum and Copper Alloys; Non-Ferrous Materials- I, Special Purpose Alloys; Ferrous Materials-I, Cast Irons and Steels; Ferrous Materials-II, Alloy Steels; Materials For Special Services-I, Ultrahigh Strength, High Temperature; Materials For Special Services- I, Electrical, Magnetic; Ceramic Materials; Semiconductors; Polymeric Materials; Composite Materials

Recommended Books:

1. The Science and Engineering of Materials, by Donald R. Askeland, Pradeep P. Fulay, and Wendelin J. Wright (Cengage Learning, 2010).

CHM-736 Solid State Electronic Devices (Cr. 3)

Semiconductor structure, Electrons and holes, energy bands, Carrier motion, drift, diffusion recombination, P-N junctions, Bipolar junction transistors, Junction field effect transistors,

Metal/semiconductor field effect transistors, Metal oxide semiconductor (MOS) devices, Integrated circuits, Optoelectronic devices (solar cells, photodiode, semiconductor lasers).

Recommended Books:

1. Solid State Electronic Devices by B. G. Streetman, (Prentice-Hall, 2000).
2. Semiconductors and Electronic Devices by A. Bar-Lev, (Prentice Hall, Inc., New York, 1993).
3. Semiconductor Devices by S. M. Sze, (Wiley, Physics and Technology, 1985).

CHM-737 Physics of Semiconductors and Devices (Cr. 3)

Physics of semiconductors: Energy bands in solids; intrinsic and extrinsic semiconductors, doping and carriers; Transport phenomena in semiconductors (drift, mobility, conductivity and diffusion); Non-equilibrium transport; Optical processes in semiconductors; Modem semiconductor structures; Junctions (Ohmic and Schottky).

Semiconductor Devices: PN-Diode (forward and reverse bias transport); Bipolar junction transistor (BJT); Field Effect Transistors (FETs); Optoelectronic devices; Light Emitting Diodes (LED); Laser Diodes (LD); Photodetectors; Solar cells; Electro-optic devices.

Recommended Books:

1. Solid State Electronic Devices by B. G. Streetman, (Prentice-Hall, 1995).
2. Semiconductor Devices–An Introduction by Jasprit Singh, (McGraw-Hill, Inc., 1994).
3. Physics of Semiconductor Devices by Michael Shur, (Prentice Hall, Inc., 1990).
4. Semiconductors and Electronic Devices by A. Bar-Lev, (Prentice Hall, 1985).
5. Physics of Semiconductor Devices by S. M. Sze, (John Wiley, 1981).

CHM-738 Characterization Techniques in Materials (Cr. 3)

Part-I: Melting points and lattice constants, quantum size effects, surface plasmon resonance, quantum transport, electrical conductivity, surface scattering, band gap engineering. Part II: X-ray diffraction XRD, small angle X-ray scattering SAXS, scanning electron microscopy SEM, transmission electron microscopy TEM, atomic force microscopy AFM, energy-dispersive X-Ray spectroscopy EDS, X-Ray photoelectron spectroscopy, XPS, ultraviolet photoelectron spectroscopy. Introduction of fluorescence, characteristics of fluorescence emission, lifetime and quantum yield, fluorescence anisotropy, resonance energy transfer, steady-state and time resonance fluorescence, solvent and environmental effects, quenching of fluorescence, mechanism and dynamics of fluorescence quenching, energy transfer mechanism. Thermo-gravimetric analysis (TGA), DTA, DSC, kinetics and thermodynamics, degradation curves.

Recommended Book:

1. Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films by Charles Evans, Richard Brundle and Wilson, (Butterworth-Heinemann, 1992).

CHM-739 Electronic Materials Processing (Cr. 3)

Introduction to Electronic Devices; Physical deposition; Thin Films and Epitaxial Growth; Molecular Beam Epitaxy and Chemical Vapor Deposition; Dielectric formation; Lithography Techniques and Patterning; Etching Processes (Wet and Dry); Oxidation; Plasma Processes.

Recommended Books:

i. The Science and Engineering of Microelectronic Fabrication by Stephan A. Campbell, (Oxford University Press 2003).

ii. Electronic Materials Science: For Integrated Circuits in Si and GaAs by James W. Mayer and S. S. Lau (Macmillian, NY, 1989).

iii. Molecular Beam Epitaxy Fundamentals and Current Status by M. A. Herman and H. Sitter, (Springer-Verlag 1996).

iv. Solid State Electronic Devices by Ben G. Streetman and Sanjay Kumar Banerjee, (Prentice-Hall, 2009).

v. VLSI Technology by S. M. Sze, (McGraw-Hill, 1988).

vi. Electronic Properties of Materials by R. E. Hummel, (Springer-Verlag, 2004).

CHM-740 Advanced Energy Conversion Devices (Cr. 3)

Sustainable Energy: Production and storage, resources and utilization. Fundamentals of solar cells: Types of solar cells, semiconducting materials, Principles for measuring the band gap of semiconductors materials, absorption of photons, excitons and photoemission of electrons, band engineering.

Solar cell properties and design: p-n junction photodiodes, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power; Single junction and triple-junction solar panels, metal semiconductor hetero junctions, and semiconducting materials for solar cells, Dye sensitized solar cell, quantum dot solar cell, conducting polymers solar cells

Energy storage devices and light conversion materials: architecture and types of supercapacitors, lithium ions battery, Hydrogen storage, Nano catalyst for optimized fuel production, , semi-conducting Nano-materials and photo catalyst, metal oxides and sulfides for hydrogen production, limitation of existing photo catalyst

RECOMEMNDED BOOKS:

1. Wilson, M., K. kannangara, B.Raguse, and M. Simmon. Nano technology: basic Science and emerging technologies. Chapman and Hall/CRC, Latest edition
2. Garcia-Martinez, J. Nanotechnology for energy challenge, Wiley-VCH, Latest edition

3. Somorjai, G.A., H. Frei, and J.Y. Park. Advancing the frontiers in nanocatalyst, biointerfaces and renewable energy conversion by innovations of surface techniques, Latest edition
4. Wong, J. Analytical electrochemistry, John Wiley & Sons, USA, Latest edition 2.
5. Christopher, M.A.B. and A. M. Brett. Electrochemistry Principles, Methods, and Application, Oxford University Press, Latest edition
6. McHardy, J. and F. Ludwig. Electrochemistry of Semiconductor and Electronics, William Andrew Publications, USA, Latest edition
7. Nelson, J. The Physics of Solar Cells, Imperial College Press, UK, Latest edition Latest edition

Organic Chemistry

CHM-741 Protecting Groups in Organic Synthesis (Cr-3)

Introduction: characteristics of good protecting groups. Protection of various functional groups: Hydroxyl, thiols, carbonyl, amino and carboxylic groups. Synthetic applications: Protection and deprotection of the various functionalities in organic synthesis including peptide bond formation.

Recommended Books

1. P.J. Kociennski, Protecting Groups, George Thieme Verlag, Stuttgart Germany (2003).
2. A.J. Person and W.R. Roush, Activating Agents and Protecting Groups, John Wiley and Sons, New York (1999).
3. T.W. Greene and P.G.M. Wuts, Protective Groups in Organic synthesis, John Willey and Sons New York (1999).
4. J.R. Hanson, Protecting Groups in Organic Synthesis, Blackwell Science Ltd. (1999).

CHM-742 Orgasnic Synthesis-Retrosynthetic Approach (Cr.3)

Introduction: Basic definitions of retrosynthesis and disconnection approach. Synthesis of aromatic compounds: One and two group C-X disconnections. Synthons: Definitions and different types of donor and acceptor synthons, concept of “Umpolung”. C-C disconnections of difunctionalised compounds: Dicarbonyl compounds such as 1,2; 1,3; 1,4; 1,5 and 1,6 diO compounds. Synthesis of ring compounds: Three, four, five six, seven and eight membered carbocycles and heterocycles. Devising synthetic schemes: Joint application of the concepts to unknown molecules and some natural products.

Recommended Books

1. S. Warren, Organic Synthesis: the Disconnection Approach, John Wiley & Sons Ltd. (1992).
2. J. Clayden, N. Greeves. S. Warren and P. Worthers, Organic Chemistry, Oxford University Press (2001).
3. R.O.C. Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd ed., Blackie Academic and Professional, London, 1993.
4. W. Carruthers, Modern Method of Organic Synthesis, Cambridge University Press (1971).
5. S. Warren, Designing Organic Syntheses, J. Wiley & Sons, Chichester (1982).
6. T.W. Greene and P.G.M. Wuts, Protective Group in Organic Synthesis, John Wiley & Sons, Inc (1999).
7. J. Fuhrhop and G. Penzlin, Organic Synthesis, 2nd Edition, VCH, Weinheim, Germany (1994).

CHM-743 Advanced Stereochemistry (Cr. 3)

Configuration and conformation of cyclic molecules: Stereochemistry and conformational analysis of cyclohexane systems, six-membered sp^2-hybridized cyclic systems, six-membered saturated heterocycles. Stereochemistry and conformational effects in ring systems: Small, common and medium bicyclic and polycyclic fused rings; bridged rings and stereochemical restrictions. Chiroptical properties: Optical rotatory dispersion (ORD) and circular dichroism (CD).

Recommended Books

1. E.L. Eliel, S.H. Wilen and M.P. Doyle, Basic Organic Stereochemistry, Wiley Interscience, New York (2003).
2. D. Nasipuri, Stereochemistry of Organic Compounds-Principles and Applications, New Age international Publishers (P) Limited, New Delhi, India (1991).
3. P.S. Kalsi, Stereochemistry and Mechanism Through Solved Problems, New Age International Publishers, New Delhi, India (2001).
4 J. Eames (Queen Mary and Westfield College, University of London) and J.M. Peach, Stereochemistry at a Glance, Blackwell Publishing (2003).
5 D.G. Morris, Stereochemistry, Royal Society of Chemistry, U.K. (2001).
6 R. Gabba, Stereochemistry, Campus Books International, New Delhi, India (2002).

CHM-744 Physical Organic Chemistry (Cr. 3)

History and development: Evolution of a hybrid discipline, energy changes during chemical reactions, theory and principles related to kinetics and equilibrium processes. Correlation of structure and reactivity: Hammett equation and other linear free energy relationships. Hückel molecular orbital (HMO) method: Correlation of HMO parameters with molecular properties, alternant and nonalternant hydrocarbons and their properties. Correlation of structure and activity: Use of molecular descriptors, Hansch analysis, Craig plots, Topliss scheme in establishing SAR. FMO method: Concept of Frontier orbitals and its application for explaining chemical reactivity.

Recommended Books

1. Miller, Advanced Mechanisms in Organic Chemistry, Pearson Education (2004).
2. T.H. Lowry and K.H. Richardson, Mechanism and Theory in Organic Chemistry, 3rd ed., Harper & Row Publisher (1987).
3. N.S. Issacs, Physical Organic Chemistry, Longman Group (1995).
4. A. Streitwieser, Jr., Molecular Orbital Theory for Organic Chemists, Wiley, New York (1961).
5. E.V. Anslyn, Modern Physical Organic Chemistry, University Science Books, US (2006).
6. F.L. Ansari, R. Qureshi and M.L. Qureshi, Electrocyclic Reactions-from Fundamentals to Research, Wiley-VCH (1999).
7. C. Hansch and A. Leo and D.H. Hoekman, Exploring QSAR:Fundamentals and Applications in Chemistry and Biology, ACS (1995).
8. A. Pross, Theoretical & Physical Principles of Organic Reactivity, Wiley Interscience (1995).

CHM-745 Nuclear Magnetic Resonance in Organic Chemistry (Cr. 3)

Spin couplings: Spin coupling in different spin systems. Double resonance experiments: Spin decoupling in ^{1}H- and ^{13}C-NMR spectroscopy, suppression of solvent signal, ^{1}H BB decoupling, gated decoupling, ^{1}H off-resonance decoupling. 1D NMR experiments with complex pulse sequence: The J-modulated spin echo, SPI, INEPT and DEPT experiments. 2D NMR Spectroscopy: Introduction, theory and presentation of 2D spectrum. 2D J-resolved NMR spectroscopy: Homo- and hetero-nuclear 2D J-resolved NMR spectroscopy. 2D shift-correlated NMR spectroscopy: H,H-COSY, H,C-COSY, NOESY, ROESY, HMBC, HMQC and TOCSY experiments. Applications: NMR use as a tool for structure elucidation and stereochemical assignments.

Recommended Books

1. H. Friebolin, Basic one-and two-dimensional NMR spectroscopy, 4th ed., Wiley-VCH, New York (2005).
2. D. Canet, Nuclear magnetic resonance: concepts and methods, John Wiley & Sons, Chichester, England (1996).
3. Atta-ur-Rehman and M.I. Chaudhry, Solving problems with NMR spectroscopy, Academic Press, California (1996).
4. R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & sons Inc., USA (2005).
5. R.S. Macomber, NMR spectroscopy: basic principles and applications, Harcourt Brace Jovanovich Publishers, San Diego (1988).
6. S. Berger and S. Braun, 200 and more NMR experiments, Wiley-VCH, Weinheim, Germany (2004).

7. Handbook of proton-nmr spectra and data, Asahi Research Center Co., Academic Press, New York (1985).

8. J.K.M. Sanders, et al., Modern NMR spectroscopy: a guide for chemists, The University Press, Oxford (1993).

9. Breitmaier and Eberhard, Structure elucidation by NMR in organic chemistry: a practical guide, John Wiley, West Sussex (2002).

10. Y.C. Ning, Spectral Identification of organic compounds with spectroscopic techniques, Wiley-VCH, Weinheim (2005).

CHM-746 Advances in Chromatographic Techniques (Cr. 3)

Introduction: Principles of chromatographic separation. Conventional chromatographic techniques: Paper, thin layer, and column chromatography. Pressure chromatographic techniques: High performance-, medium pressure-, high pressure thin layer liquid-, vacuum liquid-, flash-, centrifugal thin layer- and gas chromatography. Liquid-liquid chromatography: Droplet counter current, counter current distribution, and rotation locular counter current chromatography. Miscellaneous chromatographic techniques: Paper electrophoresis and capillary zone electrophoresis. Hyphenated chromatographic techniques: Gas chromatography- mass spectrometry and liquid chromatography-mass spectrometry. Application of chromatographic techniques: Separation of natural products and mixtures of other organic compounds.

Recommended Books

1. K. Hosttetman, A. Marston and M. Hostettmann, Preparative chromatography Techniques, Springer (1997).

2. Richard J. P. Cannel (editor), Natural products isolation, Humana press, New Jersey, USA (1998).

3. W.M.A Niessen and J. Van der Greef, Liquid Chromatography-mass spectrometry: principles and applications, Marcel Dekker, New York (1992).

4. H.M. McNair and J.M. Miller, Basic Gas Chromatography, John Wiley & Sons, Inc. (1998).

5. D. Hage, Handbook of Affinity Chromatography, Hage David Saylor & Francis, Inc. (2005).

6. B. Kolb and L.S. Ettre, Static Headspace-Gas Chromatography: Theory and Practice, Wiley, John & Sons, Inc. (2006).

7. P.R. Brown, Advances in Chromatography, Vol. 41, E. Grushka (Ed.), Marcel Dekker (2001).

8. P.R. Brown, Advances in Chromatography, Vol. 40, E. Grushka (Ed.), Marcel Dekker (2000).

6. P.R. Brown, Advances in Chromatography, Vol. 37, E. Grushka (Ed.), Marcel Dekker (1997).

9. R.E. Ardrey, Liquid Chromatography – Mass Spectrometry: An Introduction, John Wiley & Sons (2003).

CHM-747 Chemistry of Isoprenoids and Steroids (Cr. 3)

Introduction, classification, isolation, structure elucidation, reactions and biological activity: Terpenes, bile acids, cholesterol, ergosterol, vitamin D, estrogens, gastrogens, androgens, adrenocortical hormones, cardiac steroids and bufadienolides. Total synthesis: Equilinen, cholesterol, oestrone and epiandrosterone.

Recommended Books

1. D.F. Cane, D.H.R. Barton, K. Nakanishi and O. Meth-Cohn, Comprehensive Natural Products Chemistry: Isoprenoids Including Carotenoids and Steroids, Vol. 2, Elsevier Science Ltd. (1999).
2. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).
3. F.L. Ansari, R. Quershi and M.L. Quershi, Electrocyclic Reactions, John Wiley & Sons (1999).
4. F.J. Leeper, Biosynthesis: Aromatic Polyketides, Isoprenoids, Alkaloids, Springer Verlag (2000).
5. S.V. Bhat, B.A. Nagasampagi and S. Minakshi, Chemistry of Natural Products, Narosa Publishing House (2005).
6. J.H. Fuhrhop and C. Endisch, Molecular and Supramolecular Chemistry of Natural Products and Their Model Compounds, Macel Dekker, Inc. New York (2000).

CHM-748 Chemistry of Glycosides (Cr. 3)

Introduction: Glycosides of flavonoids, coumarins and saponins, isolation, detection and chromatographic separation, biological importance of glycosides. Chemical reactions: Acid, alkaline and enzymatic hydrolysis to aglycones, derivatization. Structure elucidation: Identification of sugar residue, spectroscopic determination of aglyones and glycosides.

Recommended Books

1. R. Ikan (Ed.), Naturally Occurring Glycosides, Wiley, John & Sons, Inc. (1999).
2. B.A. Bohm, Introduction to Flavonoids, Harwood Academic Publishers, Canada (1998).
3. K.R. Markham, Techniques of Flavonoid Identification, Academic Press, London (1982).
4. J.B. Harborn, The Flavonoids – Advances in Research Since 1986, Chapman & Hall, London (1994).
5. J. Mann, R.S. Davidson and J.B. Hobbs, Natural Products: Their Chemistry and Biological Significance, Longman Group UK Limited (1994).
6. D. Crich, Reagents for Glycoside, Nucleotide and Peptide Synthesis, John Wiley & Sons (2005).
7. D.E. Levy and C. Tang, The Chemistry of C-glycosides, Pergamon Press (1995).

8. K. Hostettmann and A. Marston, Saponins, Cambridge University Press (2005).
9. V. Ahmed and A. Basha, Spectroscopic Data of Saponins, Vol. III, CRC Press (2000).
10. R. O'Kennedy, R.D. Thornes, Coumarins: Biology, Applications and Mode of Action, John Wiley & Sons (1997).
11. R. Douglas, H. Murray and J. Méndez, The Natural Coumarins: Occurrence, Chemistry, and Biochemistry, Stewart Anglin Brown (1982).

CHM-749 Biosynthesis of Natural Products (Cr. 3)

Introduction: Classification of natural products, primary and secondary metabolites, enzymes and coenzymes. Biosynthesis: Fatty acids, polyketides, isoprenoids, amino acids and alkaloids. Metabolites from shikimic acid: ArC_1, ArC_2 and ArC_3 metabolites. Mixed biosynthesis: Metabolites derived from acetate and mevalonate, shikimate and mevalonate, acetate and shikimate, tryptophan and mevalonate.

Recommended Books

1. S.P. Stanforth, Natural Product Chemistry at a Glance, Oxford: Blackwell (2006).
2. J. Mann, Secondary Metabolism, Oxford Science Publications, (1987).
3. J.D. Bu'Lock, The Biosynthesis of Natural Products, McGraw-Hill, London (1965).
4. S. Ranganathan, Art in Biosynthesis, Academic Press, New York (1976).
5. R.H. Thomson (Ed.), The Chemistry of Natural Products, 2nd ed., Springer- Verlag New York, LLC (1993).
6. R.B. Herbert, The Biosynthesis of Secondary Metabolites, Springer-Verlag, New York, LLC (1989).
7. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).

CHM-750 Chemistry of Organometallic Compounds (Cr. 3)

Introduction, synthesis, reactivity and reactions: Grignard's reagents and alkyllithium. Applications: Alkyllithium as metallating agents in organic synthesis. Organotransition metal compounds: Organo palladium compounds, cupperates and organo zinc compounds, their synthesis and applications.

Recommended Books

1. M.Gielen, R. Willem and B. Warckmeyer (Eds.), Physical Organometallic Chemistry, Vol.3, John Willey and Sons, New York (2002).
2. L.S. Heqedus and L.G. Wade, Transition Metals in the Synthesis of Complex Organic Molecules, 2nd ed., John Willey and Sons. Ltd., New York (1999).

3. M. Schlosser, Organometallics in Synthesis, John Willey and Sons, Ltd. New York (1996).
4. A.W. Parking and R.C. Poller, An Introduction to Organometallic Chemistry, McMillian Education Ltd., New York (1987).
5. E.I. Negishi, Organometallics in Organic Synthesis, Vol.1, John Willey and Sons, New York (1980).
6. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, Oxford University (2001).
7. G.M. Loudon, Organic Chemistry, 4th ed., Oxford University Press, New York (2002).

CHM-751 Reactive Intermediates in Organic Chemistry (Cr. 3)

Introduction: Reactive intermediates and transition states. Carbocations: Classical and non-classical carbocations, reactions of non-classical carbocations with stereochemical aspects, pericyclic reactions involving carbocations. Carbanions: Generation of carbanions, kinetic and thermodynamic control, stability and reactions, carbanions stabilized by heteroatoms, rearrangements. Free radicals, carbenes, nitrenes and arynes: Generation and reactions, relative stability and stereochemical aspects of reactions.

Recommended Books

1. R. A. Moss, M. S. Platz and Maitland Jr. (Eds.), Reactive Intermediate Chemistry, Jones. Wi (2004).
2. N. Issac, Reactive Intermediate in Organic Chemistry, John Wiley and Sons (1974).
3. M. Jones and R. A. Moss, Reactive Intermediates, John Wiley and Sons, New York (1978).
4. M.B. Smith and J. March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, John Wiley & Sons (2007).

CHM-752 Advanced Heterocyclic Chemistry (Cr. 3)

Oxygen, nitrogen and sulphur containing heterocycles: Synthesis, reactions, stereochemistry and spectroscopy. Heterocycles with more than one heteroatom: Synthesis, reactions and spectroscopy of five - seven membered heterocycles. Fused ring systems: Benzofused five - seven membered heterocycles.

Recommended books

1. H. El-Syed, Heterocyclic Chemistry, Blackwell Publishing (2006).
2. J. Joule, Synthesis of Naturally Occurring Heterocycles from Carbohydrates, Blackwell Publishing (2006).
3. R.K. Bansel, Heterocyclic Chemistry, New Age International, New Delhi (1996).
4. R.H. Acheson, An Introduction to Chemistry of Heterocycles Compounds, 3rd ed., John Wiley, New York (1976).
5. J.M. Loudon, Organic Chemistry, Oxford University Press (2002).

6. F.A. Carey, R.J. Sandberg, Advance Organic Chemistry, Kulver Academic/ Plenum Publisher (2000).

CHM-753 Advanced Mass Spectrometry (Cr. 3)

Introduction: Aims and scope, theory and basic terminology. Instrumentation: Instrumental design, ionization techniques, types of analyzers and detectors. Applications: Modes of fragmentation of various organic compounds, interpretation of mass spectra of unknown organic compounds.

Recommended Books

1. C.G. Herbert and D.P. Schulz, Mass Spectrometry Basics, Taylor & Francis, New York (2003).
2. F.W. McLafferty, F. Turecek and J. Choi, Interpretation of Mass Spectra, University Science Books, California (1993).
3. E. De Hoffmann, J. Charette and V. Stroobant, Mass Spectrometry, Principles & Applications, John Willey & sons (1996).
4. J.H. Gross, Mass Spectrometry, Springer-Verlag New York (2004).
5. A.Frigerio, Essential Aspects of Mass Spectrometry, Spectrum Publications Inc. New York (1974).
6. H.E. Duckworth, R.C. Barber and V.S. Venkatasubramanian, Mass Spectroscopy, Cambridge University Press, London (1986).
7. R.E. Ardrey, Liquid Chromatography – Mass Spectrometry: An Introduction, John Wiley & Sons (2003).
8. S.M. Nelms, Inductively Coupled Plasma Mass Spectrometry Handbook, Taylor & Francis, New York (2005).

CHM-754 Organic Photochemistry (Cr. 3)

Introduction: Electronic structure of molecules, electronic transitions, radiative and non-radiative processes, energy transfer and sensitization, hydrogen abstraction. Photochemical reactions: Photo-elimination, photo-substitution, photo-oxidation and photo-reduction of carbonyl compounds and olefins. Pericyclic reactions: Photochemical dimerization, cycloadditions and rearrangements. Applications: Photochemical organic industrial processes.

Recommended Books

1. J.D. Coyle, Introduction to Organic Photochemistry, Wiley & Sons Inc. (1986).
2. J. Kopecky, Organic Photochemistry, John Wiley & Sons Inc. (1991).
3. A.G. Griesbeck, Synthetic Organic Photochemistry, Marcel Dekker Inc. (2004).
4. V. Ramamurthy, Organic Photochemistry, Marcel Dekker Inc. (1997).
5. R.O.C. Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd ed., Chapman Hall, London (1993).
6. M.B. Smith and J. March, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, John Wiley & Sons (2007).

CHM-755 Organic Polymer Chemistry (Cr.3)

Fundamental concepts: types of polymers, classification. Mechanism and kinetics: Step growth, free radical addition polymerization, ionic polymerization, Ziegler-Natta polymerization. Stereochemistry: Definition and examples of Isotactic, atactic, syndiotactic polymers and their stereoregulation. Molecular weight determination: Different methods used to determine the absolute and relative molecular weights of polymers. Structure-property relationship. Reactions of synthetic polymers. Polymer degradation and stability: Special emphasis on thermal and photo-degradation.

Recommended Books

1. H.R. Allcock, F.W. Lampe and J.E. Mark, Contemporary Polymer Chemistry, 3rd ed., Pearson Education mc, Pearson Prentice Hall (2003).
2. F.W. Billrneyer Jr., A Textbook of Polymer Science, J. Wiley & Sons, Pte. Ltd., Singapore (1994).
3. G. Odian, Principles of Polymerization, 4th ed., John Wiley & Sons, Inc. (2004).
4. M.S. Bhatnagar, A Textbook of Polymers, Vol. I, II, III, S. Chand & Co. Ltd. (2004).
5. L.H. Sperling, Introduction to Physical Polymer Science, 2nd ed., John Wiley & Sons (1992).
6. J.R. Fried, Polymer Science & Technology, Prentice Hall, Inc. (1995).

CHM-756 Pericyclic Reactions (Cr. 3)

Introduction and significance: Concerted and nonconcerted processes, pericyclic reactions, their classification and examples. Mechanism and analysis: Analysis of pericyclic reactions based on orbital symmetry conservation, frontier orbital method, Möbius-Hückel approach and theoretical & computational approach. Synthetic application: Synthesis of carbocycles and heterocycles through pericyclic reactions.

Recommended Books

1. F.L. Ansari, R. Qureshi and M.L. Qureshi, Electrocyclic Reactions from Fundamentals to Research, Wiley – VCH (1999).
2. T.H. Lowry and K.H. Richardson, Mechanism and Theory in Organic Chemistry, 3rd ed., Harper & Row Publisher (1987).
3. F.A. Carey and R.J. Sandberg, Advance Organic Chemistry, Kulver Academic/ Plenum Publisher (2000).
4. G.M. Loudon, Organic Chemistry, 3rd ed., The Benjamin/Cummings Publishing Company (1995).
5. E.A. Halevi, Orbital Symmetry and Reaction Mechanism, Springer Verlag (1992).
6. T. Rauk, Orbital Interaction Theory of Organic Reaction, John Wiley (1994).

7. R.T. Morrison and R.N. Boyd, Organic Chemistry, 6th ed., Prentice Hall, New Jersey (1992).
8. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, Oxford University (2001).
9. R.O.C. Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd ed., Chapman Hall, London (1993).

CHM-757 Advanced Stereoselective Synthesis (Cr. 3)

Biological significance of chirality: Stereogenic units and types of chirality, chiral natural products, need for stereoselective synthesis. Strategies for synthesis of chiral compounds: First and second generation methods: chiral starting materials and chiral auxiliaries; third and fourth generation methods: asymmetric reactions, reagents and catalysts. Asymmetric total synthesis: Diastereoselective and enantioselective syntheses.

Recommended Books

1. M. Nogradi, Stereoselective Synthesis: A Practical Approach Wiley VCH (1994).
2. R.S. Atkinson, Stereoselective Synthesis, Wiley, Chichester, (***1995)***.
3. E.M. Carreira and O. Reiser, Classics in Stereoselective Synthesis, Wiley-VCH, Weinheim (2007).
4. A. Koskinen, Asymmetric Synthesis of Natural Products, Wiley (1993).
5. Guo-Qiang Lin, Yue-Ming Li, Albert S. C. Chan, Principles and Applications of Asymmetric Synthesis, Wiley-Interscience (2001).
6. G.R. Stephenson, Advanced Asymmetric Synthesis, Springer; 1st edition (1996).

CHM-758 Modern Name Reactions in Organic Synthesis (Cr. 3)

Recent modifications and advancements in classical name reactions: Evans Aldol Condensation, Mukaiyama Aldol, Barton-McCombie Reaction, Baylis-Hillman Reaction, Biginelli Reaction, Bishler-Napieralski Reaction, Blanc Reaction, Brook Rearrangement, Castro-Stephens Coupling, Cory-Kim Oxidation, Dakin-West Reaction, Hetero-Diels-Alder Reaction, Eschenmoser Fragmentation, Friedlander Synthesis, Horner-Wadsworth-Emmons reaction, Milas Hydroxylation Reaction, Pictet-Spengler Ritter Reaction, Doebner Modification. Recent name reactions and their application: Sharpless Dihydroxylation, reactions, CBS reduction, Dess-Martin Oxidation, Swern Oxidation, Stephen aldehyde synthesis, Corey-Fuchs reaction, Fukuyama, Sonogashira, Stille Suzuki, McMurry and Heck coupling, Ugi reaction, Wittig Rearrangement, Mitsunobu Reaction, McMurry coupling, Fujimoto-Belleau reaction, Tebbe olefination, Tamao oxidation, Weinreb synthesis..

Recommended Books

1. L. Kurti and B. Czako, Strategic Applications of Name Reactions in Organic Synthesis, Academic Press, New York (2005).

2. L. Kurti and B. Czako, Name Reactions and Reagents in Organic Synthesis, 2nd ed., Elsevier, Amsterdam (2005).
3. B. P. Mundy, M. G. Ellerd, et al., Name Reactions and Reagents in Organic Synthesis, John Wiley, New York (2005).
4. T. Laue and A. Plagens, Name Organic Reactions, John Wiley and Sons: Chichester, England, New York (1998).
5. J. J. Li, Name Reactions: A Collection of Detailed Reaction Mechanisms, 3rd ed., Springer-Verlag, Berlin (2006).

CHM-759 Special Topics in Organic Chemistry (Cr. 3)

Topics under recent investigation and of current interest (the choice will depend upon the interests of the teacher giving this course).

CHM-760 Advanced Natural Product Chemistry (Cr. 3)

Biosynthetic pathways for different classes of natural products i.e. Acetate, shikimate and mavalonate pathways. New developments in the separation of natural products. Biological screening of plant extracts.

Recommended Books:

1. P. S.Kalsi, S. Jagtap. Pharmaceutical, Medicinal and Natural Product Chemistry. Narosa Publishing House, New Delhi, India. ((2013).
2. J. Clayden, N. Greeves, S. Warren and P. Worthers, Organic Chemistry, OxfordUniversity (2001).
3. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural Products, Longman Group Ltd., U.K. (1994).
4. K. Nakanishi, T. Goto, S. Ioto, S. Natori, S. Nozone, et al., Natural Products Chemistry, Vol. 1, Academic Press Inc, New York (1974).
5. N. H. Fischer, M. B.Isman, H. A. Staffard. Modern Phytochemical Methods, Springer International Edition, New York, USA. (1991).

Analytical Chemistry

CHM-761 Frontiers Nanomaterials for Bio-applications (Cr. 3)

Course Contents:

Foundation of Nano: Feyman talk, Discovery of Carbon Nanotube and bucky Balls, Nanomaterials; Definition, classification (Size, Shape and nature), Methodologies of Nanomaterial

Synthesis, Characterization techniques, etc. Introduction of Biomolecules: Basic molecular Biology and classification of Biomolecules, self-organization of Biomolecules into functional Units (bio-macromolecules), biological motors and pumps Merging nanotechnology with biotechnology; Biological properties of nanomaterials, theoretical study of biomolecules and nanomaterials interaction, interfacial study between nanomaterials and biomacromolecules, analysis of bio-nano interactions etc. Applications of nanomaterials in biotechnology: Cancer diagnosis and treatment, Labeling and image analysis, Drug targeting, Drug encapsulation and delivery, nanotherapeutics, nanomedicines, bio nanosensor, bio nanochips, nanodevices in medicines, future of nanobiotechnology.

Recommended Books:

1. Neimeyer, C. M. and C. A. Mirkin, 2004. Nanobiotechnology: Concepts, Applications and Perspectives. 1st Ed. Wiley VCH. Germany.
2. Nicolini, C. 2008. Nanobiotechnology and Nanobiosciences. 1st Ed. Pan Stanford Publishing Pvt Ltd. Singapore.
3. Jain, K. K. 2006. Nanobiotechnology in Molecular Diagnostics: Current Techniques and Applications. Horizon Bioscience.UK.
4. Prasad, S. K. 2008. Advanced Nanotechnology. Discovery Publishing House Pvt Ltd. New Delhi, India.
5. Prasad, S. K. 2008. Progress in Nanotechnology. Discovery Publishing House Pvt Ltd. New Delhi, India.
6. Storrs, H. J. 2006. Nanofuture: What'sNext for Nanotechnology. Manas Publications. New Delhi, India.
7. Shalini, S. 2006. Nanotechnology: Basic Science to Emerging Techology. APH Publishing Corporation. New Delhi, India.
8. Wiwanitkit, V. 2008. Advanced Nanomedicine and Nanobiotechnology. 1st Ed. Nova Science Publishers Inc. New York, USA.

CHM-762 Advanced Analytical Instrumental Techniques (Cr. 3)

Principles of mass spectrometry and gas chromatography, instrumentation, application of mass spectrometry to organometallics, organosilicon and organophosphorous compounds. Mass

spectrometry coupled with gas chromatography. Discussion on relevant research papers and review articles.

Recommended Books

1. D.A. Skoog, Principles of Instrumental Analysis, 3rd ed., Saunder College Publishing, Philadelphia (1984).
2. G.W. Ewing, Instrumental Methods of Chemical Analysis, McGraw-Hill, New York (1985).
3. D.A. Skoog, et al., West and Holler, Fundamentals of Analytical Chemistry Office, 8th ed., Thomson, Brooks/Cole, Australia (2004).

CHM-763 Advanced Thermal Analysis (Cr. 3)

Theory and instrumentation: Thermogravimetry (TG), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Quantitative interpretation: TGA, DTA and DSC curves. Kinetic and thermodynamic parameters. Applications: DTA, TGA in cements, catalysts, clays, minerals, biological materials, drugs, polymers and textiles. High temperature reflectance spectroscopy (HTRS): Instrumentation and applications to various inorganic compounds.

Recommended Books

1. T. Hatakeyama and F.X. Quinn, 2nd ed., Thermal Analysis Fundamentals and Applications to Polymer Science, John Wiley, New York (1999).
2. P.J. Haines, Thermal Methods of Analysis, Blackie Academic and Professional, London (1995).
3. W.W.M. Wendlandt, Thermal Analysis, 3rd ed., John Wiley, New York (1986).
4 T. Daniels, Thermal Analysis, Kogan Page, London (1973).
5 J.W. Dodd and K.H. Tonge, Thermal Method: Analytical Chemistry by Open Learning, John Wiley (1987).

CHM-764 Water and Soil Chemistry (Cr. 3)

Aquatic environment: hydrological cycle, water quality criteria, physical, chemical and biological characteristics of water, utilization, contamination and protection of water resources, collection and preservation of water samples. Physico-chemical analysis of water: Fresh water bodies, stratification and turn-over. Eutrophication: Causes and control. Water pollution: Soap, detergents and agricultural sprays. Water management: Policies and tools. Deposition of sediments: Trace metals in the hydrocycle and sediments, quantification of environmental impact in sediments. Formation and composition of soil: Soil types and their properties, soil degradation and pollution, soil management for sustainable agriculture. Contamination of soils: Analysis of physical and chemical characteristics of soils, effects of mining on geoenvironment. Geological hazards and geotechnology: Standards and guidelines for water and soil quality by national and international organizations/agencies.

Recommended Books

1. R.M. Harrison, An Introduction to Pollution Science, The Royal Society of Chemistry, UK (2006).
2. D. Langmuir, Aqueous Environmental Geochemistry, Prentice Hall, New Jersey (1997).
3. S.E. Manahan, Environmental Science and Technology, Lewis Publishers, New York (1997).
4. H.L. Bohn, Soil Chemistry, John Wiley & Sons, New York (1985).
5. P. Evangelou, Environmental Science and Water Chemistry, John Wiley & Sons, Inc., New York (1998).
6. L. Friberg, G.F. Nordberg and V.B. Vouk, Handbook on the Toxicology of Metals, Volume 1, Elsevier Science Publishers, Amsterdam (1986).
7. P. Patnaik, Handbook of Environmental Analysis, CRC Press Inc., Florida, USA. (1997).
8. B.J. Alloway, Heavy Metals in Soils, John Wiley & Sons Inc., New York (1990).
9. APHA, AWWA and WPCF, Standard Methods for the Examination of Water and Wastewater, 20th ed., Washington DC, USA (1998).
10. R.A. Bailey, H.M. Clark, J.P. Ferris, S. Krause and R.L. Strong, Chemistry of the Environment, 2nd Edition, Academic Press, London (2002).

CHM-765 Analysis and Characterization of Polymers (Cr. 3)

The polymerization processes and techniques, molecular weight and its determination, polymer additives (plasticizers, stabilizers and fillers). Chemical analysis, GPC and other chromatographic methods of analysis. Mechanical, thermal, spectroscopic, microscopic and X-ray diffraction analyses. Synthetic and degradation reactions.

Recommended Books

1. J.M.G. Cowie, Polymers: Chemistry and Physics of Modern Materials, International Textbook Co., London (1973).
2. F.W. Billmeyer, Textbook of Polymer Science, 3rd ed., John Wiley & Sons, New York (1994).
3. C.E. Carraher, Seymour/Carraher's Polymer Chemistry, 5th ed., Revised and Expanded, Marcel Dekker, New York (2000).

4 C.E. Carraher, Introduction to Polymer Chemistry, CRC Taylor and Francis Group, New York (2007).

5 J.R. Fried, Polymer Science and Technology, Prentice Hall PTR (1995).

6 A. Rudin, The Elements of Polymer Science and Engineering, Academic Press (1999).

7 T.R. Crompton, Analysis of Polymers: An Introduction, Pergamon Press (1989).

8 C.E. Carraher, Jr., Polymer Chemistry, An Introduction, 4th ed., Marcel Dekker, Inc. (1992).

CHM-766 Advanced Atomic Spectroscopy (Cr. 3)

Atomic spectroscopy: Quantitative and qualitative aspects, spectra from high energy sources. Atomic absorption spectroscopy: Flame and electrothermal atomization, cold vapour and hydride generation techniques, construction, working, advantages and limitations of instrumental components. Optimization parameters: interferences and applications of atomic absorption spectroscopy. Atomic fluorescence spectroscopy: Theory and applications, comparison of AFS with AAS. Atomic emission spectroscopy: Based on plasma sources, simultaneous and sequential systems, experimental considerations and performance characteristics, instrumentation and applications of ICP-AES. Electric arc and spark emission spectrophotometric methods: Lasers, analytical applications in atomic spectroscopy. QA and QC in atomic spectroscopic methods: Data handling and statistical manipulation.

Recommended Books

1. E.H. Evans, An Introduction to Analytical Atomic Spectrometry, John Wiley & Sons Ltd., New York (1998).
2. J.R. Dean, Atomic Absorption and Plasma Spectroscopy, 2nd ed., D.J. Ando, (Ed), John Wiley and Sons (1997).
3. A. Montaser and D.W. Goloightly, Inductively Coupled Plasmas in Analytical Atomic Spectrometry, VCH Publishers Inc., New York (1992).
4. M. Thompson, and J.N. Walsh, Handbook of Inductively Coupled Plasma Spectrometry, 2nd Edition, Blackie and Son Ltd., Glasgow and London (1989).
5. F. Rouessac and A. Rouessac, Chemical Analysis – Modern Instrumental Methods and Techniques, John Wiley & Sons, Ltd., UK (2000).
6. K.A. Rubinson and J.F. Rubinson, Contemporary Instrumental Analysis, Prentice-Hall, Inc., USA (2000).
7. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders College Publishing, USA (1992).
8. R.D. Braun, Introduction to Instrumental Analysis, McGraw-Hill Book Company (1987).
9. J. Mendham, R.C. Denney, J.D. Barnes, and M. Thomas, Vogel's Textbook of Quantitative Analysis, 6th ed., Pearson Education Ltd. (2000).
10. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).

CHM-767 Atmospheric Chemistry (Cr. 3)

Atmospheric structure: Natural constituents, anthropogenic emissions and atmospheric pollution. Air quality criteria pollutants: Sources, dispersion models and sinks of atmospheric pollutants. Measurement and monitoring methods: Gaseous pollutants and particulate matter in the atmosphere, dry and wet depositions. Effects: Effects of air pollutants on humans, animals, plants, materials and visual range, controlling the anthropogenic pollutants. Photochemical smog-formation: Types and effects. Acid rain: Causes, effects and control. Ozone Chemistry: Stratospheric ozone production and depletion, causes and significance of ozone hole, catalytic and non-catalytic processes, effects of UV on the biosphere. Global warming: Green house gases,

production, control and future trends of green house gases, consequences of global warming. Control management: Standards and legislation regarding the atmospheric pollution.

Recommended Books

13. J. Colls, Air Pollution-An Introduction, SPON Press, Taylor & Francis Group, London (1997).
14. S.E. Manahan, Environmental Science and Technology, Lewis Publishers, New York (1997).
15. R. Miroslav and N.B. Vladimir, Practical Environmental Analysis, The Royal Society of Chemistry, UK (1999).
16. J.H. Seinfeld, Atmospheric Chemistry and Physics of Air Pollution, John Wiley & Sons, New York (1986).
17. J.H. Seinfeld and S.N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley & Sons, New York (1998).
18. WHO, Guidelines for Air Quality, World Health Organization, Geneva (2000), (wwwwhoint/environmental information/Air/Guidelines/aqguide7pdf)
19. P. Patnaik, Handbook of Environmental Analysis, CRC Press Inc., Florida, USA (1997).
20. R.A. Bailey, H.M. Clark, J.P. Ferris, S. Krause and R.L. Strong, Chemistry of the Environment, 2nd ed., Academic Press, London (2002).
21. R.M. Harrison, An Introduction to Pollution Science, The Royal Society of Chemistry, UK (2006).
22. S.T. Holgate, J.M. Samet, H.S. Koren and R.L. Maynard, Air Pollution and Health, Academic Press, New York (1999).

CHM-768 Chromatographic Methods of Analysis (Cr. 3)

Introduction: Classification of chromatographic methods, theory of separations and retention characteristics, descriptions of chromatograms. Chromatographic parameters: The van-Deemter equation, column efficiency, band broadening and resolution. Quantitation techniques: Sample loading, loss of material on column, column packing, flow rates, detector response, batch separations, symmetrical and asymmetrical peaks. Types of liquid chromatography: Working methodology, instrumentation and applications of adsorption, partition, ion-exchange, gel permeation, affinity and high performance liquid chromatography, effect of temperature, particle size, column size, pressure and HETP. Detectors for liquid chromatography: High performance thin layer chromatography. Gas-Chromatography: Sample introduction, splitters, columns and detectors in GC, optimization of gas-chromatographic separations. Supercritical fluid Chromatography: Working principle, instrumentation and applications. Gel-electrophoresis: Theory and applications.

Recommended Books

1. D. Harvey, Modern Analytical Chemistry, McGraw-Hill Companies Inc. (2000).

2. K.A. Rubinson and J.F. Rubinson, Contemporary Instrumental Analysis, Prentice-Hall, Inc., USA (2000).

3. A. Braithwaite and F.J. Smith, Chromatographic Methods, Chapman and Hall, New York (1985).

4. J. Weiss, Ion Chromatography, 2nd ed., VCH Publishers Inc, New York (1995).

5. F. Rouessac and A. Rouessac, Chemical Analysis – Modern Instrumental Methods and Techniques, John Wiley & Sons, Ltd., UK (2000).

6. G.D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons Ltd., Singapore (2003).

7. D.A. Skoog and J.J. Leary, Principles of Instrumental Analysis, 4th ed., Saunders College Publishing, USA (1992).

8. D.C. Harris, Quantitative Chemical Analysis, 3rd ed., W.H. Freeman Company, New York (1991).

9. R.D. Braun, Introduction to Instrumental Analysis, McGraw-Hill Book Company (1987).

10. R. Kellner, J.M. Mermet, M. Otto, M. Valcarcel and H.M. Widmer, Analytical Chemistry, 2nd ed., Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (2004).

CHM-769 Diffraction Methods of Analysis (Cr. 3)

Introduction: Principles and instrumentation of diffractional methods. Applications: Application of X-ray, electron and neutron diffraction methods in the determination of structure of compounds. Geometry: Determination of geometry and other related parameters for crystalline solids by X-ray method. Pair distribution: Determination of pair distribution functions of solids and liquids.

Recommended Books

1. M. Ladd, R. Palmer, Structure Determination by X-ray Crystallography, 4th ed., Kluwer Academic/Plenum Publishers, (2003).

2. B.D. Culity, S.R. Stock, Elements of X-ray Diffraction, 3rd ed., Prentice Hay, (2003).

3. J.P. Glusker, K.H. Trueblood, Crystal Structure Analysis, A. Primer, 2nd ed., Oxford University Press, (1985).

4. G.H. Stout, L.H. Jenson, X-ray Structure Determination, A Practical Guide, 2nd ed., John Wiley & Sons (1989).

CHM-770 Experimental Techniques in Nanotechnology (Cr. 3)

Students (in groups or individuals) will be given a project in the relevant area. They will do a comprehensive literature review and experiments and present at least 2 seminars; one after 7 weeks and one after 14 weeks of the semester.

Recommended Books:

1. Characterization, Design, and Processing of Nanosize Powders and Nanostructured Materials by Kevin G. Ewsuk, Yury Gogotsi, (Wiley-Interscience, 2006).

2. Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films by Charles Evans, Richard Brundle and Wilson, (Butterworth-Heinemann, 1992).

CHM-771 Applied Industrial Processes (Cr. 3)

Course Contents:

The importance of chemical industries for the economic development of Pakistan; chemistry of ceramics and its processing; the agrochemical industry; chemistry of structural adhesives; dyes and pigments; chemistry of silicone technology; chemistry of fuel technology; corrosion; quality control (analytical and statistical).

Recommended Books

1. G.T.Austin, Shreve's Chemical Processes Industries. 5th ed., McGraw-Hill. International Editions, New York (1984).

2. K.H. Davis, Hand Book of Industrial Chemistry, Vol. 2. CBS Publshers, New Delhi (2004).

3. R. J. Farrauto, Fundamental of Industrial Catalytic Processes. Blackie Ac demic, London (1997)

CHM-772 Special Topics in Analytical Chemistry (Cr. 3)

Topics under recent investigation and of current interest (the choice will depend upon the interests of the teacher giving this course).

Biochemistry

CHM-781 Biochemistry of Disease (Cr.3)

Course Contents:

Etiology, pathogenesis, diagnosis, and immunobiology of the major microbial diseases, with emphasis on their prevention. Identification, antibiotic sensitivity and treatment of disease causing microorganisms. Haematology assessments of the numbers and quality of the various blood and bone marrow cells to identify diseases such as iron deficiency anaemia and leukaemia. Blood tests including blood grouping and antibody screening to ensure safety of transfusions. Biochemical analysis of clinical samples including blood and body fluids to assist in the diagnosis and monitoring of patients with metabolic or physiological diseases, such as diabetes. Endocrinology

measures to interpret and assess hormone levels and hormonal actions (eg. thyroid hormones) in patients with dysfunctional endocrine states that can result in a wide range of conditions and diseases. Understanding the immune system and how it protects us from the outside world to use and interpret laboratory tests that help understand where things go wrong (eg autoimmune diseases). Use of the specialized techniques at the cutting edge of science to investigate the genetic basis of disease and assessing the risk of developing disease based on genetic make-up. Histology of tissues or lesions removed from a patient to enable the microscopic diagnosis of disease processes such as cancer or infection. Cytological examination of smears of cells such as pap smears to enable the early detection of cells that may indicate the presence of malignancy.

CHM-782 Advances in Enzyme structure and function (Cr.3)

Three-dimensional conformations of proteins and protein folding with emphasis on structure-function relationships. Basic concepts of proteomic techniques and theinvestigations of protein structures. Introduction to enzyme catalysis with respect to coenzyme requirements, kinetics, catalytic mechanism and regulation of enzymatic activities. Enzyme diversity. Structure of enzyme-substrate complexes. Multienzyme complexes. Chemical catalysis. The basic equations of enzyme kinetics. Enzymatic rate constants. pH dependence of enzyme catalysis. Stereochemistry of enzymatic kinetics. Enzyme inhibition. Allosteric interactions. Specificity and editing mechanisms. Structure and mechanisms of selected enzymes. Practical kinetics. Genetic engineering and enzymology.

CHM-783 Fermentation and Biotransformation (Cr.3)

Microbial physiology and molecular genetics. Bacterial structure, energy production,nutrition and growth. Gene transfer in bacteria. Expression of the genetic information. History and Introduction to Biocatalysis. Production, Purification and Use of Biocatalysts. Comparison Enzymes vs. Whole Cell Biotransformation. Scale-Up (From Lab to Industry). Industrial Application and Processes (Food, Detergents, Pharmaceutical Intermediates, Fine Chemicals), Down Stream Processing. Glycerol fermentation. Acetone-butanol fermentation. Production of lactic acid by fermentation. Propionic acid fermentation. Production of vitamin B12. Citric acid fermentation. Fumaric acid fermentation. Production of amino acids by microorganisms. Microbiological transformations of steroids. Antibiotics. Biochemical engineering aspects of fermentations. Drug

Biotransformation.

CHM-784 Fundamentals of Molecular Biology (Cr.3)

Cell theory and the Mendelian world. Independent segregation. Independent assortment. Theory of heredity. Chromosomes, Genes and nucleic acids. Gene protein relationship. Cellular life and the laws of chemistry. Nucleic acids and the flow of genetic information. Structure of DNA, RNA and proteins. Replication. Recombination. Mutation and DNA repair. Transcription. Translation. The genetic code.Recombinant DNA technology. Molecular biology of development. Development, differentiation, rearrangements and amplifications and morphogenesis. Gene cloning. Genetic engineering and biotechnology. Applications of biotechnology in health, agriculture and environment.

CHM-785 Metabolomics (Cr.3)

Glycolysis, Regulatory Control Exerted by Phosphofructokinase. Gluconeogenesis, Reciprocal Regulation of Glycolysis and Gluconeogenesis. Pyruvate Dehydrogenase, Shuttling Metabolites. Citric Acid Cycle, Amphibolic Nature of the Pathway. Glucokinase and Diabetes Susceptibility. Electron-Transferring Reactions. Free Energy Changes Accompanying Electron Transfer. ATP Synthase. Pentose Phosphate Pathway. Regulatory Control of ATP Synthase. Glycogen Degradation, reversible Control by Phosphorylation. Fatty Acid Oxidation, Carnithine Shuttle of Fatty Acids into the Mitochondria. Reciprocal Regulation of Fatty Acid Synthesis and Breakdown, Fatty Acid Synthase Complex. Regulation of Cholesterol Biosynthesis, LDL Receptors and. Hypercholesterolemia. Amino Acid Degradation, Transaminase Action and Vitamin B6. Energy Cost of Urea Synthesis. Nitrogen Fixation, Synthesis of Amino Acids from Major Metabolic Intermediates. Synthesis of Amino Acids from Major Metabolic Intermediates. Amino Acids as Precursors to Neurotransmitters. Nitric Oxide Synthase and NO. Purine Nucleotide Synthesis, Pyrimidine Nucleotide Synthesis and Degradation. Nucleotide Metabolism Disorders, Gout, Lesch-Nyhan Syndrome, Adenosine Deaminase Deficiency. Hormonal Regulation of Metabolism. Integration of Metabolism.

CHM-786 Metabolic regulations (Cr.3)

Enzymatic regulation. Receptor-mediated regulation. Biosynthesis of carbohydrates, lipids,

DNA, RNA and proteins. The metabolism of amino acids and components of nucleic acids; prokaryotic gene regulation; DNA mutation and repair. The integration of metabolic pathways. Regulation and integration of metabolism in mammals. Molecular and cellular aspects of carbohydrate, lipid and amino acid metabolism. Supply of and demand for different fuels by different tissues. Handling of dietary carbohydrate and fat; fasting, starvation and diabetes. Influence of dietary fats on cardiovascular risk markers.

CHM-787 Biological Oxidations (Cr.3)

oxidation of food stuff, the mitochondrion transport of ions and metabolites through shuttle system, thermodynamics of electron transport chain, Redox reactions, Applications of redox reactions in biochemical reactions, high energy phosphate compounds, co-enzymes involved in biochemical redox reactions, reducing equivalents, flow of electron through electron transport chain, ATP formation, ROS, enzyme complexes involved in electron transport chain, Antioxidants, clinical problems associated with deficiency of some of enzymes and co-enzymes.

CHM-788 Lab Techniques in Biochemistry (Theory + Lab Work) (Cr.3)

Introduction. Techniques used for isolation, purification, quantification and characterization of various bio-molecules such as Homogenization, Sonication, Electrophoresis, Centrifugation, Chromatography, Spectroscopy etc.

CHM-789 Biostatistics (Cr.3)

Population and samples. Measures of central tendency. Measures of dispersion and variability. Probabilities. The normal distribution. Sample hypotheses. The analysis of variance. Multiple comparisons. Two-factor analysis of variance. Data transformations. Factorial analysis of variance. Multivariate analysis of variance. Simple linear regression. Simple linear correlation. Polynomial regression. Testing for goodness fit. Testing for randomness.

CHM-790 Research Methodology and scientific writing (Cr. 3)

Introduction. Developing a scientific hypothesis. Synopsis writing. Literature review. Primary and secondary resources. Plagiarism. Designing experimental strategies. Importance of appropriate controls. Basic laboratory procedure and precautions.Computation and analysis of the experimental data. Data presentation. Tables, diagrams, graphs, illustrations and computation.

Quantification and Statistical analysis.Using appropriate computer softwares. Making conclusions. Dissertation write-up.Making a thesis statement. Writing a preliminary report. Literature citation. Preparing the manuscript: structure, substance, style, language and layout. Impact factor. Editing and proof reading. Formats and guidelines. Progress reports. Research ethics.

CHM-791 Techniques in Molecular Biology (Cr.03)

DNA isolation and purification from microbial, animal and plant cells. Basic microbiological techniques. Ultracentrifugation. PAGE and agarose gel electrophoresis. Capillary electrophoresis. Restriction endonucleases. Restriction digestion, analysis and mapping. DNA sequencing. Primer extension and reverse transcription. DNA ligation. Plasmids, vectors, cosmids and bacteriophages. DNA amplification through plasmid preps and PCR technology. DNA ligation and selection of recombinants. Transformation of bacterial and non-bacterial cells. Cloning vectors of E. coli. Cloning vectors for organisms other than E. coli. Cloning vectors for higher plants. Cloning vectors for mammalian cells. Expression vectors. Southern, Northern and Western blottings. Protein purification and analysis. Techniques to study protein-nucleic acid and protein-protein interactions.

CHM-792 Special Topics in Biochemistry (Cr. 3)

CHM-793 Forensic Chemistry (Cr.03)

Forensic Science: Evidence and the Scene of the Crime. Identification, characterization, recovery and weighing of trace evidence types. Crime scene searching methodologies; the integrity and continuity of evidence. Introduction to laboratory testing dealing with glass, tool-mark, shoe-mark and tire impressions. Procedures at crime scenes illustrated by reference to crimes of burglary, murder and sexual offences. Fingerprint history, classification, recovery and chemical enhancement of fingerprints. Blood pattern analysis supporting the advances in DNA techniques. Sexual offence investigation and body fluid identification. Clinical indicators of death and murder scene investigation. Drug Abuse, Alcohol and Forensic Toxicology. Drugs of abuse and their identification. Drugs, alcohol poisons and their metabolism. Toxicology and the role of the

forensic toxicologist. Qualitative and quantitative laboratory analysis. Signature and handwriting identification. Paper, inks and printed documents. Damage characterization. Fires and Explosions: Arson. Fire and combustion. Types of explosives and the nature of explosions. The crime scene investigation: sampling and laboratory analysis

CHM-794 Drug Designing (Cr. 3)

Introduction to Drug Design: An overview to classical drug discoveries. Drug discovery from nature. Advanced drug design; receptor and ligand based drug design. At least one specific example of a selected drug with background, mechanism, current status and future prospects. Concepts in Drug Design: Bioisosterism, transition state inhibitors, fragment based drug design, virtual library design, etc. Biomacromolecules, their major biochemical functions and mechanisms: Introduction and chemistry of all biomacromolecules including nucleic acids, protein, carbohydrates, lipids, fats and hormones. Their important biochemical functions and possible mechanisms, disorders and regulation of their disorders

SCHEME OF STUDIES FOR DOCTOR OF PHILOSOPHY IN CHEMISTRY

Duration:	**Semesters**
Courses:	**18 credits**
Thesis:	**50 credits**
Seminar-I:	**01 Credit**
Seminar-II:	**01 Credit**
Total:	**70 Credits**

Courses

I. Physical Chemistry

CHM-801 Physical Chemistry of Polymers (Cr. 3)

CHM-802 Advanced Quantum Chemistry (Cr. 3)

CHM-803 Electrode Process (Cr. 3)

CHM-804 Magnetic Resonance Spectroscopy (Cr. 3)

CHM-805 Advanced Chemical Kinetics (Cr. 3)

CHM-806 Advanced Molecular Spectroscopy (Cr. 3)

CHM-807 Advanced Photochemistry (Cr.3)

CHM-808 Advanced Surface Chemistry (Cr. 3)

CHM-809 Advanced Solution Chemistry (Cr. 3)

CHM-810 Chemistry of Advanced Materials (Cr. 3)

CHM-811 Advanced Statistical Mechanics (Cr. 3)

CHM-812 Solid State chemistry (Cr. 3)

CHM-813 Colloid Chemistry (Cr. 3)

CHM-814 Advanced Nuclear and Radiation Chemistry (Cr. 3)

CHM-815 Applied Chemical Thermodynamics (Cr. 3)

CHM-816 Electroanalytical Methods and Techniques (Cr. 3)

CHM-817 Synthesis of Nanomaterials by Chemical and Physical Routes (Cr. 3)

CHM-818 Physical Chemistry of Environment (Cr.3)

CHM-819 Special Topics in Physical Chemistry (Cr. 3)

CHM-820 Polymer Physics (Cr. 3)

II. Inorganic Chemistry

CHM-821 Multinuclear NMR Spectroscopy (Cr. 3)

CHM-822 Inorganic Electronic Spectroscopy (Cr. 3)

CHM-823 Kinetics and Mechanisms of Inorganic Reactions (Cr. 3)

CHM-824 Organo-transition Metal Chemistry (Cr. 3)

CHM-825 Bio-Inorganic Chemistry (Cr. 3)

CHM-826 Physical Methods in Inorganic Chemistry (Cr. 3)

CHM-827 Inorganic Material Chemistry (Cr. 3)

CHM-828 Catalysis (Cr. 3)

CHM-829 Special Topics in Inorganic Chemistry (Cr. 3)

CHM-830 Advanced Material Chemistry (Cr. 3)

CHM-831: Advanced Polymer Science
CHM-832: Computational Chemistry
CHM-833: Chemistry of Composite Materials
CHM-834: Materials Science I
CHM-835: Materials Science II
CHM-836: Solid State Electronic Devices
CHM-837: Physics of Semiconductors and Devices
CHM-838: Characterization Techniques in Materials

CHM-839 Electronic Materials Processing
CHM-840 Advanced Energy Conversion Devices (Cr. 3)

III. Organic Chemistry

CHM-841 Protecting Groups in Organic Synthesis (Cr. 3)

CHM-842 Organic Synthesis-Retrosynthetic Approach (Cr. 3)

CHM-843 Advanced Stereochemistry (Cr. 3)

CHM-844 Physical Organic Chemistry (Cr. 3)

CHM-845 Nuclear Magnetic Resonance in Organic Chemistry (Cr. 3)

CHM-846 Advances in Chromatographic Techniques (Cr. 3)

CHM-847 Chemistry of Isoprenoids and Steroids (Cr. 3)

CHM-848 Chemistry of Glycosides (Cr. 3)

CHM-849 Biosynthesis of Natural Products (Cr. 3)

CHM-850 Chemistry of Organometallic Compounds (Cr. 3)

CHM-851 Reactive Intermediates in Organic Chemistry (Cr. 3)

CHM-852 Advanced Heterocyclic Chemistry (Cr. 3)

CHM-853 Advanced Mass Spectrometry (Cr. 3)

CHM-854 Organic Photochemistry (Cr. 3)

CHM-855 Organic Polymer Chemistry (Cr. 3)

CHM-856 Pericyclic Reactions (Cr. 3)

CHM-857 Advanced Stereoselective Synthesis (Cr. 3)

CHM-858 Modern Name Reactions in Organic Synthesis (Cr. 3)

CHM-859 Special Topics in Organic Chemistry (Cr. 3)

CHM-860 Advanced Natural Product Chemistry (Cr. 3)

IV. Analytical Chemistry

CHM-861 Frontiers Nanomaterials for Bio-applications (Cr. 3)

CHM-862 Advanced Analytical Instrumental Techniques (Cr. 3)

CHM-863 Advanced Thermal Analysis (Cr. 3)

CHM-864 Water and Soil Chemistry (Cr. 3)

CHM-865 Analysis and Characterization of Polymers (Cr. 3)

CHM-866 Advanced Atomic Spectroscopy (Cr. 3)

CHM-867 Atmospheric Chemistry (Cr. 3)

CHM-868 Chromatographic Methods of Analysis (Cr. 3)

CHM-869 Diffraction Methods of Analysis (Cr. 3)

CHM-870 Experimental Techniques in Nanotechnology

CHM-871 Applied Industrial Processes (Cr. 3)

CHM-872 Special Topics in Analytical Chemistry (Cr. 3)

V. Biochemistry

CHM-881 Biochemistry of Disease (Cr. 3)

CHM-882 Advances in enzyme structure and function (Cr. 3)

CHM-883 Fermentation and Biotransformation (Cr. 3)

CHM-884 Fundamentals of Molecular Biology (Cr. 3)

CHM-885 Metabolomics (Cr. 3)

CHM-886 Metabolic regulations (Cr. 3)

CHM-887 Biological Oxidations (Cr. 3)

CHM-888 Lab Techniques in Biochemistry (Theory + Lab Work) (Cr. 3)

CHM-889 Biostatistics (Cr. 3)

CHM-890 Research Methodology and scientific writing (Cr. 3)

CHM-891 Techniques in Molecular Biology (Cr. 3)

CHM-892 Special Topics in Biochemistry (Cr. 3)

CHM-893 Forensic Chemistry (Cr. 3)

CHM-894 Drug Designing (Cr. 3)

CHM-896: Comprehensive Oral Examination
CHM-897: Seminar-I (Cr. 1)
CHM-898: Seminar-II (Cr. 1)
CHM-899 Thesis (Cr. 50)