MAHATMA GANDHI UNIVERSITY

SCHOOL OF CHEMICAL SCIENCES

PROGRAMME M Phil Chemistry

(Inorganic Chemistry/ Organic Chemistry/ Physical Chemistry/ Polymer Chemistry**)**

DURATION one year (2012 Admission onwards)

Total credits required: 36 (for 2semesters)
[Core: 28; Elective: 8]

* The student has to choose **four elective courses** for semester I.

I SEMESTER

Course Code	Course Title	Hours/Week			Credit
		L	T	P	
	Core Courses				
SCS 601	Coordination Chemistry	2	-	-	2
SCS 602	Organic Synthesis	2	-	-	2
SCS 603	Computational Methods in Chemistry	2	-	-	2
SCS 604	Polymer Physics	2	-	-	2
SCS 605	Spectroscopic Methods in Chemistry	2	-	-	2
	***Elective Courses**				
SCS 611	Organometallics	2	-	-	2
SCS 612	Chemistry of Materials	2	-	-	2
SCS 613	Asymmetric Catalysis	2	-	-	2
SCS 614	Supramolecular Chemistry	2	-	-	2
SCS 615	Computational Quantum Chemistry	2	-	-	2
SCS 616	Biopolymers	2	-	-	2
SCS 617	Polymer Synthesis and Characterisation	2	-	-	2

II SEMESTER

Course Code	Course Title	Hours/Week			Credit
		L	T	P	
	Core Courses				
SCS 631	Research Project	-	-	-	14
SCS 632	Project Seminar	-	-	-	2
SCS 633	Comprehensive Viva-Voce	-	-	-	2

SCS 601 COORDINATION CHEMISTRY

Credit: 2 **Contact Hours: 2**

Crystal Field Theory(CFT) of bonding in complexes-its merits and demerits, evidences of covalency in metal ligand bond, Ligand Field Theory(LFT), Molecular Orbital Theory(MOT)-MO energy level diagram for octahedral complexes without and with π-bonding, two-dimensional spectrochemical series.

Electronic spectra of complexes: d-d transition and charge transfer transition, selection rules for electronic transition, effect of spin-orbit coupling and vibronic coupling on electronic transition, Orgel and Tanabe Sugano diagrams.

Magnetic studies of complexes: thermal population of different energy levels-large and small multiplet widths, orbital contribution to magnetic moment, antiferromagnetism, Temperature Independent Paramagnetism(TIP), Spin State Cross Overs.

Coordination chemistry of lanthanides: factors limiting the formation of lanthanide complexes, coordination numbers and geometries, electronic spectra, covalency parameters, hypersensitive transitions, magnetic properties, bonding in lanthanide complexes.

Coordination chemistry of actinides: comparison of electronic structures of actinide with those of lanthanides, stereochemistry, absorption spectra and magnetic properties. A comparative account of the complexes of lanthanides and actinides.

Applications of the following physico-chemical methods in the structural elucidation of complexes.

1. Vibrational, electronic and ESR spectra
2. Magnetic studies
3. Thermal (TG, DTG, DTA) studies
4. Single crystal XRD studies

References

01. F.A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 3rd Edn., Wiley, 1972.
02. J.E. Huheey, R.A. Keiter, R.L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., Prentice Hall, 1997.
03. T. Moeller, International Reviews of Sciences, Inorganic Chemistry, Series-I, Vol.VII, Butterworth, 1972.
04. K. Nakamoto, Infrared and Raman spectroscopy of Inorganic and Coordination Compounds, 6th Edn., John Wiley & Sons, 2008.
05. R.S. Drago, Physical Methods in Chemistry, 2nd Edn., Saundres College, 1992.
06. A. Earnshaw, Introduction to Magnetochemistry, Academic Press, 1968.
07. W.W. Wendlant, Thermal Analysis, Elsevier, 1981.
08. E.A.V. Ebsworth, D.W.H. Rankin, S. Cradock, Structural Methods in Inorganic Chemistry, 2nd Edn., CRS Press, 1991.

SCS 602 ORGANIC SYNTHESIS

Credit: 2 **Contact Hours: 2**

Retrosynthesis: general survey of organic reactions, comparison and selection of appropriate reactions-designing synthesis. Retrosynthetic analysis, disconnection approach-one group, two group and illogical disconnections. Functional group interconversion, protection of functional groups, synthetic equivalent groups, multistep synthesis, convergent synthesis, formation of C-C bonds, carbon-heteroatom bonds, ring closure and ring opening reactions, retro syntheses of aromatic heterocycles.

Synthesis of natural products: chemistry of alkaloids, terpenes, steroids, prostaglandins, vitamins, plant hormones, insect pheromones, germination stimulants and insect control agents. Synthesis of strychnine, epimyrtine, epibatidine, juvabione, longifolene, taxol, epothilone, cholesterol, lanosterol, prostaglandin E, vitamin A, gibberellic acid, grandisol, strigol, orobanchol and pyrethrins.

Synthetic methods: macrolactonization, metathesis-Pd catalyzed coupling reactions in organic synthesis, N-heterocyclic carbenes in catalysis, asymmetric conjugate addition, chiral dienes in synthesis, chiral dienes in catalysis.

Drug Synthesis: basic principles, IC50, LogP, LogD, MIC, efficacy, adsorption, distribution, metabolism and excretion, stages in drug discovery, natural and synthetic drugs. Synthesis of the following drugs: antiviral drug-Tamiflu, antibacterial drugs (Cipro or Zyvox), β-lactam antibiotics, penicillins, qinolones and fluoroquinolones, opium analgesics, cimetidine, antiinflammatory drugs (Celebrex), non steroid anti inflammatory drugs (Ibuprofen and Naproxen), ATPase inhibitor, esomeprazole, cardiovascular drugs, statin drugs, atorvastatin, sulfonamides, central nervous system (CNS) drugs.

References

01. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry, 5th Edn., Springer,2007.
02. S. Warren, Organic Synthesis: The Disconnection Approach, John Wiley, 1984.
03. S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Springer, 2005.
04. J. Tsuji, Palladium in Organic Synthesis, Springer, 2005.
05. G. Thomas, Fundamentals of Medicinal Chemistry, John Wiley & Sons, 2003
06. A. Kar, Medicinal Chemistry, 3rd Edn., New Age International, 2005

SCS 603 COMPUTATIONAL METHODS IN CHEMISTRY

Credit: 2 **Contact Hours: 2**

Introduction to programming languages, C programming language, variables, logical variables, loops-for loop and while loop, arrays, pointers, structures, recursion.

Numerical analysis: polynomial equations, equations of fifth degree or greater polynomials, Newton Raphston method of iteration, finding the inverse and determinant of a square matrix, numerical solution of differential equations.

Non numerical algorithms: towers of Hanoi, search methods such as binary search, sorting methods such as heap sort and merge sort.

Application of programming, principles to numerical and non numerical algorithms: factorial, sin(x), cos(x), log(x), tan(x), estimation of determinant of a square matrix, inverse of a square matrix, solution of simultaneous equations using Krammer's rule, method of least squares, Newtorn Raphston method of the solution of equations, towers of Hanoi, binary search.

Stochastic programming, Monte Carlo methods, random number generators.

References

01. B.W. Kernigan, D.M. Ritchie, The C Programming Language(ANSI C), 2nd Edn., Prentice Hall, 1988.
02. E. Kreyszig, Advanced Engineering Mathematics, 10th Edn., John Wiley and Sons, 2011.

SCS 604 POLYMER PHYSICS

Credit: 2 **Contact Hours: 2**

Polymer structure and properties: solubility and cohesive energy density, structural factors influencing chain flexibility, mechanical, thermal, chemical, optical and electrical properties.

Transition phenomena in polymers: glass transition temperature and crystalline melting points, principles of corresponding temperature, molecular motion and transitions, the Boyer-Berman rule, molecular interpretation of the glassy state of polymers, types of mechanical deformation, polymer structure and transition behaviour..

Polymer viscoelasticity: types of mechanical deformation, introduction to the viscoelasic properties of polymers, simple linear viscoelastic models-Maxwell and Voigt models, the Boltzman principle, linear viscoelastic behavior of polymer solids, creep, stress relaxation, stress-strain and oscillatory experiments, the elastic modulus, time temperature equivalence, time-temperature superposition principle, Payne and Mullins effects.

Polymer rheology: Newtonian fluids, non-Newtonian fluids, pseudoplastic materials, bingham plastics, dilatants, viscoelastic fluids, time dependent fluids, rheopectic and thixotropic fluids, rheological models, elastic effects: die swell, melt fracture, Barus effect, shark skin, Weisenberg effect.

Theory of rubber elasticity, molecular and mechanical requirements for a material to be rubber, load-deformation, rubber elasticity of ideal rubber, thermodynamics of ideal rubber, statistical approach to rubber elasticity, rubber like elasticity of real rubbers, Mooney-Rivillian equation, crosslink density.

Crystallization of polymers: structural requirements for crystallinity, Friged miscelle model, Lamellar model, configurations of polymer chain, crystallization and melting, strain-induced crystallization, representative crystal structures, polymer single crystals, growth from solutions, hollow pyramids, morphology of polymer crystallized from the melt, interlamellar ties, orientation and drawing, characterization of crystallinity and crystal structure, spherulites, long period, lamellar thickness, interplanar distance.

References

01. P.J. Flory, Principles of Polymer Chemistry, Cornel University Press, 1953.
02. H.G. Elias, Macromolecules: Structure and Properties, Springer, 1977.
03. A. Tager, Physical Chemistry of Polymer, 2nd Edn., Mir Publishers, 1978.
04. R.P. Brown, Physical Testing of Rubber, 3rd Edn., Springer, 1996.
05. F.W. Billmeyer, Text Book Of Polymer Science, 3rd Edn., Wiley, 1984.
06. D.I. Bower, An Introduction to Polymer Physics, Cambridge University Press, 2002.
07. L.H. Sperling, Introduction to Physical Polymer Science, 4th Edn., John Wiley & Sons, 2006.

SCS 605 SPECTROSCOPIC METHODS IN CHEMISTRY

Credit: 2 **Contact Hours: 2**

Infrared Spectroscopy: fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), effect of H-bonding and solvent effect on vibrational frequency. Vibrational frequencies of various functional groups.

Nuclear Magnetic Resonance Spectroscopy: ^{1}H NMR spectroscopy, chemical shift and chemical equivalence, factors affecting the chemical shift values, approximate chemical shift values of various protons bonded to aliphatic, olefinic, aldehydic and aromatic carbons, anisotropic effects, effect of hydrogen bonding, proton exchange and effect of deuteration, spin-spin interaction and splitting of spectral signals, magnetic equivalence, Pople notations- AX, AB, AMX and ABC spectra, coupling constant J, first-order and non first-order spectra, enantiotopic and diastereotopic protons, Karplus curve, variation of coupling constant with dihedral angle, simplification of complex spectra using NMR shift reagents, double resonance and Nuclear Overhauser Effect (NOE).

^{13}C NMR Spectroscopy: chemical shift values of aliphatic, olefinic, alkynic, aromatic, hetero-aromatic and carbonyl carbons, coupling constants, two-dimensional NMR spectroscopy, NOESY, DEPT and INEPT terminologies. Application of 2D-NMR in macromolecules.

EPR spectroscopy: electron spin interaction with magnetic field, g factor, determination of $g_{||}$ and $g_{\perp}$, fine and hyperfine structures, Kramers' degeneracy, McConnell equation.

Mass Spectroscopy: mass spectral fragmentation of compounds of common functional groups, molecular ion peak, McLafferty rearrangements, different methods of fragmentation.

Applications of IR, NMR, EPR and mass spectroscopic techniques for structure elucidation of inorganic and organic compounds.

References

01. D.L. Pavia, G.M. Lampman, G.S. Kriz, Introduction to Spectroscopy, 3rd Edn., Brooks Cole, 2000.
02. R.S. Drago, Physical Methods in Chemistry, Saunders College, 1992.
03. W. Kemp, Organic Spectroscopy, 2nd Edn., Macmillan, 1987.
04. R.M. Silverstein, G.C. Bassler, T.C. Morril, Spectroscopic Identification of Organic Compounds, 5th Edn., Wiley, 1991.
05. C. N. Banwell, E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edn., Tata McGraw-Hill, 1994.
06. P.S. Kalsi, Spectroscopy of Organic Compounds, 6th Edn., New Age International, 2007.
07. D. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, 6th Edn., McGraw-Hill, 2008.

SCS 611 ORGANOMETALLIC CHEMISTRY

Credit: 2 **Contact Hours: 2**

Nomenclature of organometallic compounds, classification, hapticity and electron contribution of ligands, η^1, η^2, η^3, η^4, η^5 and η^6-type hapticties, μ-type organic ligands, 18- and 16-electron rules, structure prediction through electron counts. Metal carbonyls, terminally bound and bridging type metal carbonyls and its distinction by IR spectra, polynuclear carbonyls. Structure and bonding in metal nitrosyls, metal cyanides and metal phosphines.

Organometallic compounds containing metal-metal bonds and metal clusters, metal-metal multiple bonds with σ-, π- and δ-type of bonds. Structure and bonding in metal-olefins, metal-acetylenes, metal-allyls, metal-carbenes, metal-carbynes, metal-polyenes, metal-cyclooctatetraenes, metal-norbornadiene. Donor and acceptor properties of the ligands in the above compounds. A-frame complexes and their special features.

Fragment molecular orbitals (FMO) of various organic and inorganic moieties/fragments: lFMO's of C_3H_5, C_4H_4, C_4H_6, C_5H_5, C_6H_6, C_8H_8, ML_5, ML_4, ML_3 type fragments. Isolobal concept, isolobal relationships between organic and inorganic (ML_n) fragments. Structure and bonding in metallocenes, half-sandwich compounds, ML_n-cyclobutadiene and ML_n-carbenes based on FMOs and MO diagrams.

Stereochemical non-rigidity and fluxional nature of organometallic compounds, characterization of different types of fluxional nature by variable temperature NMR spectroscopy. Reactions involving various organometallic compounds-oxidative addition reactions and reductive elimination reactions, migratory insertion reactions, CO and alkene insertion reactions, 1,1- and 1,2-insertion, β-hydride elimination reactions, cyclometallation reactions.

Alkene hydrogenation (Wilkinson's catalyst), water-gas shift reaction, hydro-formylation reactions, catalytic addition of molecular oxygen to alkenes (Wacker process), synthetic gasoline, Ziegler-Natta polymerization of alkenes, Fischer-Tropsch process, alkene metathesis, oligomerisation of alkynes, metallacycles, ortho-metallation, Suzuki coupling.

Organometallics in industry, medicine, agriculture and environmental science.

References

01. J.E. Huheey, R.A. Keiter, R.L. Keiter, Inorganic Chemistry-Principles of Structure and Reactivity, 4th Edn., Prentice Hall, 1997.
02. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edn., Wiley-Interscience, 1999.
03. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver and Atkins Inorganic Chemistry, 4th Edn., Oxford University Press, 2006.
04. J.D. Atwood, Inorganic and Organometallic Reaction Mechanism, 2nd Edn., Wiley-VCH, 1997.
05. B.E. Douglas, D.H. McDaniel, J. J. Alexander, Concepts and Models of Inorganic Chemistry, 3rd Edn., Wiley-India, 2007.
06. J.P. Collman, L.G. Hegedus, J.R. Norton, R.G. Finke, Principles and Applications of Organotransition Metal Chemistry, 2nd Edn., University Science Books, 1987.

SCS 612 CHEMISTRY OF MATERIALS

Credit: 2 **Contact Hours: 2**

Materials: classification, synthesis and characterization of materials, formation of bulk materials-direct synthesis methods, solution methods, chemical deposition methods.

High-Tc oxide superconductors: structural features of cuprate superconductors, type I and type II superconductors, mechanism of superconductivity in cuprates, applications of high Tc cuprates.

Colossal magnetoresistance, rechargeable battery materials, oxide glasses-formation, composition, production and applications.

Framework materials: structures based on tetrahedral oxoanions-contemporary zeolite chemistry, aluminophosphates, phosphates and silicates, structures based on octahdra and tetrahedra.

Hydrides and hydrogen-storage materials: metal hydrides, magnesium-based metal hydrides.

Semiconductor materials: inorganic pigments-coloured solid materials, white and black pigments. Photocatalysis of nanotitania.

High energetic materials: composite solids propellants, phase stabilised ammonium nitrate.

Molecular materials and fullerides: one-dimensional metals, molecular magnets, inorganic liquid crystals, fullerides. Structure of graphene. Material property at the nanoscale.

References

01. A.R. West, Solid State Chemistry and its Applications, John-Wiley, 1984.
02. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Inorganic Chemistry, 5th Edn., Oxford University Press, 2010.
03. C.N. R. Rao, J. Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edn., Cambridge University Press,2004.
04. R.C. Buchanan, T. Park, Materials Crystal Chemistry, Marcel Dekker, 1997.
05. J.I. Gersten, F.W. Smith, The Physics and Chemistry of Materials, Wiley-Intersccience, 2001.
06. Y. Gogotsi, Nanomaterials Handbook, CRC Press, 2006.

SCS 613 ASYMMETRIC CATALYSIS

Credit: 2 **Contact Hours: 2**

Asymmetric hydrogenation: ligand design for catalytic hydrogenation, enantioselective hydrogenation of prochiral olefins, asymmetric reduction of ketones using chiral organometallic compounds, asymmetric reduction of ketones using non metallic catalysts, contributions of Brown, Kagan,and Noyori in hydrogenation reactions, different hydrogenation catalysts.

Asymmetric hydrogenation of C-C double bonds: ligand design for C-C bond formation, asymmetric hydrogenation of C-C double bonds using organometallic catalysts, asymmetric aldol and Michael reactions, enantioselective allylation.

Asymmetric oxidation: ligand design for oxidation, asymmetric epoxidation using Binol-Ph_3PO/cumene hydroperoxide, asymmetric epoxidation using chiral titanium complexes, Sharpless epoxidation, Jacobsen Katzuki epoxidation, Shi epoxidation, Aggarwal epoxidation, contributions of Backvall, Beller, Bolm and Burgess in asymmetric oxidation, asymmetric epoxidation of unfunctionalized olefins.

Green catalysis: catalysis by solid acids and bases, heterogeneous catalysis, basic principles of enzyme catalyzed reactions. Asymmetric reduction of ketones using Bakers yeast.

Non linear effects in asymmetric catalysis, asymmetric C-H bond activation, organo catalysis- Hajos Parish reaction.

References

01. K. MIkami, M. Lautens, New Frontiers in Asymmetric Catalysis, Wiley, 2007.
02. S.M. Roberts, G. Poignant, Catalysis for Fine Chemical Synthesis: Hydrolysis, Oxidation and Reduction Vol 1, John Wiley 2002
03. J.E. Backvall, Modern Oxidation Methods, Wiley VCH, 2004
04. R. A. Sheldon, I. Arends, U. Hanefeld, Green Chemistry and Catalysis, Wiley-VCH, 2007.

SCS 614 SUPRAMOLECULAR CHEMISTRY

Credit: 2 **Contact Hours: 2**

Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p and van der Waals interactions.

Synthesis and structure of crown ethers, lariat ethers, podands, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands and hemicarcerands. Host-Guest interactions, pre-organization and complimentarity, lock and key analogy. Binding of cationic, anionic, ion pair and neutral guest molecules.

Crystal engineering: role of H-bonding and other weak interactions.

Self-assembly molecules: design, synthesis and properties of the molecules, self assembling by H-bonding, metal-ligand interactions and other weak interactions, metallomacrocycles, catenanes, rotaxanes, helicates and knots.

Molecular devices: molecular electronic devices, molecular wires, molecular rectifiers, molecular switches, molecular logic.

Relevance of supramolecular chemistry to mimic biological systems: cyclodextrins as enzyme mimics, ion channel mimics and supramolecular catalysis.

Examples of recent developments in supramolecular chemistry from current literature: catenanes and rotaxanes, nonlinear optical materials, dendrimers.

References

01. J.W. Steed, J.L. Atwood, Supramolecular Chemistry, John Wiley and Sons, 2000.
02. H. Dodziuk, Introduction to Supramolecular Chemistry, Springer, 2001.
03. F. Vogtle, E. Webner, Host Guest Complex Chemistry: Macrocycles: Synthesis, Structures, applications, 2^{nd} Edn., Springer, 1985
04. P.D. Beer, P.A. Gale, D.K. Smith, Supramolecular Chemistry, Oxford University Press, 1999.
05. K. Ariga, T. Kunitake, Supramolecular Chemistry: Fundamentals and Applications, Springer, 2006

SCS 615 COMPUTATIONAL QUANTUM CHEMISTRY

Credit: 2 **Contact Hours: 2**

Introduction to theoretical methods in chemistry, the tools of computational quantum chemistry.

The concept of the potential energy surface: stationary points, the Born-Oppenheimer approximation, geometry optimization, stationary points and normal mode vibrations, zero point energy corrections.

The Huckel Molecular Orbital(HMO) and Extended Huckel Molecular Orbital (EHMO) methods: principles and simple applications.

Introduction to *ab initio* methods: basis sets, the Hartree Fock method, electron correlation, post-Hartree Fock methods.

Semi-empirical methods: introduction, applications, strengths and weaknesses of semi-empirical methods.

Density functional calculations, basic principles of density functional theory(DFT), applications of DFT, strengths and weaknesses of DFT.

References

01. D. Young, Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problem, John Wiley & Sons, 2001.
02. E.G. Lewars, Computational Chemistry, Springer, 2003.
03. C.J. Cramer, Essentials of Computational Chemistry: Theories and Models, John Wiley & Sons, 2004.
04. S.M. Bachrach, Computational Organic Chemistry, John Wiley & Sons, 2007.

SCS 616 BIOPOLYMERS

Credit: 2 **Contact Hours: 2**

Significance of biopolymers and its classification.

Polysaccharides: homopolysaccharides and heteropolysaccharides, starch, cellulose and chitin-structure and biological functions. Peptidoglycans, proteoglycans and glycoproteins.

Peptides and proteins: different structural levels-primary, secondary, tertiary and quaternary structures. Ramachandran plot, protein folding. Sequence determination by Edman method. Synthesis of peptides-different steps involved. Solid phase synthesis of peptides. Enzymes and enzyme kinetics.

Nucleic acids: structure, properties and functions of DNA and RNA. Base-pairing, double helical structure of DNA. Secondary and tertiary level organization, Various DNA forms(A,B&Z), DNA replication-transcription and translation. Recombinant DNA techniques.

Biodegradable polymer: sugar based biodegradable polymers, poly lactic acid(PLA) and polyhydroxyalkanoates (PHA), applications of biodegradable polymers.

References

01. I.L. Finar, Organic Chemistry, Vol. 2, 5th Edn., ELBS, 1995
02. R. Chandra, R. Rustgi, Biodegradable Polymers-Progress in Polymer Science, Vol. 23, 1998
03. M. Johnson, L.Y. Mwaikambo, N. Tucker, Biopolymers, Rapra Technology, 2003
04. D.K. Platt, Biodegradable Polymers, Rapra Technology, 2006.

SCS 617 POLYMER SYNTHESIS AND CHARACTERISATION

Credit: 2 **Contact Hours: 2**

Polymer synthesis: polymerization initiated by metal catalysts, Ziegler-Natta polymerization, ring opening metathesis polymerization (ROMP), controlled radical polymerization (ATRP, RAFT & NMP), group transfer polymerization (GTP), ADMET polymerization, aldol group transfer polymerization, free radical ring opening polymerization, polymerization of cyclic organic molecules, photolytic polymerization, radiation polymerization, electrolytic polymerization and plasma polymerization.

Polymer characterization: isolation and purification of polymers, identification of common plastics, determination of molecular weights by various methods: end group analysis, viscometry, osmometry, light scattering (DLS & SLS), gel permeation chromatography (GPC), light scattering method, ultracentrifugation and X-ray scattering. Thermal analysis: DSC, TGA and TMA. Structure determination by spectroscopic analysis: NMR, IR, MALDI-Tof, SEM, HR-TEM.

References.

01. H.R. Allcock, F.W. Lampe, J.E. Mark, Contemporary Polymer Chemistry, 3rd Edn., Prentice Hall, 2003.
02. J.M.G. Cowie, V. Arrighi, Polymers: Chemistry and Physics of Modern Materials, 3rd Edn., CRC Press, 2008.
03. R.P. Brown, Handbook of Plastics Test Methods, 3rd Edn., Longman, 1988.
04. M. Chanda, S.K. Roy, Plasic Plastic Technology Handbook, 4th Edn., Taylor and Francis, 2006.
05. J.R. Fried, Polymer Science and Technology, 2nd Edn., Prentice Hall, 2003.

SCS 631 RESEARCH PROJECT

Credit: 14l

The candidate has to do a project of original research on a relevant topic under the guidance of a Supervising Teacher of the School of Chemical Sciences during the second semester and submit the dissertation at the end of the second semester.

The dissertation shall be evaluated both by the Internal Examiner (Supervising Teacher) and the External Examiner. The content, literature survey, subject grasp and current interest will be considered for evaluation.

SCS 632 PROJECT SEMINAR

Credit: 2

The candidate shall give a seminar (30 minutes) on the research project submitted as per course SCS 631 Research Project. This follows discussion with the Examination Board consisting of the Chairman, the Internal Examiner and the External Examiner.

SCS 633 COMPREHENSIVE VIVA-VOCE

Credit: 2

The comprehensive viva-voce shall be conducted by the Examination Board consisting of the Chairman, the Internal Examiner and the External Examiner.

Thorough understanding of all the M.Phil. level course contents and recent trends in the broad area of chemical sciences are evaluated. If candidate's performance is found unsatisfactory, he/she has to reappear for the viva-voce.