Ph.D LEVEL COURSES FROM DEPARTMENT OF SCIENCES

SS 801 ADVANCED ORGANIC CHEMISTRY 3-1-0-4

Functional Group Inter-conversions: Introduction to various functional group transformations – concepts and strategies. Protection and deprotection of hydroxyl, carbonyl, amines, carboxylic acids and alkynes.
Retrosynthesis: Introduction to retrosynthetic analysis and designing of the synthesis. Disconnection approach, synthons, synthetic equivalents. Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Illustrative examples to explain disconnection approach.
Photochemistry: Introduction to basic law of photochemistry, electronic excitation, uni-molecular and bimolecular processes. Thermal vs. photochemical reactions. Norrish type I and II reactions, Stern-Volmer equation, Paterno-Büchi reactions, photochemistry of arenes.
Pericyclic reactions: Introduction, conservation of orbital symmetry, selection rules, electrocyclic reactions, cycloadditions, cheletropic reactions. Sigmatropic rearrangements – Sommelet, Haüser Cope and Claisen rearrangement. Examples of various [4+2] cycloadditon reactions.
Naming reactions and rearrangements: Reactions and illustrative examples of Arndt-Eistert Synthesis, Baeyer-Villegar oxidation, Barnford-Stevens reaction, Dess-Martin oxidation, Heck reaction, Jacobsen epoxidation, Lossen rearrangement, Mannish reaction, McMurry reaction, Ullmann reaction, Wittig reaction.

TEXT BOOKS/REFERENCES:

1. Jerry March, "*Advanced Organic chemistry: Reactions, Mechanisms, and Structure*", Fourth Edition, Wiley Interscience Publication, 1999.
2. Stuart Warren, "*Organic Synthesis – The Disconnection Approach*", Oxford University Press, 2001.
3. R.T. Morrison and R. N. Boyd, "*Organic Chemistry*", Sixth Edition, Dorling Kindersley Pvt. Ltd., 2009
4. I. L. Finar, "*Organic Chemistry, Vol. I and II*", Sixth Edition, ELBS, 1995

SS802 ADVANCED ELECTROCHEMISTRY 3-1-0-4

Electrified Interface: Structure and potential difference-absolute electrode potential-thermodynamics of electrified interface-reversible and irreversible states-electrode kinetics-Butler–Vohlmer equation-quantum oriented electrochemistry-chemical potential, energy states and distribution of energy –adsorption of ionic species and organic molecules at electrodes-mass transport-migration, diffusion and convection phenomena
Electro-analytical Techniques (principle and practice): Conductance and potential difference based titrations-potential sweep methods-CV, LSV, step and pulse techniques-hydrodynamic techniques-forced convection-diffusion controlled polarography-impedance methods-electroactive layers and modified electrodes-electrochemical sensors.

Industrial Electrochemical process-Electrodeposition of Alloys: Theory of alloy deposition-role of cathode diffusion layer, cathode potential and complexing agents-composition of bath and composition of deposit-correlation-structure and properties of alloy deposits.

TEXT BOOKS/REFERENCES:

1. Bockris and Reddy, *"Modern Electrochemistry", Kluwer Academic /Plenum Publishers*", 1998.
2. Brett and Brett, "*Electrochemistry (Principles, Methods and Applications)",* Oxford University Press, 2004.
3. Allen J. Bard and Larry R. Faulkner, "*Electrochemical Methods (Fundamentals and Applications)*", John Wiley and Sons, 2000.
4. Brenner, "*Electrodeposition of Alloys*", Academic Press, 1972.

SS803 INSTRUMENTAL METHODS OF ANALYSIS 3-1-0-4

Errors in chemical analysis: Evaluation of analytical data, significant figures, types of errors, minimization of errors, standard deviation, coefficient of variation, statistical treatment of data, students T test, Rejection of suspected value, Q test, sampling, standardization and calibration.

Chromatographic Techniques: Basic principles – column resolution and efficiency – gas chromatographic column. Gas liquid chromatography – instrumentation and application. CHN analysis by Gas. HPLC adsorption. Ion exchange and size exclusion chromatography, planar chromatography – application to detection and isolation of compounds.

Diffraction Techniques: X-Ray diffraction techniques – X-Ray generation and properties – lattice planes – Bragg's law – power and thin film diffraction – X-Ray scattering – X-Ray stress measurement –instrumentation and application. Electron diffraction

Thermal gravimetric analysis – instrumentation and operation. Thermal stability assessment and compositional analysis – application to specific samples. Differential scanning thermal analysis – instrumentation and application.

SEM, AFM, STM, STEM, TEM, confocal microscopy – principle, instrumentation, working, applications to characterizing Nanophase materials.

TEXT BOOKS/REFERENCES:

1. D. A. Skoog and D. M. West, "*Principles of Instrumental Analysis*", Eighth Edition. Thomsons-Brooks/Cole, 2004.
2. F. W. Fifield and D. Kealey, "*Principle and Practice of Analytical Chemistry*", Second Edition, International Book Company, 1993.
3. David Harvey, "*Modern Analytical Chemistry*", McGraw Hill Companies, 2000.

SS804 SPECTROSCOPY 3-1-0-4

NMR: Fundamental principles and theory, Instrumentation, solvents, Introduction to 1D, 2D and 3D NMR.

UV: Introduction, modern instrumentation – design and working principle. Applications of UV-Visible spectroscopy, Woodward-Fischer rules for calculating absorption maximum, Mass: Introduction, Basic principles and instrumentation, fragmentation processes and fragmentation pattern, types of ionization techniques and applications.

IR Spectroscopy: Introduction, theory of IR absorption, interaction of rotations and vibrations – Techniques and Instrumentation (outline and sample handling) and applications.

TEXT BOOKS/REFERENCES:

1. C. N. Banwell and McCagh, "*Fundamentals of Molecular Spectroscopy*", Fourth Edition, Tata McGraw Hill Publishing Co.Ltd, 1994.
2. Donaid L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan, "*Introduction to Spectroscopy"*, Fourth Edition, Cengage Learning, 2009.
3. W. Kemp, "*Organic Spectroscopy*", Second Edition, ELBS MacMillan, 1987.

SS805 ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY 3-1-0-4

Organometallic compounds: Synthesis of metal carbonyls, poly nuclear carbonyls, poly nuclear carbonyls with and without bridging groups, complexes with cyclic pi-donors, cyclopentadiene, benzene, cycloheptatriene, cyclobutadiene and cyclooctatetraene, structure and bonding, fluxional molecules, metal clusters – isolobal concept, metal complexes as liquid crystals.

Organometallics as synthetic reagents, organometallics in industry, medicine, and agriculture, reactions of compounds involving small molecules, addition, elimination and rearrangement reactions – catalysis by organometallic complexes.

Metal ions in biological systems: Metalloporphyrins, respiration, structure and function of haemoglobin – property and applications of porphyrins – photodynamic therapy, NLO property. Platinum containing anticancer agents, co-enzyme B_{12} binding of co-enzyme with protein (base off and base on mode), model compounds, cobaloximes – synthesis, reactions, structure and property relationship and applications.

Supramolecular chemistry: Self assembly, self organization, self assembly of inorganic architectures, molecular recognition – directed self-assembly of organized phases, ordered solid state structures, supramolecular synthesis, supramolecular photonic devices, light conversion and energy transfer devices, photosensitive molecular receptors, NLO properties of supramolecular species, molecular wires, molecular devices, electro switching devices.

TEXT BOOKS/REFERENCES:

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, "*Inorganic Chemistry*", Fourth Edition, Addison Wesley Publishing Company, New York, 1993.
2. Jonathan W. Steed and Jerry L. Atwood, "*Supramolecular Chemistry*", Second Edition, Wiley-Interscience, 2009.
3. Manfred Bochmann, "*Organometallics-Complexes with Transition Metal-Carbon pi-Bonds*", Oxford University Press, 1994.

SS806 SOLID PHASE SYNTHESIS 3-0-0-3

Solid phase: Introduction, Synthesis in solid phase. Solid supports, Merrifield Resins, Hydroxy Resins. Linkers/spacers: Acid labile linkers, Base labile linkers, Photo labile linkers, Safety catch linkers, Traceless linkers and cyclative cleavage linkers. Solid phase synthesis – advantages and disadvantages. Reaction monitoring of solid phase synthesis – Destructive and non-destructive reaction monitoring.

Application/examples of the utility of solid phase resins. Combinatorial synthesis and combinatorial chemistry – Introduction, combinatorial synthesis in solution phase and solid phase – examples, libraries on solid phase, mix and split – Introduction examples and applications. Instrumental automation and testing. Purification – comparison of solution phase and solid phase purification.

TEXT BOOKS/REFERENCES:

1. Bing Yan, "*Analysis and Purification Methods in Combinatorial Chemistr*y", Wiley-Interscience, 2003.
2. Pierfausto Seneci, "*Solid Phase Synthesis and Combinatorial Technologies*" Wiley-Interscience, 2000.
3. Steven A. Kates and Fernando Albericio, "*Solid Phase Synthesis – A Practical Guide*", Taylor & Francis Ltd, 2000.

SS807 MOLECULAR MODELING AND SIMULATION 3-0-0-3

Definitions, Scope and Classifications: Minimization of functions; Statistics – Macroscopic properties from molecular Simulations: Representing molecules and Molecular interactions; Energy and Forces for molecular Interactions: Constraints: periodic Boundaries and Neighbor Lists: Monte Carlo Simulations: Algorithm, Detailed balance, Computing properties, Exercises: Molecular Dynamics: Initialization, force calculation, Algorithm, Computing Equilibrium and Dynamic properties, Exercises: Computational Chemistry: Atomistic and Coarse-grained Approaches: Advanced Energy Minimization Techniques : Softwares for Molecular Modeling.

TEXT BOOKS/REFERENCES:

1. K. I. Ramachandran, Deepa Gopakumar and Krishnan Namboori, "*Computational Chemistry and Molecular Modeling: Principles and Applications*", Springer, 2008.
2. D. Frenkel and B. Smit, "*Understanding Molecular Simulations: From Algorithams to Applications*", Second Edition, Academic press, 2002.
3. M. P. Allen and D. J. Tildesley, "*Computer Simulation of Liquids*", Clarendon Press, 1987.
4. Tamar Schlick, "*Molecular Modeling and Simulation: An Interdisciplinary Guide*", Springer, 2002.

SS 808 INTRODUCTORY QUANTUM MECHANICS 3-0-0-3

Review of Planck's relation, De-Broglie relation and uncertainty principle. Basic postulates of quantum mechanics - Schrodinger equation: probabilistic interpretation of wave function, one dimension problems - particle in a box, harmonic oscillator, potential barrier and tunneling. Hydrogen atom, multi electron atom and periodic table - electrons in a magnetic field.

Bound states and resonant states - WKB approximation - Born Approximation and it's validity, time dependent perturbation theory.

Scattering theory - Expression for the scattering amplitude - scattering by a square well potential - scattering by a hard sphere.

Bosons and Fermions-Symmetric and antisymmetric wavefunctions - Elements of statistical physics: density of states, Fermi energy, Bose condensation- molecular band theory-Solid state physics: Free electron model of metals, elementary discussion of band theory and applications to semiconductor devices.

TEXT BOOKS/REFERENCES:

1. R. Shankar, *"Principles of Quantum Mechanics"*, Second Edition, Springer, 2007
2. L I Schiff, *"Quantum Mechanics*", Mc Graw Hill, Inc 2002
3. J J Sakurai, "*Modern Quantum Mechanics*", Addison Wesley, 1994
4. Kurt Gottfried, "*Quantum Mechanics*", Volume 1, W A Benjamin Toe, 1966
5. Arthur Beiser, "*Concepts of Modern Physics*", Sixth Edition, Tata McGraw Hill, 2002.

SS 809 PHOTOVOLTAICS 3-0-0-3

PhotoVolitic effect,History of solar cells, solar radiation, Radiation Absorption and Reflection, Photo action spectrum – impendance spectroscopy – shunt resistance.

Semi conductor Properties: Semiconductor Energy band diagram, extrinsic semiconductors-doping and carrier concentration, diffusion and drift of carriers, transport equations, minority carrier diffusion length, continuity equation.

Generation and Recombination in semiconductors: Dark I-V equation of p-n junction, junction under illumination, generation and recombination, optical processes, photogeneration rates, radiative recombination, Shockley Reed Hall recombinations, Auger recombinations.
Solar Cells: solar cell parameters, production of silicon solar cells –fabrications and design, optimization of process parameters, measurements of solar cell parameters-short circuit current, open circuit voltage, fill factor, efficiency. Optical losses, electrical losses, surface recombination velocity, quantum efficiency –external and internal, Thermodynamic and balance of limit efficiency, solar cell thermodynamics ,I – V characteristics .
Monocrystalline Solar Cells: Silicon solar cell design, strategies to – enhance absorption, reduce series resistance, surface recombination, Alternatives to Silicon,III –V materials for PV, GaAs Cells. Thin Film Solar cells: Amorphous Si for PV, Materials properties, fabrication , stability, polycrystalline thin film PV Materials, CdTe and CIGS solar cells.
Third Generation Solar Cells: Tandem cells, Hybrid solar cells, organic Solar cells –energy levels in molecular materials, exciton formation, diffusion, dye sensitized solar cells, bulk hetero-junction and hybrid solar cells.

TEXT BOOKS/REFERENCES:

1. Ben G Streetman , "Solid State Electronic Devices",Prentice Hall of India Pvt.Ltd.,1995.
2. Nelson J, "The Physics of Solar Cells",Imperial College Press,2006.
3. Wenham SR,"Applied Photovoltaics",Second Edition,Earthscan Publications Ltd.,2007.
4. Green MA, "Third Generation Photovoltaics: Advanced Solar Energy Conversion",Springer-verlag.2007.

SS 810 NANOMATERIALS FOR BIOSENSORS 3-1-0-4

Introduction to Biosensors: major classification of sensor- characteristic parameters of sensor-material property for designing biosensors. Introduction to Nanomaterials : Size dependence of properties –Surface to volume ratio and Quantum confinement. Microscopic techniques to study nano structures-SEM, AFM – TEM and STM.Spectroscopic techniques to characterize nano structures –Raman, XPS, Auger, EDAX. Synthetic approaches : Colloidal, Self – Assembly(self assembled monolayers-SAMs)and electrostatic self assembly, electrochemical methods(cathodic and anodic processes),sol-gel, Langmuir-Blodgett(lb) technique,chemical vapour deposition,plasma arcing and ball miling, lithography. Electrochemistry of nanostructures.Carbon nanotubes and Graphenes.Quantum Dots,wells and wires-Preparation,properties and biosensing applications: metallic and semiconducting quantum dots, wells and wires. Biofunctionalisation of nanomaterials, Mimic enzyme for biosensing, molecularly imprinted polymers, surface Plasmon resonance- Fluorescence Rsonance energy transfer (FRET) – Dendirmeric structures for biosensing.Basic experiments in biosensor characteristics and modeling.

TEXT BOOKS/REFERENCES:

1. Huangxian Ju,Xueji Zhang and Joseph Wang, "*NanoBiosensing , Principles , Development and Application*",Springer,2011.
2. Arben Merkoci (Editor), *"Biosensing using Nanomaterials",*John Wiley & Sons,2009.
3. Alexei Nabok, *"Organic and Inorganic Nanostructures*",Artech House,Inc.,2005.
4. Zhong Lin Wang (Editor), "*Characteristion of Nanophase Materials*", Wiley VCH,2000.

SS 811 BIOMATERIALS AND ITS APPLICATIONS 3-1-0-4

Metals – Properties - Thermal Treatments on metals -Strengthening by alloying, work hardening, oligo elements, Strengthening by thermal treatments, and order disorder transformation. Ceramics - Properties - Bio active ceramics - Ceramic and polymeric carbons - Biological glasses – Coatings - A Survey on the Adhesion of Ceramic to Bone Tissue. Composites – Classifications – Properties –Testing On Composite Materials - Ultrasonic techniques, Sensing of deformation and damage (health monitoring) - Environmental Effects - Applications of Composites.

Definition - classification of bio-materials, Metallic implant materials, Co- Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite- glass ceramics - medical applications. Implementation problems - inflammation, rejection, corrosion, structural failure. Surface modifications for improved compatibility. biological effects of implants.

Mechanical properties, visco elasticity, wound-healing process, Application of biomaterial for the human body, body response to implants, blood compatibility.

X-ray diffraction and molecular structure – EDAX- Nuclear Magnetic Resonance – Scanning tunneling microscope – Atomic force microscopy –SEM – TEM – optical tweezers – spectroscopy methods differential thermal analysis, Laser Raman spectroscopy, FTIR, differential thermo gravimetric analysis – NDT methods.

Materials for bone and joint replacement –dental metals and alloys – dental restorative materials – dental amalgams.– cardiovascular materials – cardiac prosthesis; vascular graft materials – cardiac pacemakers – cardiac assist devices – materials for ophthalmology contact lens – intraoccular materials – materials for drug delivery. Nano Biomaterials -matrix and filler materials

TEXT BOOKS/REFERENCES:

1. D. F. Williams (Editor), "*Material Science and Technology - A Comprehensive Treatment*", Vol. 14, Medical and Dental Materials, VCH Publishers Inc., New York, 1992.
2. Jonathan Black, "*Biological Performance of Materials, Fundamentals of Biocompatibility*", Marcel Dekker Inc., New York, 1992.
3. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, "*Instrumental Methods of Analysis*", CBS Publishers, New Delhi, 1986.
4. Vasantha Pattabhi and N.Gautham, "Biophysics", A*lpha science International Ltd*. UK, 2002

5. Rodney M J Cotterill, "*Biophysics - An Introduction*", John Wiley & sons Ltd., 2002
6. Vasantha Pattabhi and N.Gautham, "Biophysics", A*lpha science International Ltd*. UK, 2002.

SS812 LASER INSTRUMENTATION FOR BIOMEDICAL APPLICATIONS 3-1-0-4

Basic optical theory: nature of electromagnetic radiation, interaction of radiation with matter, reflection, refraction, polarization, Laser fundamentals, laser beam characteristics, Q-switching, mode locking, continuous wave, beam quality (laser cavity modes), types of lasers, energy and power.

Laser interaction with materials: Absorption, reflection, refraction and polarization, optical properties of materials, tissues – laser interaction with tissues - pathology of laser reaction in tissues - thermal effects - non thermal reactions of laser radiation.
Laser instrumentation: Doppler flowmetry - Laser flow cytometry - single cell separation - micro irradication. Laser fluorescent micro irradiation - Laser eye instrumentation. Laser tissue transillumination & diaphanography - Speckle intereferometry, reflectance in tumer diagnostics, holography - Application Safety with biomedical Lasers.

TEXT BOOKS/REFERENCES:

1. Markolf H. Niemz, "*Laser-Tissue Interactions: Fundamentals and Applications*", Springer, 2007.
2. Valerii Viktorovich Tuchin, "*Tissue Optics: Light Scattering Methods and Instruments for Medical Diagnosis*", SPIE Publications 2007.
3. Leon Goldman, "*The Biomedical Laser Technology and Clinical Applications*", Springer-Verlag, 1981.
4. Myron L. Wolbarsht, "*Laser Applications in Medicine and Biology*", Springer, 1991.

SS813 MICROFLUIDICS 3-1-0-4

Origin, Definition, Benefits, Challenges, Commercial activities, Physics of miniaturization, Scaling laws.Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations - Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects - Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels - Hydraulic resistance and Circuit analysis, Straight channel of different cross-sections, Channels in series and parallel.Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect. Electrohydrodynamics fundamentals- Electro-osmosis, Debye layer, Thin EDL limit, Ideal electro-osmotic flow, Ideal EOF with back pressure, Cascade electro-osmotic micropump, EOF of power-law fluids- Electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size-Dielectrophoresis, Induced polarization and DEP , Point dipole in a dielectric fluid, DEP force

on a dielectric sphere, DEP particle trapping, AC DEP force on a dielectric sphere- Electro-capillary effects, Continuous electro-wetting, Direct electro-wetting, Electro-wetting on dielectric. Materials, Clean room, Silicon crystallography, Miller indices- Oxidation, photolithography- mask, spin coating, exposure and development, Etching, Bulk and Surface micromachining, Wafer bonding- Polymer microfabrication, PMMA/COC/PDMS substrates, micromolding, hot embossing, fluidic interconnections. Micropumps, Check-valve pumps, Valve-less pumps, Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps- Microvalves, Pneumatic valves, Thermopneumatic valves, Thermomechanical valves, Piezoelectric valves, Electrostatic valves, Electromagnetic valves, Capillary force valves- Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Coriolis flow sensors, Thermal flow sensors- Micromixers, Physics of mixing, Pe-Re diagram of micromixers, Parallel lamination, Sequential lamination, Taylor-Aris dispersion- Droplet generators, Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport- Microparticle separator, principles of separation and sorting of microparticles, design and applications- Microreactors, Design considerations, Liquid-phase reactors, PCR, Design consideration for PCR reactors. Drug delivery, Diagnostics, Biosensing.

TEXT BOOKS/REFERENCES:

1. Nguyen, N. T., Werely, S. T., "Fundamentals and applications of Microfluidics", Artech house Inc., 2002.
2. Bruus, H., "Theoretical Microfluidics", Oxford University Press Inc., 2008.
3. Madou, M. J., "Fundamentals of Microfabrication", CRC press, 2002.
4. Tabeling, P., "Introduction to microfluidics", Oxford University Press Inc., 2005.
5. Kirby, B.J., "Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices", Cambridge University Press, 2010.
6. Colin, S., "Microfluidics", John Wiley & Sons, 2009.

SS 814 MATHEMATICAL PHYSICS 4 0 0 4

Review of Analysis, Complex variables, vector calculus, generalized functions, infinite series, Fourier series and transforms.

Partial differential equations of Mathematical physics: Physical background of: Laplace, Poisson, wave and Klein Gordon equations

Methods of solving differential equations: Classification of Partial differential equations and Boundary conditions. The Cauchy problems. Separation of variables in Cartesian, spherical and Cylindrical coordinates. Ordinary and singular points. Ordinary differential equations and their series solutions. Ordinary and singular points. Regular and irregular singular points. Wronskian of second order differential equations. Expansion about a singular point.

Special Functions: Gamma function, Legendre polynomials. Recurrence relations and orthogonal properties of the falling special functions. Neumann functions. Bessel functions of imaginary argument. Hyper geometric functions.

Linear integral equations: Types of integral equations. Integral equation with separable kernels, Solution of integral equation of second kind by successive substitutions. Fredholm's method of solution of the inhomogeneous equation and the homogeneous equation

TEXT BOOKS / REFERENCES:

1. A K Ghatak, I C Gayal, S J Chua, *"Mathematical Physics",* McMillan India Limited, 1995.
2. R Courant and D Hilbert*, Methods of Mathematical Physics,* Wiley Eastern, 1953

SS 815 NUMERICAL METHODS AND PROGRAMMING 3 0 0 3

Differentiation: Numerical methods, forward difference and central difference methods, Lagrange's interpolation method.

Integration: Newton – cotes expression for integral, trapezoidal rule, Simpson's rule, Gauss quadratue method.

Solution of Differential Equations: Taylor series method, Euler method, Runge - Kutta, predictor – corrector methods.

Roots of Equations: Polynomial equations, graphical methods, bisection, Newton – Raphson and False position methods.

Solutions of Simultaneous Equations: Elimination method for simultaneous linear equations, Gauss elimination, pivotal condensation, Gauss – Seidal iteration, Gauss Jordan and Matrix inversion methiods.

Eigen Values and Vectors of Matrices: Determinant of a matrix, characteristic equation, eigen values and vectors of a matrix, power method.

Development of FORTRAN Codes for the above methods

TEXT BOOKS / REFERENCES:

1. C Xavier, *FORTRAN 77 and Numerical Methods, New* Age International Limited, 1994.
2. Rubin H Landau & Manuel Jose Paez Mejia*, Computational Physics,* John Wiley and Sons, 1997.
3. Suresh Chandra*, Computer Applications in Physics,* Narosa Publishing House, New Delhi, 2003.
4. M Hijroth Jensen*,* Department of Physics, University of Oslo, 2003 (Available in the web)

SS816 ADVANCED QUANTUM MECHANICS 4 0 0 4

Fundamental Concepts: Basic postulates of quantum mechanics, Linear operators, Hermitian operators. Orthogonality of Eigen functions of a Hermitian operator. Completeness of Eigen functions. Commuting operators and their Eigen functions. Dirac's bra and ket notation.

Representation of operators as matrices. Change of basis. Unitary transformation and its significance. Equations of motion. Schrodinger's picture and Heisenberg picture. Interpretation of the wave function. Schwartz Inequality and Uncertainty principle. Classical limit of the Schrodinger's equation.

Angular Momentum: Orbital and Spin angular momenta. Total angular momentum operator. Eigen values of I. The Eigen values and Eigen functions of Pauli spin matrices. Commutation relations. Spin functions for two spin ½ particles. Addition of angular momenta. Clebsch Gordan coefficients.

Identical Particles: Physical meaning of identity. Symmetric and anti symmetric wave functions. Construction from unsymmetrized functions. The Pauli's exclusion principle.

Symmetry in Quantum Mechanics: Symmetries in classical physics. Symmetry in quantum mechanics. Conservation laws and degeneracies. Parity, or space inversion. Lattice translation as a discrete symmetry. Time reversal discrete symmetry.Scattering Theory: Green's functions: incoming and outgoing solutions. Expressions for the scattering amplitude. Born approximation and its validity. Partial wave analysis. Optical theorem. Relation between phase shift and potential. Ramsauer-Townshed effect. Scattering by a square well potential. Scattering by a hard sphere. Coulomb nuclear scattering. Optical theorem.

TEXT BOOKS/REFERENCES:

1. J J Sakurai, *Modern Quantum Mechanics,* Addison Wesley, 1994.
2. L I Schiff, *Quantum Mechanics*, McGraw Hill Inc., 1949.
3. Ghatak Ajoy, *Basic Quantum Mechanics,* McMillan 2002.
4. V K Thankappa, *Quantum Mechanics* , 2nd Edition, New Age International, 1995.
5. Kurt Gottffried, *Quantum Mechanics,* Vol I, W A Benjamin Inc., 1966.

SS817 ADVANCED NUCLEAR PHYSICS 4 0 0 4

Basic Nuclear Concepts: Maas, Charge and constituents of the nucleus, Nuclear size and distribution of nucleons, Energies of nucleons in the nucleus, Angular momentum, Parity and Symmetry, Magnetic dipole moment and electric quadrupole moment. Energy levels and mirror nuclei.

Nuclear Forces: Characteristics of nuclear forces – range and strength, Simple theory of two nucleon system – deuterons, Spin states of two nucleon system, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron.

Review of Mathematical Techniques: Spherical Harmonics, Phase Shift Analysis, Coupling of Angular Momenta.

Fundamental Properties of Nuclei: Interaction of Electromagnetic field with matter, Static Electromagnetic moments, Gamma Transition and Nuclear models.

Particle Radioactivity: Alpha, Beta activities, Fermi's theory of Beta Decay, Basic theory of alpha emission.
Nuclear Reaction: Basic reaction theory, Compound Nucleus and Statistical theories, Optical model, Direct reactions

TEXT BOOKS/REFERENCES:

1. R R Royand B P Nigam, *"Nuclear Physics",* John Wiley & Sons, 1967.
2. S S M Wong, *" Introduction to Nuclear Physics",* Wiley VCH, 1998
3. L R B Elton, *"Inrtoductory Nuclear theory",* W B Saunders Company, 1996.
4. G R Satchler, " *Introduction to Nuclear Reactions",* McMillan, 1990.
5. I E McCarthy, *"Introduction to Nuclear Theory",* John Wiley & Sons Inc., 1968
6. Irving Kaplan, *Nuclear Physics,* Addison – Wesley Publishing Company, 1962

SS818 ANALYTICAL TECHNIQUES 3-0-0-3

Error Analysis- Determinate and Indeterminate errors, Significant figures, Accuracy, Precision, Standard Deviation, Correlation Coefficient, Regression Curve, Confidence limits, Robustness, Ruggedness and Rejection of a result –T test and F test, Separation Techniques- Principles of chromatography, Column efficiency, High performance Liquid Chromatography (HPLC), Thin Layer Chromatography (TLC), Paper Chromatography, Size Exclusion Chromatography, lon exchange Chromatography, Gas Chromatography (GC), Gas Chromatography with Mass spectrometry (GC-MS), Liquid Chromatography with Mass Spectrometry (LC-MS), Ultra Performance Liquid Chromatography (UPLC), Thermal, Activation and Diffraction Techniques- Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), X-ray techniques – powder, diffraction and fluorescence. Spectrophotometric and electro analytical techniques-UV/ Visible Spectroscopy, IR Spectroscopy, NMR Spectroscopy and Mass Spectroscopy-theory, instrumentation and applications: Spectrophotometric identification of organic compounds. ESCA / Auger Technique, SEM, AFM,TEM, STM and confocal AFM,TEM,STM and confocal, CV, Tafel polarization and Impedance analysis (EIS).

TEXT BOOKS/ REFERENCES:

1. Willard, Dean, Merit, Settle, *"Instrumental Methods of Analysis",* Seventh Edition, CBS Publishers and Distributors, 1996.
2. Skoog DA, FJ Holler and TA Nieman, *"Principles of Instrumental Analysis",* Fifth Edition, Harcourt Brace & Company, Saunders College Publishers, 2001.
3. C.N. Banwell; Elaine M. McCash, *"Fundamentals of Molecular Spectroscopy",* McGraw-Hill Publishing Company, 1995.

4. Robert M Silverstein, Francis X Webster, *"Spectrophotometric Identification of Organic Compounds",* Sixth Edition, *John* Wiley and Sons Inc., 2005.
5. Ernst Meyer, Hans, Josef Hug, Rolanamd Bennenitz, *"Scanning Probe Microscopy- The Lab on a Tip",* Springer Publications, 2004.

SS 819 INTRODUCTION TO PHOTOCHEMISTRY 4-0-0-4

Unit-1 Light induced processes in everyday life
The Nature of Light, Photosynthesis, Vision, Photoresponse Mechanisms in Plants and Animals, Photomedicine, Photochemical effects of Visible and UV light, Bioluminescence, Photodegradation, Imaging processes

Unit 2 - Photochemistry - Principles and Reactions
Rates of absorption, Beer Lambert's Law, Stark-Einstein Law, Fluorescence lifetimes, quantum yield; Fluorescence, Phosphorescence, Jablonski diagram, cis-trans isomerisation, Paterno-Buchi reaction, Norrish Type I and II reactions, photo reduction of ketones, di-pimethane rearrangement, photochemistry of arenes, Hoffmann-Loffler-Freytag reaction, Barton reaction, Photochemistry of cyclohexadienones.

Unit 3- Excited state processes
Adiabatic and Non-adiabatic processes, Monophotonic and multiohotonic proceses, Primary and secondary photochemical processes,kinetics of photochemical reactions, photo-ionization , light induced electron capture and electron transfer reactions, Intramolecular and intermolecular electron transfer, Marcus-Hush Model of Electron transfer, Electronically excited molecules-Excimers and Exciplexes, Charge transfer in excited states, twisted intramolecular charge transfer state, quenching of excited states, Stern Volmer equation, electron transfer, energy transfer,paramagnetic quenching, concentration quenching, static and dynamic quenching

Unit 4-Mechanisms of Photochemical reactions
Organic Photochemistry -Quenching, Sensitization, Unimolecular and bimolecular reactions, Photoelectrochemistry-reactions at electronically excited semiconductor electrodes, Inorganic photochemistry, photochemistry and photophysics of metal complexes, Photochemistry in solids and organized assemblies, Photochemical reactions in glasses, excitons in polymers and crystals, photochemistry in micelles, photochemical reactions of free radicals

Unit 5- Light in Industry
Photographic processes-Spectral sensitization, Colour photography, Instant photography, Electrophotography, Photopolymerisation and photochemical degradation of polymers, Phototchemistry in synthesis –photochlorination of polymers, Synthesis of caprolactam, Vitamin D, Photochemistry of Dyes and Pigments, Phtochromism, Energy conversion and storage – photoelectrochemical cells,Ozone layer-its photochemical formation and degradation.

TEXT BOOKS / REFERENCES:
1. Modern molecular photochemistry- N. J. Turro (University Sci. 1991)
2. Chemistry and Light- P. Suppan (RSC 1999)

3. Organic and Inorganic Photochemistry; Volume 2 of Molecular and supramolecular photochemistry - V. Ramamurthy, Kirk S. Schanze (M. Dekker, 1998)
4. Organic Photochemistry- James Morriss Coxon, Brian Halton, (Cambridge University Press, 1987)
5. Principles of Organic Synthesis- R.O.C. Norman & Coxon (CRC Press; 1993)
6. Fundamentals of Photoinduced Electron Transfer- G. J. Kavarnos (Wiley-VCH, 1993)
7. Essentials of Molecular Photochemistry - A Gilbert and J Baggott (Blackwell,1991)
8. Principles and applications of photochemistry- R. P. Wayne (OUP 1988)
9. Photochemistry - C. E. Wayne and R. P. Wayne (OUP Primer

SS 820 FRONTIERS OF PHOTOCHEMISTRY 4-0-0-4

Unit 1 Spectrophotometry, Measurements in Solution

The Absorption Spectrum,The General Absorption Characteristics of Molecules ,Qualitative Analysis, Quantitative Treatment of the Absorption Intensity ,Quantitative Analysis ,The Method of the Standard Additions, Analysis of Mixtures of Absorbing Species,Spectrophotometric Titrations ,Instrumentation,The Light Source,The Monochromator ,The Sample Holder ,The Detector ,The Spectrophotometers ,The Sample Measurement. ,The Instrumental Precision ,Experimental Examples

Unit 2 Photochemical Techniques

Photochemical Apparatus, Light Sources , Selection of the Exciting Radiation , Reaction Cells,Optical Material , Control of Temperature and Stirring, Photoreaction Quantum Yield ,Chemical Actinometers, Potassium Ferrioxalate ,Potassium Reineckate, Azobenzene , Aberchrome 540 ,A Photochromic Diarylethene Compound ,Irradiation Experiments.

Unit 3 Spectrofluorimetry, Spectroelectrochemistry & CD spectroscopy

Spectrofluorimetry ,Reference Standards for the Determination of Fluorescence Quantum Yields ,Reference Standards for the Determination of Phosphorescence Quantum Yields, Luminescence Measurements on Solid Samples , Sample Inhomogeneity ,Concentration Effects , SpectroelectrochemistryAbsorption and Emission Spectroscopy with Polarized Light , Linear and Circular Dichroism Spectroscopy , Polarized Light, Birefringence and Circular Dichroism, Linear Dichroism, Observables in Circular Dichroism Spectroscopy

Unit 4 Transient Absorption Spectroscopy

Transient Absorption with Nanosecond Resolution, Measure of Absorbance Change,The Sample Compartment , The Optical System ,The Electronic Detection System, Transient Absorption Spectroscopy in Supramolecular Systems ,Fullerene Derivatives ,Ligand–Protein Complexes , Sub-Nanosecond Transient Absorption ,Shortening the Laser Pulse, Ti: Sapphire Laser ,Chirped Pulse Amplification , Regenerative Amplification, Ultrafast Transient Absorption Spectroscopy, Femtochemistry ,Pump and Probe Experiments ,Photoinduced Electron Transfer in a Multichromophoric System, Femtosecond Systems, Experimental Suggestions

Unit 5- Supramolecular Photochemistry

Definition of a Supramolecular System , Photoinduced Energy and Electron Transfer in Supramolecular Systems , Excimers and Exciplexes ,Electron Transfer Processes,Marcus

Theory, Quantum Mechanical Theory ,Optical Electron Transfer , Energy Transfer Processes,Coulombic Mechanism, Exchange Mechanism,The Role of the Bridge in Supramolecular Systems

TEXT BOOKS/ REFERENCES:

1. The Exploration of Supramolecular Systems and Nanostructures by Photochemical Techniques -Paola Ceroni Springer, 2012.
2. Electrochemistry of Functional Supramolecular Systems (The Wiley Series on Electrocatalysis and Electrochemistry) -Paola Ceroni, Alberto Credi, Margherita Venturi Wiley-Interscience, 2010.
3. Supramolecular Photochemistry- Vincenzo Balzani, Springer, 1987.
4. Designing Dendrimers - Sebastiano Campagna, Paola Ceroni, Fausto Puntoriero,Wiley, 2011.
5. Electron Transfer in Chemistry: Molecules-level electronics, imaging and information, energy and the environment; Volume 5 of Electron Transfer in Chemistry- Vincenzo Balzani, Wiley-VCH, 2001

SS 821 PHOTOVOLTAICS 3-0-0-3

Photovoltaic Effect, History of Solar cells, Solar Radiation, Radiation Absorption and Reflection, Photo action spectrum – impedance spectroscopy – shunt resistance.

Semiconductor Properties: Semiconductor Energy band diagram, extrinsic semiconductors – doping and carrier concentration, diffusion and drift of carriers, transport equations, minority carrier diffusion length, continuity equation. Generation and Recombination in Semiconductors: Dark I-V equation of p-n junction, junction under illumination, generation and recombination, optical processes, photogeneration rates, radiative recombination, Shockley Reed Hall recombinations, Auger recombinations. Solar Cells: Solar cell parameters, production of silicon solar cells – fabrication and design, optimization of process parameters, measurements of solar cell parameters-short circuit current, open circuit voltage, fill factor, efficiency. Optical losses, electrical losses, surface recombination velocity, quantum efficiency-external and internal, Thermodynamic and balance of limit efficiency, solar cell thermodynamics, I-V characteristics. Monocrystalline Solar Cells: Silicon solar cell design, strategies to - enhance absorption, reduce series resistance, surface recombination, Alternatives to Silicon, III-V materials for PV, GaAs cells. Thin film Solar cells: Amorphous Si for PV, Materials properties, fabrication, stability, polycrystalline thin film PV materials, CdTe and CIGS solar cells. Third Generation Solar Cells: Tandem cells, Hybrid solar cells, *Organic Solar cells* – energy levels in molecular materials, exciton formation, diffusion, dye sensitized solar cells, bulk hetero-junction and hybrid solar cells.

TEXT BOOKS / REFERENCES:

1. Ben G Streetman , *"Solid State Electronic Devices"*, Prentice-Hall of India Pvt. Ltd., 1995.
2. Nelson J, *"The Physics of Solar Cells"*, Imperial College Press, 2006.

3. Wenham SR, *"Applied Photovoltaics",* Second Edition, Earthscan Publications Ltd., 2007.
4. Green MA*, "Third Generation Photovoltaics: Advanced Solar Energy Conversion"*, Springer-Verlag, 2007.

SS822 HETEROCYCLIC CHEMISTRY 3-1-0-4

Five-membered hyeterocycles with one heteroatom – pyrroles, furans and thiophenes – nomenclature, synthesis and applications. Five-membered hyeterocycles with two heteroatoms – imidazoles, pyrazoles, thiazoles, isothiazoles, oxazoles and isoxazoles – nomenclature,synthesis and applications.

Six-membered hyeterocycles with one heteroatom – pyridines – nomenclature, synthesis and applications. Six-membered hyeterocycles with two heteroatoms – pyridazines, pyrimidines and pyrazines – nomenclature, synthesis and applications.

Seven-membered hyeterocycles with one heteroatom – Azepines, oxepines and thiepins. Fused heterocycles – indoles, quinolines, isoquinolines, coumarines, benzofurans and purines.

TEXT BOOKS / REFERENCES:

1. Raj K. Bansal, " *Heterocyclic Chemistry*", New age International Pvt. Ltd., New Delhi, fourth edition, 2005.
2. Jerry March, " *Advanced Organic Chemistry: Reactions, Mechanisms and Structure*", John Wiley and Sons Inc, fourth edition, 2007.
3. R.O.C. Norman and J. M. Coxon, "*Principles of organic synthesis*", Nelson Thrones, third edition, 2005

SS823 POLYMER CHEMISTRY 3-1-0-4

FUNDAMENTALS**:**Basics of polymers – polymer c,assifications based on occurrence, types, process, structure and end uses. Polymer microstructure – chemical and geometrical structure – ladder, star and telechelic polymers – interpenetrating networks – tacticity – crystalline and amorphous nature – crystallization and crystallizability – effect on properties – thermal transitions – TGA and DSC.

REACTION MECHANISMS: Reactive intermediates – carbocations, carbanions and free radicals. Nucleophilic aliphatic substitution -sN1, sN2. Electrophilic aliphatic and aromatic substitutions – orientation and reactivity in mono-substituted benzene rings, applications like nitration, sulphonation and halogenation.

POLYMERIZATION METHODS**:**Kinetics and mechanism of free radical, cationic, anionic and coordination polymerization – Ziegler Natta catalysts – monometallic mechanism – stereo regular polymerization – chain transfer reaction and constant – living polymers – alfin catalysts.

STEP GROWTH POLYMERIZATION AND COPOLYMERIZATION**:** Polycondensation polymerization – copolymerization – kinetics – copolymer equation – composition of copolymers by NMR – monomer reactivity ratios and their significance – polymerization reactions – metathetical, electrochemical, GTP and ring opening.

MOLECULAR WEIGHT, SOLUBILITY AND FRACTIONATION OF POLYMERS**:**Number, weight and viscosity average molecular weights – polydispersity – molecular weight distribution – determination of molecular weight by GPC and viscometry – polymer dissolution – thermodynamics of polymer dissolution – solubility parameter – fractionation of polymers – reactions of polymer molecules with specific groups like OH, CHO, CO, COOH, NH_2 – polymer crosslinking, cyclisation – polymer degradation – thermal, mechanical, photo and radiation.

TEXT BOOKS / REFERENCES:

1. F. W. Billmayer, Text Book of Polymer Science, 3rd edition, John Wiley and sons, New York, 2002.
2. M. S. Bhatnagar, A Textbook of Polymers (Chemistry and Technology of Polymers), Vol. I, II and III, 1st edition, S. Chand and Company, New Delhi, 2007.
3. R. J. Young, Introduction to Polymers, Chapman and Hall Limited, London, 1999.
4. George Odeon, Principles of Polymerization, 4th edition, McGraw Hill Book Company, New York, 2004.

SS824 CORROSION AND ITS CONTROL 3 0 0 3

Thermodynamics of corrosion- mechanism of electrochemical corrosion- different forms of electrochemical corrosion. Kinetic aspects of corrosion- rate of corrosion – determination of corrosion – anodic polarization and impedance spectroscopic methods. Corrosion behavior of metals - ferrous and non ferrous metals and alloys - non metallic corrosion - polymers and ceramics.

Corrosion protection methods - electrochemical methods of protection. Metallic coating - hot dipping - galvanizing- tinning - cladding- electroplating and electrolessplating. Inorganic coatings - phosphating and chromating - anodizing. Corrosion inhibitors - passivators and vapor phase inhibitors. Corrosion protection by surface modification - thermal evaporation- arc vaporization- sputtering and ion plating- vapour deposition processes.

TEXT BOOKS / REFERENCES:

1. M. G. Fontana, “Corrosion Engineering”, Mc Graw Hill, New York, 1997.
2. H.H. Uhlig and R. W. Reviees, “Corrosion and its Control”, Wiley, 1985.
3. D. Gabe, “Principles of Metal Surface Treatment and Protection”, Merlin Books, London, 1993.
4. P. A. Schweitzer, “Fundamentals of corrosion”, Taylor and Francis, Indian reprint 2012.

SS825 PRINCIPLES OF SPACE RADIATION INTERACTIONS 3 0 0 3

Space Radiation Environmental Effects: The Natural Space Environment, Plasma, Geomagnetic Field, Solar Environment, and Ionizing Radiation. **Sources of radiation in Earth space:** Plasma, Trapped Particles, Solar Particles, Galactic (Cosmic) Rays. Potentials of surfaces in space

Space "Radiation" Effects: Spacecraft Charging (S/C), Total Ionizing Dose (TID), Displacement Damage, Single Event Effects (SEEs)

Effect of radiation on Materials: Metals, Alloys, and Metal-to-Metal Bonds, Polymers: Thermosetting Plastics, Thermoplastics, Adhesives, Elastomers. Ceramics, Graphite, and Glasses, Thermal-Control Coatings. Mechanical properties, Thermophysical properties.

Solar Radiation and its effects on Atmosphere: Solar radiation at the top of atmosphere, attenuation of solar radiation in the atmosphere, radiative transfer, thermal effects of radiation, photochemical effects of radiation.

TEXT BOOKS / REFERENCES:

1. Handbook of Radiation Effects Hardcover, Andrew Holmes-Siedle, Len Adams, Oxford University Press, 2nd Ed. 2002.
2. Spacecraft Environments Interactions: Space Radiation and its Effects on Electronic Systems, J. W. Howard, Jr., D. M. Hardage, NASA Technical documents, 1999.
3. Space Radiation Effects on Graphite-Epoxy Composite Materials, Scott Milan Milkovich, Carl T. Herakovich, George F. Sykes., NASA Technical document, 1984.

SS826 BIOMATERIALS AND ITS APPLICATIONS 3 1 0 4

Introduction to Materials: Metals Properties - Thermal Treatments on metals -Strengthening by alloying, work hardening, oligo elements, Strengthening by thermal treatments, and order disorder transformation.Ceramics - Properties - Bio active ceramics - Ceramic and polymeric carbons - Biological glasses – Coatings - A Survey on the Adhesion of Ceramic to Bone Tissue.Composites – Classifications – Properties –Testing On Composite Materials - Ultrasonic techniques, Sensing of deformation and damage (health monitoring) - Environmental Effects - Applications of Composites.

Biomaterials and its properties: Definition - classification of bio-materials, Metallic implant materials, Co- Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite-glass ceramics - medical applications. Implementation problems - inflammation, rejection, corrosion, structural failure. Surface modifications for improved compatibility. biological effects of implants.Mechanical properties, visco elasticity, wound-healing process, Application of biomaterial for the human body., body response to implants, blood compatibility.

Characterization techniques: X-ray diffraction and molecular structure – EDAX- Nuclear Magnetic Resonance – Scanning tunneling microscope – Atomic force microscopy –SEM – TEM – optical tweezers – spectroscopy methods differential thermal analysis, Laser Raman spectroscopy, FTIR, differential thermo gravimetric analysis – NDT methods.

Applications: Materials for bone and joint replacement –dental metals and alloys – dental restorative materials – dental amalgams.– cardiovascular materials – cardiac prosthesis; vascular graft materials – cardiac pacemakers – cardiac assist devices – materials for ophthalmology contact lens – intraoccular materials – materials for drug delivery. Nano Biomaterials -matrix and filler materials

TEXT BOOKS / REFERENCES:

1. D. F. Williams (editor), Material Science and Technology - A comprehensive treatment, Vol. 14, Medical and Dental Materials, VCH Publishers Inc., New York, 1992.
2. Jonathan Black, Biological Performance of materials, Fundamentals of Biocompatibility, Marcel Dekker Inc., New York, 1992.
3. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986.
4. Vasantha Pattabhi and N.Gautham, Biophysics, Alpha science International Ltd. UK, 2002.
5. Rodney M J Cotterill, Biophysics an introduction, John Wiley & sons Ltd., NY, 2002

SS827 WASTEWATER TREATMENT TECHNOLOGIES AND BIOREMEDIATION

3 0 1 4

Sewage and Wastewater Treatment System - sewage characteristics, primary, secondary and tertiary treatments, efficiency measurements, and environmental pollution control. Biofilms-wastewater treatment, development and Kinetics, aerobic biofilms.

Industrial Wastewater Treatment - primary, secondary, advanced, physical, chemical and biological unit processes, aerobic, anaerobic attached and suspended growth processes, sources of heavy metal pollution. Advanced wastewater treatment - carbon adsorption, ion exchange, membrane processes and pollution control in selected process industries – tannery, textile, paper, sugar and distillery units.

Bioremediation - in *situ* and *ex situ* bioremediation, constrains, priorities and evaluating bioremediation, bioremediation of VOCs, biodegradation, factors affecting process of biodegradation - methods in determining ,contaminant availability for biodegradation, microbial interactions with inorganic pollutants, microbial metal resistance, microbial transformation, accumulation and concentration of metals, and heavy metal pollution.

TEXT BOOKS / REFERENCES:

1. Raina M. Maier, Ian L.Pepper and Charles P. Gerba, “Environmental Microbiology”, Academic Press, 2000.
2. Martin Alexander, “Biodegradation and Bioremediation”, Second Edition, Academic Press, 1999.
3. Gabriel Bitton, “Wastewater Microbiology”, Second Edition, Wiley- Liss, 1999.
4. S. P. Mahajan, “Pollution Control in Process Industries”, Tata McGraw Hill, 2001.

SS828 PHYSICS OF SOLAR CELLS 4-0-0-4

Module I(10hrs)

Introduction to Semi conductors: Basic Concepts, Electronic States in Semiconductors-Band structure, Density of States, electron and hole currents, Electron distribution function, Fermi Dirac Statistics, Boltzmann approximation, Types of semiconductors-intrinsic , extrinsic, Semiconductor under bias, Drift and Diffusion currents

Module II (12hrs)

Generation and recombination of charge carriers: Semiconductor transport equations. Types of Generation and Recombination, Formulation of transport problem, Origin of photovoltaic actions, metal semiconductor junction, Semiconductor –semiconductor junctions, Electro chemical junction, Junctions in organic materials.

Module III (12hrs)

Analysis of the P-N-Junctions: Formation of p-n Junctions, Depletion approximation, Calculation of carrier and current densities, General solution for current density, p-n junction under dark and under illumination, effect on junction characteristics, Other device structures.

Module IV (10 hrs)

Photovoltaic cell and power generation, Characteristic of the Photovoltaic Cell. The Solar Resource and types of solar energy converters, Work available from a photo voltaic device, requirements of an ideal photoconverter

Module V (12)

Principles of a solar cell design, material and design issues, Silicon material properties, and its solar cell design, III-V semiconductor material properties, Semiconductor solar cell design(GaAs), Thin film solar cells, requirements for suitable materials, Hetero junctions in thin film solar cell design, Managing light in solar cells(qualitative): Light confinement, photon recycling

TEXT BOOKS / REFERENCES:

1. Physics of Solar cells-Jenny Nelson, Imperial College Press(2006)
2. Solid State Physics-Structure and properties of materials-M.A.Wahab(Narosa)
3. Solid State Physics-N.W.Aschroft and N.D.Mermain.
4. Optical properties of thin films—O.S Heavens (Dover)