Functional Group Inter-conversions: Introduction to various functional group transformations – concepts and strategies. Protection and deprotection of hydroxyl, carbonyl, amines, carboxylic acids and alkynes.


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:


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:


SS803 INSTRUMENTAL METHODS OF ANALYSIS

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

TEXT BOOKS/REFERENCES:

SS804  SPECTROSCOPY  3-1-0-4

NMR: Fundamental principles and theory, Instrumentation, solvents, Introduction to 1D, 2D and 3D NMR.
IR Spectroscopy: Introduction, theory of IR absorption, interaction of rotations and vibrations – Techniques and Instrumentation (outline and sample handling) and applications.

TEXT BOOKS/REFERENCES:

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 B12 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.
SS806 SOLID PHASE SYNTHESIS


TEXT BOOKS/REFERENCES:

SS807 MOLECULAR MODELING AND SIMULATION

TEXT BOOKS/REFERENCES:


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


TEXT BOOKS/REFERENCES:

SS 809 PHOTOVOLTAICS 3-0-0-3

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.


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:**

**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:


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

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

TEXT BOOKS/REFERENCES:


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.


TEXT BOOKS/REFERENCES:

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

TEXT BOOKS/REFERENCES:

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
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:**

**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 quadrature method.
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:**
4. M Hijroth Jensen, Department of Physics, University of Oslo, 2003 (Available in the web)

**SS816 ADVANCED QUANTUM MECHANICS 4 0 0 4**


**TEXT BOOKS/REFERENCES:**

**SS817 ADVANCED NUCLEAR PHYSICS 4004**

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.

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:

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, Ion 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:

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

TEXT BOOKS / REFERENCES:
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)
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

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

Unit 4 Transient Absorption Spectroscopy

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:

SS 821 PHOTOVOLTAICS 3-0-0-3


TEXT BOOKS / REFERENCES:

SS822  HETEROCYCLIC CHEMISTRY  3-1-0-4

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

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

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

TEXT BOOKS / REFERENCES:

SS823  POLYMER CHEMISTRY  3-1-0-4


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.


TEXT BOOKS / REFERENCES:

SS824 CORROSION AND ITS CONTROL


Review:

TEXT BOOKS/REFERENCES:


SS825 PRINCIPLES OF SPACE RADIATION INTERACTIONS 3003


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


TEXT BOOKS / REFERENCES:

SS826 BIOMATERIALS AND ITS APPLICATIONS 3104

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

**Biomaterials and its properties:** Definition - classification of bio-mat... 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.


**TEXT BOOKS / REFERENCES:**

SS827 WASTEWATER TREATMENT TECHNOLOGIES AND BIOREMEDIATION

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:

Module I (10hrs)

Introduction to Semiconductors: 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)


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 photovoltaic 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:
4. Optical properties of thin films—O.S Heavens (Dover)