PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- To provide training in Research Methodology as a pre Ph.D course.
- To provide knowledge in advanced topics in Physics and in particular, Materials Science.
- To provide specialized training and advanced knowledge in the field of interest.
- To provide training in undertaking project work, so as to analyze and solve the problem independently.
- To provide training for making technical presentation and publishing results in any chosen topic related to the field of specialization.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

- The student is motivated and trained to carry out research.
- The student is trained to identify research problem, analyze and interpret data.
- The student gains knowledge in Advanced materials science.
- The student gains knowledge in his/her field of specialization.
- The student is trained to make seminar presentation with confidence.
- The student is trained to communicate effectively and develop leadership qualities.
- The student is trained to approach and analyze any problem independently.
- The student is trained to prepare project reports and present their work in conferences.
- Students will acquire confidence for self education and ability for life-long learning.

SEMESTER I

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TOTAL NUMBER OF CREDITS TO BE EARNED FOR THE AWARD OF DEGREE - 33

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### Employability Enhancement Courses (EEC)

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3
OBJECTIVE
- To impart knowledge on various materials of technological importance

UNIT I  SEMICONDUCTING MATERIALS  12

UNIT II  CERAMIC MATERIALS  12

UNIT III  POLYMERIC MATERIALS  12
Polymer semiconductors – Photoconductive polymers – Composition and structure of polymers – Electrical conductivity – LEP’s design and fabrication – Applications – Mechanical properties – nanoindentation techniques.

UNIT IV  OPTICAL MATERIALS  12

UNIT V  NEW MATERIALS  12

TOTAL: 60 PERIODS

OUTCOME
- The students will acquire knowledge on semiconducting materials, ceramic materials, polymeric materials, optical materials and new materials

REFERENCES

OBJECTIVE
- To expose the student with various mathematical methods for numerical analysis and use of computation tools

UNIT I  RESEARCH METHODOLOGY  12
Introduction - Defining research problem - research design - Important concepts - different research design - basic principles of experimental design - sampling design - steps and types of sampling design. Purpose and problem statements - Literature review - Frameworks - Research questions and hypotheses - Multimethod research.
UNIT II  NUMERICAL INTERPOLATION, DIFFERENTIATION AND INTEGRATION  12
Newton’s forward and backward interpolation formulae - Lagrange’s interpolation formula for unequal intervals - Error in polynomial interpolation and Newton’s interpolation formula - Numerical differentiation - Maximum and minimum of a tabulated function - Numerical integration - Trapezoidal rule - Romberg’s method - Simpson’s rule - Practical applications of Simpson’s rule.

UNIT III  NUMERICAL SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT IV  EMPIRICAL LAWS AND CURVE FITTING  12
Linear law and laws reducible to linear law - Graphical method - method of group averages - principle of least squares - Fitting of straight line and parabola.

UNIT V  C - PROGRAMMING  12
Variables, constants, strings - Arrays - arithmetic operations and statements - shorthand assignment - input and output statements (scanf, printf) - format specifications - relational operators - local expressions and operators - if / else, for, while loops - functions (library and user-defined) - simple programs using standard numerical methods from the above chapters (four different programs at least from each chapter).

OUTCOME
- The students will gain knowledge on systems of equation, probability statistics and error analysis and programming concepts.

REFERENCES

TOTAL: 60 PERIODS

UNIT I  INTRODUCTION  12

UNIT II  SUPERIONIC MATERIALS AND STRUCTURES  12
Types of ionic solids - Superionic materials - Alkali metal ion conductors - silver ion conductors - Copper ion conductors - structural: principles for high silver and copper ion conductors - proton conductors - electronic conductors with ion transport - Hydrogen storage materials.
UNIT III  
**EXPERIMENTAL PROBES**  
- Structural characterization  
- Thermodynamic properties  
- Ion transport (macroscopic properties)  
- Ion dynamics (microscopic properties)  
- Phoelectron spectroscopy - EXAFS (extended X-ray absorption fine structure)  
- Local environment studies - FTIR, Thermal analysis - DTA - DSC - TG  
- Particle size analysis - SEM-TEM.

UNIT IV  
**APPLICATION OF SUPER IONIC SOLIDS**  
- Diffusion coefficient measurement in solids/liquids-sensor and partial pressure gauges  
- Oxygen sensors (concentration cell type)  
- Sulfur sensor (formation cell type)  
- Fuel cells - solid state battery - super capacitors.

UNIT V  
**LITHIUM BATTERIES**  
- Principles and general background of ambient temperature lithium batteries  
- Synthesis of nano materials for lithium batteries - properties, structure and conductivity of organic and inorganic electrolytes for lithium battery systems  
- Thin film deposition - pulsed laser deposition of electrodes  
- Preparation and fabrication - characterization of Li-ion cells  
- Comparison of lead acid-NiCd and Li-ion batteries  
- Application of Lithium batteries in electronic devices and electric vehicle - Solar energy conversion devices.

**TOTAL: 60 PERIODS**

**OUTCOME**
- The students will gain knowledge on fundamentals of solid state physics, superionic materials and structures, experimental probes, applications of superionic solids and lithium batteries.

**REFERENCES**

PX7002  
**ADVANCED SOLID STATE THEORY**  

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**OBJECTIVE:**
- To expose the students with theoretical aspects of solid state theory

UNIT I  
**ATOMIC MOLECULAR STRUCTURE**  
- Central field approximation - Thomas Fermi model and its application  

UNIT II  
**DENSITY FUNCTIONAL THEORY**  
- Hohenberg-Kohn theorem - Kohn-Sham ansatz - approach to many-body problem using independent particle methods  
- Solving Kohn-Sham equations - LDA - LSDA - GGA - nonlocal functionals.

UNIT III  
**BAND STRUCTURE METHODS**  
- The tight-binding method - linear combination of atomic orbitals - application to bands from s-levels general features of tight-binding levels - Wannier functions
UNIT IV OTHER BAND STRUCTURE METHODS

UNIT V PREDICTING PROPERTIES OF MATTER FROM ELECTRONIC STRUCTURE
Lattice dynamics from electronic structure theory - phonons and density response functions - periodic perturbations and phonon dispersive curves - dielectric response functions - effective charges - electron-phonon interactions and superconductivity - magnons and spin response functions.

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on band theory and band structure methods.

REFERENCES

PX7003 ADVANCES IN CRYSTAL GROWTH AND CHARACTERISATION

OBJECTIVE
• To introduce the knowledge on crystal growth and characterization.

UNIT I NUCLEATION

UNIT II CRYSTAL GROWTH THEORY

UNIT III BULK CRYSTAL GROWTH

UNIT IV CRYSTAL GROWTH – FILMS AND EPITAXIAL LAYERS

UNIT V CHARACTERIZATION TECHNIQUES

TOTAL: 60 PERIODS
OUTCOME
- The students will understand the theories of nucleation and crystal growth, crystal growth from solution, melt and vapour phase and their characterization.

REFERENCES

OBJECTIVE
- To prepare the students to understand the concepts of chaos in electronic circuits

UNIT I LINEAR AND NONLINEAR CIRCUITS 12

UNIT II BIFURCATION AND CHAOS 12

UNIT III DISCRETE MAP BASED CHAOTIC CIRCUITS 12

UNIT IV CONTINUOUS TYPE CHAOTIC CIRCUITS 12

UNIT V HIGHER-ORDER CHAOTIC CIRCUITS 12

TOTAL: 60 PERIODS
OUTCOME
• The students will understand the concepts of chaos phenomena and experimental realization of different types of chaotic electronic circuits.

REFERENCES

PX7005 CRYSTAL GROWTH AND STRUCTURE DETERMINATION

OBJECTIVE
• To provide knowledge on crystal growth and structure determination

UNIT I NUCLEATION CONCEPT 12

UNIT II GROWTH OF CRYSTAL FROM MELT 12
Bridgman method - Kyropoulos method - Czochralski method - Verneuil method - Zone melting method

UNIT III GROWTH OF CRYSTALS FROM VAPOUR PHASE 12

UNIT IV SYMMETRY LATTICE 12
Unit cell and Bravais lattices - crystal planes and directions - basic symmetry elements, operations - translational symmetries - point groups - space groups - equivalent positions - Bragg’s law – reciprocal lattice concept - Laue conditions - Ewald and limiting spheres - diffraction symmetry - Laue groups.

UNIT V STRUCTURE DETERMINATION 12
X-ray diffraction - Powder method - rotating crystal method - specimen preparation - measurement of d-values - indexing procedure for crystals - Single crystal diffractometer - four crystal diffractometer - double crystal diffractometer -determination of unit cell and space group. - X-ray topography(XRT) - Neutron diffraction

TOTAL: 60 PERIODS
OUTCOME
• The students will gain knowledge on nucleation theory, various techniques of crystal growth, symmetry lattice and structure determination.

REFERENCES

PX7006 CRYSTAL STRUCTURE ANALYSIS L T P C
4 0 0 4

OBJECTIVE
• To teach the students about the concepts of crystal structure analysis

UNIT I SYMMETRY: LATTICE 12
Unit cell and Bravais lattices - crystal planes and directions - basic symmetry elements - operations - translational symmetries - point groups - space groups - equivalent positions - Bragg's law - reciprocal lattice concept - Laue conditions - Ewald and limiting spheres - diffraction symmetry - Laue groups.

UNIT II DIFFRACTION 12

UNIT III STRUCTURE ANALYSIS 12
Single crystal diffractometers - geometries - scan modes - scintillation and area detectors - intensity data collection - data reduction - factors affecting X-ray intensities - temperature and scale factor - electron density - phase problem - normalised structure factor - direct method fundamentals and procedures - Patterson function and heavy atom method - structure refinement - least squares method - Fourier and difference Fourier synthesis - R factor - structure interpretation - geometric calculations - conformational studies - computer program packages.

UNIT IV POWDER METHODS 12
UNIT V PROTEIN CRYSTALLOGRAPHY

REFERENCES

OBJECTIVE
• To make the students understand the concepts of fibre optics communications

UNIT I INTRODUCTION TO OPTICAL COMMUNICATION

UNIT II INSTRUMENTS

UNIT III SIGNAL PROPAGATION

UNIT IV OPTICAL NETWORKS AND WDM CONCEPTS
UNIT V  DISPERSION COMPENSATION AND SOLITONS  12

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on the basics fibre optical communication, instruments, signal propagation, optical networks & WDM concepts and dispersion compensation and solitons.

REFERENCES
3. J.Gowar, Optical communication systems, Prentice Hall India, 1987

PX7008  HIGH PRESSURE PHYSICS  L T P C
4 0 0 4

OBJECTIVE
• To introduce the knowledge on high pressure physics

UNIT I  GENERAL TECHNIQUES  12

UNIT II  HIGH PRESSURE DEVICES FOR VARIOUS APPLICATIONS  12

UNIT III  HIGH PRESSURE PHYSICAL AND CHEMICAL PROPERTIES  12

UNIT IV  MECHANICAL PROPERTIES AND INDUSTRIAL APPLICATIONS  12

UNIT V  DYNAMIC PRESSURES  12

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on the general techniques of producing high pressure and their measurement, high pressure devices, high pressure physical, chemical mechanical properties & industrial applications and concept of dynamic pressures.
REFERENCES

PX7009 INTRODUCTION TO NANOTECHNOLOGY  L T P C
4 0 0 4

OBJECTIVE
- To introduce knowledge on basics of Nanotechnology and importance of Nanotechnology

UNIT I NANO SYSTEMS
Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Reason for change in optical properties, electrical properties, and mechanical properties. Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Top down and Bottom up approach.

UNIT II SYNTHESIS OF NANOMATERIALS
Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – laser ablation- Sol-Gel- Ball milling –Electro deposition- electro less deposition – spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis

UNIT III NANOTUBES
Single walled and Multi walled Nanotubes (SWNT and MWNT) - synthesis and purification - synthesis of carbon Nanotubes by pyrolysis techniques - arc-discharge method - nanotube properties – Nanowires – methods of preparation of nanowires –VLS mechanism

UNIT IV CHARACTERIZATION
Principle and working of Atomic Force Microscopy (AFM) and Scanning tunneling microscopy (STM) - near-field Scanning Optical Microscopy – Principle of Transmission Electron Microscopy (TEM) – applications to nanostructures – nanomechanical characterization – nanoindentation

UNIT V NANOTECHNOLOGY APPLICATIONS

TOTAL: 60 PERIODS

OUTCOME
- The students will gain knowledge on the fundamental aspects leading to nanotechnology

REFERENCES
**INTRODUCTION TO NONLINEAR OPTICS**

**OBJECTIVE**
- To enlighten the students with the concepts of nonlinear optics.

**UNIT I  ORIGIN OF OPTICAL NONLINEARITIES**
- Effects due to quadratic and cubic polarization
- Response functions
- Susceptibility tensors
- Linear, second order and \( n \)th order susceptibilities
- Wave propagation in isotropic and crystalline media
- The index ellipsoid

**UNIT II  SECOND HARMONIC GENERATION (SHG) AND PARAMETRIC OSCILLATION**
- Optical SHG
- Phase Matching
- Experimental verification
- Parametric oscillation
- Frequency tuning
- Power output and pump saturation
- Frequency up conversion
- Materials

**UNIT III  THIRD ORDER NONLINEARITIES**
- Intensity dependent refractive index
- Nonlinearities due to molecular orientation
- Self-focusing of light and other self-action effects
- Optical phase conjugation
- Optical bistability and switching
- Pulse propagation and temporal solitons

**UNIT IV  ELECTRO–OPTIC AND PHOTOREFRACTIVE EFFECTS**
- Electro–optic effects
- Electro-optic modulators
- Photorefractive effect
- Two beam coupling in Photorefractive materials
- Four wave mixing in Photorefractive materials

**UNIT V  STIMULATED SCATTERING PROCESSES**
- Stimulated scattering processes
- Stimulated Brillouin scattering
- Phase conjugation
- Spontaneous Raman effect
- Stimulated Raman Scattering
- Stokes – Anti-Stokes Coupling in SRS
- Stimulated Rayleigh-Wing Scattering

**OUTCOME**
- The students will gain knowledge on the concepts of origin of optical nonlinearities, second harmonic generation & parametric oscillation, third order nonlinearities, electrooptic and photo refractive effects and stimulated scattering process.

**REFERENCES**

**INTRODUCTION TO PHYSICAL METALLURGY**

**OBJECTIVE**
- To teach the students about the basic concepts of physical metallurgy

**UNIT I  STRUCTURE OF ALLOYS**
- Hume Rothery rules
- Intermediate phases
- Intermetallic compounds
- Improvement in mechanical and electrical properties
- Metallography: Optical microscope
- SEM
- TEM
- Determination of chemical composition
- Electron probe microanalysis
- Structural stability of alloys-EXAFS measurements
UNIT II PHASE DIAGRAMS 12

UNIT III DIFFUSION 12

UNIT IV MECHANICAL PROPERTIES 12
Stress-strain curve – Compressibility – Plastic deformation mechanisms, Tensile strength – Creep – Fracture – Fatigue failures – Effect of grain size on mechanical properties – Hardness.

UNIT V ENGINEERING ALLOYS 12

TOTAL : 60 PERIODS

OUTCOME
• The students will understand the concepts of structure of alloys, phase diagrams, diffusion, mechanical properties and engineering alloys.

REFERENCES

PX7012 LASER THEORY AND APPLICATIONS L T P C
4 0 0 4

OBJECTIVE:
• To expose the students with theoretical aspects of laser theory and its applications.

UNIT I LASER THEORY 12
Absorption - Spontaneous and stimulated emission - Einstein’s coefficients - threshold conditions for laser action - Line broadening, Mechanism - Lorentzian and Doppler line shapes - Small signal gain - Gain coefficient - gain saturation - Rate equations for 3 and 4 level systems.

UNIT II RESONATORS AND SWITCHING THEORY 12
Resonant cavity - Fox and Li - Boyd and Gorden’s theory on resonators - modes - Spot size - Types of resonators - Mode selection - Q switching theory and technique - Mode locking theory and technique.

UNIT III GAS AND LIQUID LASERS 12
He-Ne, Argon Ion, Carbon dioxide, Nitrogen - Metal vapour - Gas dynamics - Excimer - Free electron lasers - Dye lasers organic dyes - Pulsed and CW dye lasers - Threshold conditions - Puming configurations.

UNIT IV SOLID STATE AND SEMICONDUCTOR LASERS 12
UNIT V APPLICATIONS

TOTAL: 60 PERIODS

OUTCOME
- The students will gain knowledge on laser theory, resonators and switching theory, gas & liquid lasers, solid state & semiconductor lasers and their applications.

REFERENCES

PX7013 MATERIALS CHARACTERIZATION

OBJECTIVE
- To introduce various methods available for characterizing the materials

UNIT I THERMAL ANALYSIS

UNIT II MICROSCOPIC METHODS

UNIT III ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY
SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation – data collection, processing and analysis - Scanning tunneling microscopy(STEM)- Atomic force microscopy(AFM) - Scanning new field optical microscopy

UNIT IV ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

UNIT V X-RAY AND SPECTROSCOPIC METHODS
Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR,NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) – Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer - interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

TOTAL: 60 PERIODS
OUTCOME
• The students will understand the thermal, microscopic, electrical and spectroscopic methods of characterization.

REFERENCES

PX7014 MECHANICAL BEHAVIOR OF MATERIALS

OBJECTIVE:
• To introduce knowledge on basics of nanoindentation and the importance of nanoindentation

UNIT I MECHANICAL PROPERTIES OF BULK MATERIALS
Mechanical properties of inorganic materials (metals, ceramics) and organic materials (polymers, fibres) and composites (material blends, nanocomposites, filled and reinforced systems). Mechanical testing, enthalpy elasticity, rubber elasticity, viscoelasticity, plasticity, viscoplasticity, fracture properties, deformation velocity and temperature influence. Molecular and morphological influence on the mechanical properties. External influence including moisture, solvents and oxidation. Introduction to the mechanical behavior of small scale components, structures and devices.

UNIT II MECHANICAL PROPERTIES OF THIN FILMS
Stresses in thin films -Measurement of stresses in thin films -Wafer curvature and Stoney equation - Stresses due to different deposition processes.

UNIT III MECHANICAL PROPERTIES OF BIOMATERIALS
Introduction to nanomechanics - Force versus distance curve - Single cell mechanics Qualitative introduction to inter- and intermolecular forces - Quantitative description of intra- and intermolecular forces - Molecule - surface interactions - Colloids and interparticle potentials - Van der Waals forces at work: Gecko feet adhesion - The electrical double layer (EDL) theory - Nanomechanics of cartilage - Protein - surface interactions - Nanomechanics and biocompatibility: Protein-biomaterial interactions -

UNIT IV MECHANICAL PROPERTIES OF NANOMATERIALS
Deformation behaviour of nanomaterials. – comparison of mechanical characteristics in bulk and nano – Reason for change in characteristics - Fracture and creep - Nanomechanics and nanotribology.

UNIT V INSTRUMENTS FOR MEASUREMENT

TOTAL: 60 PERIODS
OUTCOME
• The students will gain knowledge on the nanoindentation testing methods in bulk nanomaterials and biological materials.

REFERENCES
3. Nanoindentation, 3rd Edition Fischer-Cripps Laboratories Pty Ltd.

PX7015 MECHANICAL PROPERTIES OF BIOLOGICAL MATERIALS L T P C

OBJECTIVE:
• To introduce knowledge on basics of Nanoindentation and the importance of Nanoindentation

UNIT I PREVIEW OF MECHANICS OF THE MUSCULOSKELETAL SYSTEM 12
Kinematics and kinetics of the musculoskeletal system, forces, stress and strain. - Review of continuum mechanics - Review of continuum mechanics II: vector and tensor algebra - Nano- and ultrastructure of biological tissues and tissue components –

UNIT II NANOMECHANICS OF BIOLOGICAL TISSUE COMPONENTS 12
Entropic elasticity - Mechanics of the musculoskeletal system - Bone I: Material properties, mechanical analysis and characterization of bone tissue - Mechanics of the musculoskeletal system - Bone -Modelling, remodelling, fracture mechanics, pathological degeneration and repair of bone Tissue

UNIT III SOFT TISSUE MECHANICS 12

UNIT IV MECHANICS OF THE MUSCULOSKELETAL SYSTEM 12
UNIT V  INSTRUMENTATION  12

OUTCOME
• The students will gain knowledge on the Nanoindentation testing methods in biological materials

REFERENCES

PX7016  METHODS OF CHARACTERIZATION OF NANOMATERIALS  L T P C
4 0 0 4

OBJECTIVE
• To expose the students with knowledge of understanding the basic characterization of nanomaterials

UNIT I  X-RAY ANALYSIS OF NANOMATERIALS  12

UNIT II  SURFACE ANALYTICAL TOOLS FOR NANO-MATERIALS  12
UV and X-ray photoelectron spectroscopy; Auger electron spectroscopy; low energy electron diffraction and reflection high energy electron diffraction - secondary ion mass spectrometry - Rutherford backscattering - Medium energy ion scattering- Electron energy loss spectroscopy (EELS) and high resolution EELS. X-ray Photoelectron Spectroscopy, Auger photoelectron Spectroscopy.

UNIT III  NANOSCALE ELECTRICAL SPECTROSCOPY  12
I-V/C-V; Hall, quantum Hall effects; transient charge spectroscopy. Optical spectroscopy: micro Photoluminescence; Absorption Spectroscopy, Excitation Spectroscopy, micro Raman Spectroscopy; Time domain spectroscopy.

UNIT IV  ELECTRON MICROSCOPY  12
UNIT V  NANO-IMAGING SPECTROSCOPY  12
Basic principles - Scanning Tunneling Microscopy, Scanning Force Microscopy (SFM/AFM),
and scanning holographic microscopy - image interpretations; Scanning Near Field Optical
Microscopy and scanning ion conductance microscopy.

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on the various techniques used for analyzing the
  nanomaterials.

REFERENCES

UNIT I  INTRODUCTION TO ALTERNATIVE ENERGY SOURCES AND UTILIZATION  12
Principles of energy conversion: thermodynamic first and second laws, energy balances - Solar
energy: Solar intensity and spectrum, global solar energy potential and current level of
utilization, Photovoltaic - history, principles and theoretical limits. Solar cells – Batteries –
Hydrogen storage materials – wind energy – Geothermal energy – Power from Water -
Biomass - thermal power plants – Economy on energy projects – Utilizations.

UNIT II  FUNDAMENTALS OF ELECTROCHEMISTRY AND ELECTRODE KINETICS  12
Introduction to Electrochemistry - Charge transfer reaction and reaction kinetics – Interface –
Defects chemistry – Electrocatalysis – Electrochemical Reactors – Cell – Configurations and
classifications - Electrode Processes – Potential and thermodynamics of a Cell – Electroactive
layers – modified electrodes - Cell stack and thermal management.

UNIT III  HYDROGEN AS A RENEWABLE ENERGY SOURCE  12
Fuel cell – Principle of working, construction - Characteristics and Classifications of Fuel Cells
– Hybrid Fuel Cells – Electrical Vehicles – applications. Hydrogen Production: Direct
electrolysis of water, thermal decomposition of water, biological and biochemical methods of
hydrogen production- Storage of Hydrogen: Gaseous, Cryogenic and Metal hydride-
Environmental impact.

UNIT IV  BATTERIES AND SUPER CAPACITORS  12
Introduction to Primary and Secondary batteries- Principle- Battery materials - anode, cathode
and electrolyte materials - Concepts of Rechargeable batteries – Applications of Lithium
batteries, Lithium ion and polymer batteries. — Super-capacitors: principles and working,
electrode materials synthesis process, fabrication of the devices and their applications.

UNIT V  BIOMASS UTILIZATION AND NUCLEAR ENERGY  12
Biodiesel and ethanol, Biomass utilization, Nuclear Energy: Potential of Nuclear Energy,
International Nuclear Energy Policies and Regulations. Nuclear Energy Technologies – Fuel
enrichment, Different Types of Nuclear Reactors, Nuclear Waste Disposal, and Nuclear
Fusion.

TOTAL: 60 PERIODS
OUTCOME

• The students will understand the importance of alternate energy sources and basics of various energy conversion devices.

REFERENCES


PX7018 MOLECULAR BIOPHYSICS

OBJECTIVE:

• To study the basic concepts of molecular biophysics

UNIT I INTRAMOLECULAR INTERACTIONS

Contact distance criteria - van der Wall’s interactions - Electrostatic interactions – Hydrogen Bonding interactions - Distortional energies - Description of various interactions by potential functions.

UNIT II STRUCTURE OF PROTEINS

Peptide bond and peptide unit - cis and trans configuration - phi and psi conventions - streic hindrance - allowed conformations - Ramachandran diagram - conformational maps for glycine and other natural amino acids - energy maps - patterns of folding - primary, secondary, ternary and quaternary structures - supersecondary and domain structures - types of secondary structures - alpha helix, beta sheets, reverse turns - structures of fibrous and globular proteins - collagen, hemoglobin and lysozyme.

UNIT III STRUCTURE OF NUCLEIC ACIDS


UNIT IV STRUCTURE OF POLYSACCHARIDES

Monosaccharides - stereoisomerism of hexapyranose sugars - structure and conformation of maltose, cellobiose, cellulose amyllose and chitin.

UNIT V BIOMOLECULAR ASSEMBLY

Molecular models for membrane structures and conformation of phospolipids, membrane proteins - Structure of chromatin, nucleosomes, polynucleosomes and viruses.

TOTAL: 60 PERIODS
OUTCOME
• To provide the knowledge on the basic concepts of intermolecular interactions, structure of proteins, nuclei acids, polysaccharides and biomolecular assembly.

REFERENCES

PX7019 NONLINEAR DYNAMICS OF NANODEVICES AND SYSTEMS

OBJECTIVE
• To prepare the students to understand the concepts of nonlinear dynamics in nanodevices and systems

UNIT I NONEQUILIBRIUM NANOSYSTEMS 12

UNIT II SURFACE EFFECTS 12
Introduction – dynamics of nanoscopic capillary waves – Nonlinear dynamics of surface steps – Casimir forces and geometry in nanosystems.

UNIT III NANOELECTROMECHANICS 12

UNIT IV NANOELECTRONICS 12

UNIT V OPTIC-ELECTRONIC COUPLING 12

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on the analysis of nonlinear dynamical effects in nanosystems.

REFERENCES

PX7020 NONLINEAR SCIENCE: SOLITONS AND CHAOS

OBJECTIVE
• To enlighten the students about the basic concepts of nonlinear science: solitons and chaos.

UNIT I GENERAL
Linear waves-ordinary differential equations(ODEs)-Partial differential equations(PDEs)-Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators-Nonlinear waves-Qualitative features.

UNIT II COHERENT STRUCTURES

UNIT III BIFURCATIONS AND ONSET OF CHAOS

UNIT IV CHAOS THEORY AND CHARACTERISTION

UNIT V APPLICATIONS

OUTCOME
• The students will understand the general mathematical concepts of partial differential equation, nonlinear waves, coherent structures, bifurcation and onset of chaos, chaos theory & characterization and applications.

REFERENCES
OBJECTIVE

- To expose the students with the theoretical concepts of Solid State Physics.

UNIT I  CRYSTAL STRUCTURE AND BINDING  12
Symmetry - crystal lattice - unit cell (conventional and Wigner-seitz unit cell) - crystal structures - reciprocal lattice - Brillouin zone - crystallographic point groups and space groups - force between atoms - cohesive energy - bonding in solids - ionic, covalent, metallic - hydrogen bonded crystals.

UNIT II  ELECTRONIC PROPERTIES  12
Free electron theory (classical and quantum) - electronic specific heat - electrical and thermal transports - failures of free electron model - periodic crystalline potential - Bloch theorem - formation of energy bands - classification of solids - effective mass and concept of hole - intrinsic and extrinsic semiconductors - direct and indirect bandgap of semiconductors - Fermi surface of metals.

UNIT III  LATTICE DYNAMICS  12
Vibration modes of mono and diatomic lattices - quantization of lattice vibration - lattice specific heat theories (Einstein and Debye models) - phonon momentum - scattering of neutrons by phonons - neutron diffraction - lattice thermal conductivity - normal and Umklapp process - anharmonicity and thermal expansion

UNIT IV  DIELECTRIC AND OPTICAL PROPERTIES  12
Polarization - theory of polarizability - Clausius-Mossotti relation - piezo - pyro and ferroelectric properties of crystals - antiferroelectricity and ferrielectricity - absorption process in semiconductors - photoconductivity - photoluminescence - Defects in crystals- color centers

UNIT V  MAGNETIC PROPERTIES AND SUPERCONDUCTIVITY  12

TOTAL: 60 PERIODS

OUTCOME

- The students will acquire knowledge on crystal structure and binding, electronic properties, lattice dynamics, dielectric & optical properties and magnetic and superconducting properties of materials.

REFERENCES

OBJECTIVE

- To introduce the basic concepts and applications of various spectroscopic techniques.

UNIT I  INFRARED SPECTROSCOPY  12

UNIT II  RAMAN SPECTROSCOPY  12

UNIT III  SEM –EDX AND FT-IR MICROSPETROSCOPY  12

UNIT IV  ESR SPECTROSCOPY  12

UNIT V  NQR AND MOSSBAUER SPECTROSCOPY  12
General principles of NQR – energy levels of quadruple transitions for half-integral spins – design of NQR Spectrometer – Application of NQR (Molecular Structure). Principle of Mossbauer Effect – Schematic arrangement of Mossbauer spectrometer – Isomer shift – Quadruple interaction – magnetic hyperfine interactions – applications of Mossbauer spectroscopy (Biological applications)

TOTAL: 60 PERIODS

OUTCOME

- The students will understand various spectroscopic methods, principles, experimental techniques and their applications

REFERENCES

SUPERCONDUCTIVITY AND ITS APPLICATIONS

OBJECTIVE:
- To enlighten the students with the concepts of superconductivity.

UNIT I BASIC EXPERIMENTAL ASPECTS

UNIT II SUPERCONDUCTING MATERIALS
Elemental superconductors – superconducting compounds and its alloys – A15 compounds – chevral phase compounds

UNIT III HIGH TEMPERATURE SUPERCONDUCTORS

UNIT IV THEORETICAL ASPECTS
Isotope effect – BCS theory – Role of electrons and phonons – applications of electron band structure results to calculate electron – Phonon coupling constant, McMillan’s formula – GLAG theory – recent theories on high Tc materials, Coherence length, expression for critical temperature Tc, critical field Hc, critical current Jc – heavy fermion superconductivity.

UNIT V APPLICATIONS

TOTAL: 60 PERIODS

OUTCOME
- The students will gain knowledge on superconducting materials, theoretical aspects and the applications of superconductors.

REFERENCES
UNIT II  DETERMINATION OF VELOCITY OF PROPAGATION OF ULTRASONICS  12
Pulse Echo methods – Phase comparison methods – Pulse superposition – Measurements at high Pressure and high temperature– Transducer Coupling materials.

UNIT III  ULTRASONIC TRANSDUCERS  12
Piezoelectric and magnetostrictive transducers – Equivalent circuits – Efficiency – Transducer mounting – Linear and sector transducers – Variable frequency systems.

UNIT IV  ABSORPTION OF ULTRASONIC RADIATION  12

UNIT V  APPLICATIONS OF ULTRASONICS  12

TOTAL: 60 PERIODS

OUTCOME
• The students will gain knowledge on propagation of ultrasonic waves in medium and determination of its velocity, ultrasonic transducers, absorption of ultrasonic radiation and applications of ultrasonics.

REFERENCES