# M. Phil (Physics)

## Semester I

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**Total No. of Credits: 33**

## Electives for M.Phil. (Physics)

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

OBJECTIVE:
- To impart the knowledge on systems of equations, probability statistics and error analysis and programming concepts.

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

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).

TOTAL : 60 PERIODS

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

OBJECTIVE:
- To impart knowledge on crystal structure and binding, electronic properties, lattice dynamics, dielectric & optical properties and magnetic and superconducting properties of materials.

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

REFERENCES
AIM:
- To impart knowledge on various materials of technological importance.

OBJECTIVE:
- To teach the students about semi conducting materials, ceramic materials, polymeric materials, optical materials and new materials.

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

REFERENCES
AIM:
- To expose the students with theoretical aspects of advanced solid state ionics and their applications.

OBJECTIVE:
- To provide the knowledge on fundamentals of solid state physics, superionic materials and structures, experimental probes, applications of superionic solids and lithium batteries.

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 12
Structural characterization - Thermodynamic properties - ion transport (macroscopic properties) - Ion dybnamics (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 10
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 14
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.

REFERENCES
1. Superionic solids - Principles and applications, S. Chandra, North Holland Amsterdam (1981)

TOTAL : 60 PERIODS
AIM:
- To expose the students with theoretical aspects of solid state theory.

OBJECTIVE:
- To provide the knowledge on band theory and band structure methods.

UNIT I  ATOMIC MOLECULAR STRUCTURE  12

UNIT II  DENSITY FUNCTIONAL THEORY  12

UNIT III  BAND STRUCTURE METHODS  12
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  12

UNIT V  PREDICTING PROPERTIES OF MATTER FROM ELECTRONIC STRUCTURE  12
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.

REFERENCES

AIM:
To introduce the knowledge on crystal growth and characterization.

OBJECTIVE:
- To expose the students with theories of nucleation & crystal growth, crystal growth by from solution, melt and vapour phase and their characterization.
UNIT I  CLASSICAL THEORY OF NUCLEATION  

UNIT II  THEORIES OF CRYSTAL GROWTH  
Surface energy theory - Diffusion theory - Adsorption layer theory - Volmer theory - Bravais theory - Kossel theory - Stranski's treatment. Two dimensional nucleation theory

UNIT III  CRYSTAL GROWTH BY MASS TRANSFER PROCESSES  
Bulk diffusion model - Surface diffusion growth theories - Physical modeling of BCF theory - BCF differential surface diffusion equation - single straight step - Multiple straight parallel steps - Temkins model of crystal growth. PBC theory of crystal growth

UNIT IV  GROWTH OF CRYSTAL FROM MELT  

UNIT V  GROWTH OF CRYSTALS FROM VAPOUR PHASE  
Vapour phase epitaxy (VPE) - Liquid phase epitaxy (LPE) - Molecular Beam Epitaxy (MBE) - Atomic layer Epitaxy (ALE) - Electroepitaxy - Metalorganic Vapour Phase Epitaxy (MOVPE) - Chemical Beam Epitaxy (CBE).

UNIT VI  CRYSTAL CHARACTERISATION  

REFERENCES

PX8005  CHAOTRONICS  
L T P C  4 0 0 4

AIM:
- To prepare the students to understand the concepts of chaos in electronic circuits.

OBJECTIVE:
- The students will gain knowledge in the concepts of chaos phenomena and experimental realization of different types of chaotic electronic circuits.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025
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  13

UNIT V  HIGHER-ORDER CHAOTIC CIRCUITS  11

TOTAL : 60 PERIODS

REFERENCES:

PX8006 CONFORMAL RADIOTHERAPY  L T P C
4 0 0 4

AIM:
• To expose the students with basic concepts of conformal radiotherapy.

OBJECTIVE:
• To impart knowledge on three dimensional radiation therapy treatment planning, treatment optimization, conformal therapy with multileaf collimators, treatment machine features for conformal therapy, imaging for conformal radiotherapy planning.

Attested
Director
Centre For Academic Courses
Anna University, Chennai-600 025
UNIT I
THREE DIMENSIONAL RADIATION THERAPY TREATMENT PLANNING
Conformal radiotherapy treatment planning- Registration of two image datasets for 3D treatment planning - Summary and the NCI study of 3D therapy planning - Stages of Treatment Planning - Dosimetry - Beam data Acquisition, Dosimetry with special detectors, data analysis and Input into 3D planning system - Dose verification with Phantom measurements.

UNIT II
TREATMENT OPTIMIZATION
General Considerations - The impossibility of true inverse Computed Tomography - The case of circularly-symmetric dose distribution - Primitive blocked rotation therapy. Methods for 2D and 3D optimization - Evaluation of Plans - DVH.

UNIT III
CONFORMAL THERAPY WITH MULTILEAF COLLIMATORS

UNIT IV
TREATMENT MACHINE FEATURES FOR CONFORMAL THERAPY
Earliest treatment machine for conformal therapy with a CsI37 source - Tracking Units - A tracking LINAC with MLC and CT combination - Universal Wedge - Dynamic Wedge - Wedges with MLC's - Linear Accelerators with independent collimators - 4.8) Two Dimensional tissue Compensators.

UNIT V
IMAGING FOR CONFORMAL RADIOTHERAPY PLANNING

TOTAL: 60 PERIODS

REFERENCES

PX8007
CRYSTAL GROWTH AND STRUCTURE DETERMINATION

AIM:
To provide knowledge on crystal growth and structure determination.

OBJECTIVE:
- To impart knowledge on nucleation theory, various techniques of crystal growth, symmetry lattice and structure determination.

UNIT I
NUCLEATION CONCEPT
Kinds of nucleation - Homogeneous nucleation - Heterogeneous nucleation - Energy of formation of a critical nucleus - Theories of crystal growth - Two dimensional nucleation theory - thermodynamics of nucleation - Free energy of formation of a two dimensional nucleus - Rate of nucleation - Mononuclear model - Polynuclear model - Birth and spread model - Modified Birth and...
spread model - Physical modeling of BCF theory - BCF differential surface diffusion equation - single straight step - Temkins model of crystal growth.

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

UNIT III  GROWTH OF CRYSTALS FROM VAPOUR PHASE

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

TOTAL : 60 PERIODS

REFERENCES

PX8008  CRYSTAL STRUCTURE ANALYSIS

AIM:
- To teach the students about the concepts of crystal structure analysis.

OBJECTIVE:
- To make the students to understand lattice, X ray generation & diffraction, structure analysis, powder diffraction and protein crystallography.
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**TOTAL : 60 PERIODS**

**REFERENCES**

AIM:
- To make the students understand the concepts of fibre optics communications.

OBJECTIVE:
- To impart knowledge on basics fibre optical communication, instruments, signal propagation, optical networks & WDM concepts and dispersion compensation and solitons.

UNIT I  INTRODUCTION TO OPTICAL COMMUNICATION  12

UNIT II  INSTRUMENTS  12

UNIT III  SIGNAL PROPAGATION  12

UNIT IV  OPTICAL NETWORKS & WDM CONCEPTS  12

UNIT V  DISPERSION COMPENSATION AND SOLITONS  12

TOTAL : 60 PERIODS

REFERENCES
3. J.Gowar, Optical communication systems, Prentice Hall India, 1987
AIM:
- To introduce the knowledge on high pressure physics.

OBJECTIVE:
- To make the students understand 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.

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

REFERENCES
UNIT I NANO SYSTEMS 12
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 12
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 12
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 12
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 NANTECHNOLOGY APPLICATIONS 12

TOTAL : 60 PERIODS

REFERENCES

PX8012 INTRODUCTION TO PHYSICAL METALLURGY L T P C
4 0 0 4

AIM:
• To teach the students about the basic concepts of physical metallurgy.

OBJECTIVE:
• To expose the students about the concepts of structure of alloys, phase diagrams, diffusion, mechanical properties and engineering alloys.
UNIT I  STRUCTURE OF ALLOYS  

UNIT II  PHASE DIAGRAMS

UNIT III  DIFFUSION

UNIT IV  MECHANICAL PROPERTIES
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

REFERENCES

PX8013  LASER THEORY AND APPLICATIONS  
AIM:
To expose the students with theoretical aspects of laser theory and its applications.

OBJECTIVE:
To provide the knowledge on laser theory, resonators and switching theory, gas & liquid lasers, solid state & semiconductor lasers and their applications.

UNIT I  LASER THEORY
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
Resonant cavity - Fox and Li - Boyd and Gordey'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
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 - Pumping configurations.
UNIT IV  SOLID STATE AND SEMICONDUCTOR LASERS  12

UNIT V  APPLICATIONS  12

TOTAL : 60 PERIODS

REFERENCES

PX8014  MATERIALS CHARACTERIZATION  L T P C
4 0 0 4

AIM:
• To introduce various methods available for characterizing the materials.

OBJECTIVE:
• To expose the student with thermal, microscopic, electrical and spectroscopic methods of characterization.

UNIT I  THERMAL ANALYSIS  12

UNIT II  MICROSCOPIC METHODS  12

UNIT III  ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY  12
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  12
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

REFERENCES

PX8015  MECHANICAL BEHAVIOR OF MATERIALS  L  T  P  C
AIM:
To introduce knowledge on basics of Nanoindentation.

OBJECTIVE:
- To make the students understand the importance of Nanoindentation.
- To make the students learn the Nanoindentation testing methods in bulk, nanomaterials and biological materials

UNIT I  MECHANICAL PROPERTIES OF BULK MATERIALS  12
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  12
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  12
Introduction to nanomechanics - Force versus distance curve - Single cell mechanics - Qualitative introduction to intra - 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  12
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 12

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

PX8016 MECHANICAL PROPERTIES OF BIOLOGICAL MATERIALS L T P C
AIM:
• To introduce knowledge on basics of Nanoindentation.

OBJECTIVE:
• To make the students understand the importance of Nanoindentation.
• To make the students learn the Nanoindentation testing methods in biological materials

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
Non-linear continuum mechanics – Kinematics, strain and strain rate measures

UNIT IV MECHANICS OF THE MUSCULOSKELETAL SYSTEM 12
Cartilage: Material properties, mechanical analysis and characterization of cartilage - Material properties, mechanical analysis and characterization of tendon and ligaments - Various topics of Mechanical properties of biological materials –Skin: Material properties, mechanical analysis and characterization of skin - Muscle: Material properties, mechanical analysis and characterization of
UNIT V INSTRUMENTATION

TOTAL: 60 PERIODS

REFERENCES:

UNIT I X-RAY ANALYSIS OF NANOMATERIALS

UNIT II SURFACE ANALYTICAL TOOLS FOR NANO-MATERIALS
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
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
Principle of SEM – EDAX analysis- standardization of elements - nanoSEM, basic principles- STM -
STEM - sample preparation – nanoparticles – thin films - TEM - High resolution TEM -

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

REFERENCES
1. G. Gao, Nanostructures and Nanomaterials, Imperial College Press, London, 2006

PX8018  MODERN ALTERNATIVE ENERGY CONVERSION DEVICES  L  T  P  C
AIM:
To introduce knowledge on alternative energy sources.

OBJECTIVE:
- To introduce the importance and overview of alternate energy sources.
- To make the students learn the basics of various energy conversion devices

UNIT I  INTRODUCTION AND OVERVIEW OF ALTERNATIVE ENERGY SOURCES AND
UTILIZATION  12
Global energy budget; origins of fossil fuels, Principles of energy conversion: thermodynamic first and
second laws, the Carnot cycle,  Solar energy: Solar intensity and spectrum, global solar energy
potential and current level of utilization, Photovoltaic: history, principles and theoretical limits,  Solar
cells and modules, semiconductor materials, single and multiple layer p-n junction diodes, Solar cells
and modules, maximum power output, energy efficiency, quantum efficiency- Solar cells:
characterization and modeling-Photovoltaic utilization.

UNIT II  FUNDAMENTALS OF ELECTROCHEMISTRY AND ELECTRODE KINETICS  12
Charge transfer reaction and reaction kinetics, Third-generation solar cells: dye-sensitized photocell,
organic/polymer solar cell-Fuel cells: overview of types, basic operation and performance, Fuel cells:
catalysis, Fuel cells: charge and mass transport, PEM fuel cells' Molten carbonate fuel cells-Solid
oxide fuel cells-Overview of fuel cell systems: fuel-cell stack and thermal management.

UNIT III  HYDROGEN AS A RENEWABLE ENERGY SOURCE  12
Sources of Hydrogen, Fuel cell – Principle of working, construction and applications. Fuel for
Vehicles, 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:  12
Primary and Secondary batteries-principles and application- 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:  

TOTAL: 60 PERIODS

REFERENCES:
2. Principles of Thermal Process: Duffie -Beckman
4. Solar Cell: Marteen A. Green
8. Batteries Volume (I) and (II) – Collins

PX8019 MOLECULAR BIOPHYSICS L T P C
4 0 0 4

AIM: To study the basic concepts of molecular biophysics.

OBJECTIVE: To make the students to understand the basic concepts of intermolecular interactions, structure of proteins, nuclei acids, polysaccharides and biomolecular assembly.

UNIT I INTRAMOLECULAR INTERACTIONS 12
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 12

UNIT III STRUCTURE OF NUCLEI ACIDS 12
Nucleosides and nucleotides - tautomeric equilibria of bases - ionisation equilibria of nucleosides and nucleotides - Conformation of nucleosides and nucleotides - Structure and conformation of oligonucleotides - Base pairing interactions - base stacking interactions - Double helical model of DNA - DNA polymorphism - Structure of A, B and Z - DNA structure of TRNA.

UNIT IV STRUCTURE OF POLYSACCHARIDES 12
Monosaccharides - Stereoisomerism of hexapyranose sugars - Structure and conformation of maltose, celllobiose, cellulose amyllose and chitin.
UNIT V  BIOMOLECULAR ASSEMBLY  12
Molecular models for membranes structure and conformation of Phospolipids, membrane proteins - Structure of chromatin, nucleosomes, polynucleosomes and viruses.

TOTAL : 60 PERIODS

REFERENCES

PX8020  NONLINEAR DYNAMICS OF NANODEVICES AND SYSTEMS  L T P C
4 0 0 4

AIM:
- To prepare the students to understand the concepts of nonlinear dynamics in nanodevices and systems.

OBJECTIVE:
- The students will gain knowledge in the topic of analysis of nonlinear dynamical effects in nanosystems.

UNIT I  NONEQUILIBRIUM NANOSYSTEMS  12

UNIT II  SURFACE EFFECTS  11
Introduction – dynamics of nanoscopic capillary waves – Nonlinear dynamics of surface steps – Casimir forces and geometry in nanosystems.

UNIT III  NANOELECTROMECHANICS  12

UNIT IV  NANOELECTRONICS  13

UNIT V  OPTIC-ELECTRONIC COUPLING  12

TOTAL : 60 PERIODS

REFERENCES:

PX8021 NONLINEAR OPTICS  L T P C
4 0 0 4

AIM:
To enlighten the students with the concepts of nonlinear optics.

OBJECTIVE:
- To make the students to understand the concepts of origin of optical nonlinearities, second harmonic generation & parametric oscillation, third order nonlinearities, electrooptic and photo refractive effects and stimulated scattering process.

UNIT I ORIGIN OF OPTICAL NONLINEARITIES 12

UNIT II SECOND HARMONIC GENERATION (SHG) AND PARAMETRIC OSCILLATION 12

UNIT III THIRD ORDER NONLINEARITIES 12
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 12

UNIT V STIMULATED SCATTERING PROCESSES 12

TOTAL : 60 PERIODS

REFERENCES
AIM: To enlighten the students about the basic concepts of nonlinear science: solitons and chaos.

OBJECTIVE:
- To impart knowledge on general mathematical concepts of partial differential equation, nonlinear waves, coherent structures, bifurcation and onset of chaos, chaos theory & characterization and applications.

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 CHARACTERIZATION

UNIT V  APPLICATIONS

REFERENCES

AIM: To teach the students about the basic concepts of radiation physics.

OBJECTIVE:
- To impart knowledge on radiation and interaction, principles of radiation detection and measurement, radiation therapy techniques, diagnostic radiology and radiation protection.
UNIT I  RADIATION AND INTERACTIONS  12

UNIT II  PRINCIPLES OF RADIATION DETECTION AND MEASUREMENT  12
Radiation units and definitions - G.M. Counter - Scintillation detectors - Solid state detectors - Photofilm method - Pocket dosimeter - TLD - FBX dosimeters.

UNIT III  RADIO THERAPY TECHNIQUES:  12
Telegamma unit - accelerators for therapy - Iridium and cobalt needles - preparation of tracers and labeled compound - uses of radioisotopes (Gamma and beta) in brachytherapy. Dosimetry in medical applications - beta particles dose computation for biological models - dosimetry of internally administered isotopes Principles and overview of conformal radiotherapy, SRS, SRT and IMRT.

UNIT IV  DIAGNOSTIC RADIOLOGY:  12
The physical basis of diagnostic radiology - the diagnostic X-ray tube - electrical circuits - rating of the x-ray unit - factors on which quality and quantity of x-ray production depends - geometric factor which influences the radiographic image - fluoroscopy - tomography - radio isotopes in clinical medicine - rectilinear scanner - gamma camera.

UNIT V  RADIATION PROTECTION  12

TOTAL : 60 PERIODS

REFERENCES

PX8024  STEREOTACTIC RADIOSURGERY AND RADIOTHERAPY  L  T  P  C
4  0  0  4

AIM:
To expose the students with concepts of stereotactic radiosurgery and radiotherapy.

OBJECTIVE:
- To provide the knowledge on stereotactic radiosurgery & stereotactic radiotherapy, clinical indications, radiobiology of radiation therapy-radiosurgery in particular, linac based radiosurgery and quality assurance.

UNIT I  STEREOTACTIC RADIOSURGERY AND STEREOTACTIC RADIOTHERAPY  12
UNIT II  CLINICAL INDICATIONS  12
Structure and Functioning of the brain. Clinical implications and malformations - AV AOVM, glioma, meningioma, acoustic schwanoma, pituitary adenoma and others.

UNIT III  RADIOBIOLOGY OF RADIATION THERAPY-RADIOSURGERY IN PARTICULAR  12
Physical and Biological factors affecting cell survival-tumor regrowth and normal tissue response-Non conventional fractionation scheme and their effect of reoxygenation, repair redistribution in the cell cycle - High LET radiation therapy - TDF- LQ Model-Radiobiology of Radiosurgery - Radiobiology of fractionated Stereotactic Radiotherapy.

UNIT IV  LINAC BASED RADIOSURGERY  12
Physical principles involved in the design of current Accelerators-Design and Characteristics - Modifications to the normal accelerators for Radiosurgery- Dosimetry of various collimators-3D calculation algorithms for noncoplanar fields-Quality assurance checks for radiosurgery-Image fusion in treatment planning and treatment evaluation.

UNIT V  QUALITY ASSURANCE  12
Scope of Computers in Radiation Treatment planning-Factors to be incorporated in computational algorithms- Cost effectiveness of Treatment Planning System -Hardware and Software requirements- Periodic software and hardware Q.A checks - Installation and Quality Acceptance of TPS and Linac accessories for Radiosurgery.

TOTAL : 60 PERIODS

REFERENCES

PX8025  SUPERCONDUCTIVITY AND APPLICATIONS  L T P C
4 0 0 4

AIM:
To enlighten the students with the concepts of superconductivity.

OBJECTIVE:
- To impart knowledge on superconducting materials, theoretical aspects and the applications of superconductors.

UNIT I  BASIC EXPERIMENTAL ASPECTS  12
UNIT II SUPERCONDUCTING MATERIALS 12
Elemental superconductors – superconducting compounds and its alloys – A15 compounds – chevral phase compounds

UNIT III HIGH TEMPERATURE SUPERCONDUCTORS 12

UNIT IV THEORETICAL ASPECTS 12
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 12

REFERENCES

TOTAL : 60 PERIODS

AIM: To study the basic concepts of Ultrasonics.

OBJECTIVE: To provide the knowledge on propagation of ultrasonic waves in medium & determination of its velocity, ultrasonic transducers, absorption of ultrasonic radiation and applications of ultrasonics.

UNIT I ULTRASONIC PROPAGATION IN SOLIDS AND LIQUIDS 12
Propagation of Ultrasonics waves in solids – Plane wave propagation - Relation of the velocity of sound to the elastic properties – Adiabatic and Isothermal elastic constants – Ultrasonic propagation in liquids – Internal pressure and free volume calculations.

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

REFERENCES

PX8027 MEDICAL APPLICATIONS OF LASERS

AIM:
To teach the students about medical applications of lasers.

OBJECTIVE:
• To make the students proficient in the areas of laser theory and medical lasers, fundamentals of laser-tissue interaction, thermal applications, non thermal applications and safety regulations.

UNIT I LASER THEORY AND MEDICAL LASERS 12

UNIT II FUNDAMENTALS OF LASER-TISSUE INTERACTION 12
Laser characteristics as applied to medicine and Biology - Different types of Laser tissue interaction : Photochemical - Photothermal - Photoablative and Electromechanical effects - Tissue optics - Experimental methods and determining the optical properties of tissue - Theory of Integrating sphere.

UNIT III THERMAL APPLICATIONS 12
UNIT IV  NON-THERMAL APPLICATIONS  

UNIT V  SAFETY REGULATIONS  
Protection standards for lasers - Safety regulations - specific precautions - medical Surveillance  
TOTAL: 60 PERIODS

REFERENCES