PH101 APPLIED PHYSICS  
Credit: 2:0:2  
Marks: (40+50) + (60+50)

Unit I: Laser  

Optical Fibers  
Light wave propagation in optical fibers – types of optical fibers – multimode fibers – engineering and medical applications.

Unit II: Properties of Materials  

Unit III: Superconductivity  
Qualitative study of the phenomenon – Meissner’s effect – Josephson effect Type I & II super conductors – BCS theory of superconductivity – applications – cryotron, super conductivity magnets, magnetic levitation.

Unit IV: Ultrasonics  
Production of ultrasonics – magnetostriction effect piezoelectric generator – detection of ultrasonics – properties of ultrasonics – applications – drilling, welding and soldering, NDT.

Unit V: X-Rays  

Text Book  

Reference Books  
PH102 (PH101 P) APPLIED PHYSICS LABORATORY

Credit: 0:0:2
Marks: 50+50

List of Experiments

1. Frequency Determination – Melde’s Method.
2. Velocity of Sound Determination – Helmholtz Resonator.
5. Thickness Measurement – Air Wedge Method.
11. Efficiency of Solar Cell.
13. Characteristic Study Of Junction Transistor.
15. Logic Gates – Using IC’s.
PH103 APPLIED PHYSICS

UNIT I : Optics


UNIT II : Electric Field and Maxwell’s Equation


UNIT III : Structure of Solids
Introduction – Classification of solids – Periodicity in crystals – Crystal structure – Geometry of space lattice – Unit cell – Bravis lattices – Crystal systems – Crystal symmetry – The unit cell characteristics The three cubic lattices – Atomic packing – Characteristics of a HCP cell – Crystallographic planes and miller indices – Inter planar distance in a cubic crystal.

UNIT IV : Architectural Acoustics


UNIT V : Elements of Thermodynamics:

Text Book
Reference Books
Unit I: Optics

Unit II: Structure of Solids
Introduction – Classification of solids – Periodicity in crystals – Crystal structure – Geometry of space lattice – Unit cell – Bravais lattices – Crystal systems – Crystal symmetry – The unit cell characteristics The three cubic lattices – Atomic packing – Characteristics of a HCP cell – Crystallographic planes and Miller indices – Inter planar distance in a cubic crystal.

Unit III: Materials

Unit IV: Acoustics

Unit V: Atomic Physics

Text Book:
Reference Books:
DEPARTMENT
OF
PHYSICS
ADDITIONAL SUBJECTS

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<td>Thermodynamics &amp; Statistical Mechanics</td>
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<td>PH314</td>
<td>Microprocessor / Controller Lab</td>
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PH301 CLASSICAL MECHANICS

Credit: 4:0:0  Marks : 40+60

Unit I: Mechanics of a System of Particles

Unit II: The Two Body Central Force Problem

Unit III: The Kinematics of Rigid Body Motion
The independent coordinates of a rigid body – orthogonal transformations – The Euler Angles – Symmetric top – Rate of change of a vector – angular velocity vector in terms of the Euler angles.
Small Oscillation
Formulation of the problem – Eigen value equation and the principal axis transformation – frequencies of free vibration – Triatomic molecule.

Unit IV: Special Relativity In Classical Mechanics
The basic problem of special relativity – The Lorentz’s transformation – Lorentz’s transformation in real four dimensional space – covariant four dimensional formulations – The force and energy equation in relativistic mechanics.

Unit V: The Hamilton Equations Of Motion
Legendre Transformations and the Hamilton equation of motion – Cyclic coordinates – Routh’s procedure and oscillations about steady motion – Derivation of Hamilton’s
equations from variational principle – The equations of canonical transformation – Examples of canonical transformation.

**Books for Study**


**PH302 THERMODYNAMICS AND STATISTICAL MECHANICS**

**Credit: 4:0:0  Marks : 40+60**

**Unit I : Review of the Laws of Thermodynamics and their Consequences**

**Unit II : Statistical Description of Systems of Particles**

**Unit III : Simple Applications of Statistical Mechanics**

**Statistical Thermodynamic Properties of Solids:**

**Unit IV : Quantum Statistics of Ideal Gases**

**Unit V : Phase Transitions in Statistical Mechanics**

**Books for Study**

1. Fundamentals of Statistical and Thermal Physics – Federick Reif.
Reference Books
1. Statistical Mechanics – Bipin K. Agarwal and Melvin Einsner

PH303 MATHEMATICAL PHYSICS: I
Credit: 3:1:0  Marks: 40+60

Unit I : Vector Analysis

Unit II : Matrices

Unit III : Tensor Analysis

Unit IV : Second Order Linear Differential Equations and Special Functions
Sturm Liouvilile Theory – Orthogonality of eigen functions – Legendre, Hermite, Laugere, Bessel and Hypergeometric functions – Series solutions of these differential equations – Generating functions – Orthogonality relations and important recurrence formulae – Gamma and Beta functions.

Unit V : Theory of Errors
Different types of errors, principle of least squares – Errors and residuals. Gaussian error curve. Binomial, Poisson and Gaussian distribution and their properties Mean, Median, Mode, Dispersion, and range, Mean deviation and standard deviation – Least square and curve fitting.

Books for Study

PH304 ELECTRONICS

Credit: 4:0:0 Marks: 40+60

Unit I: Semiconductor Devices

Unit II: Fabrication of Integrated Circuits
Integrated circuits fabrication and characteristics – Integrated circuit technology, basic monolithic integrated circuits – epitaxial growth, masking and etching – Diffusion of impurities – Monolithic diodes, integrated resistors, integrated capacitors and inductors monolithic layout, addition isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI) – The metal semiconductor contact.

Unit III: Linear Integrated Circuits

Unit IV: Microwaves
Microwave generation and application, Klystron, Magnetron, travelling wave tube – Microwave propagation in rectangular and cylindrical wave guides. H_{01}, E_{01} modes – Attenuators – Crystal detection – measurement of SWR.

Unit V: Digital Electronics
Boolean Algebra – Demorgan Theorem Arithmetic circuits Karnaugh map simplifications, (synchronous and asynchronous) counters registers – Multiplexures – Demultiplexures memories (EPROM, PROM, S-RAM) – LSI, VLSI Devices (PLD, PGAS)

Books for Study
1. Integrated Electronics – Millmaan. J. and Halkias C.C
2. Electronic Devices and Circuits – Allen Mottershead
3. Microwaves – Gupta K.C
4. Digital Principles and Applications – Malvino and Leach.

PH305 ELECTRO MAGNETIC THEORY

Credit: 4:0:0 Marks: 40+60

Unit I: Electro Statics

Unit II : Magneto Statics

Unit III : Time Varying Fields

Unit IV : Plane Electromagnetic Waves
Plane wave in a non conducting medium – Boundary conditions – Reflection and refraction of e.m. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting or dissipative medium.

Unit V : Electrodynamics

Books for study
1. Classical electrodynamics – J.D. Jackson

PH306 MATHEMATICAL PHYSICS – II
Credit: 3:1:0
Marks : 40+60

Unit I : Complex Variables

Unit II : Fourier Series and Transforms

Unit III : Vector Spaces
Greens Function
Definition and construction – Symmetry properties – Expression for Green’s functions in terms of eigen functions – Green’s functions for simple second order differential operators.

Unit IV : Group Theory

Unit V : Numerical Analysis

Books for Study
5. Methods of Mathematical Physics, B.D. Gupta.

PH307 QUANTUM MECHANICS
Marks : 40+60

Unit I : Formulation of Quantum Mechanics


Unit II : Simple Applications
Solutions to square well potential – Schrodinger equation for spherically symmetric potentials – Eigen values and eigen functions of the Hamiltonian for the isotropic Harmonic oscillator – Extension to three dimensional oscillator – Rigid Rotator – Hydrogen Atom.

Unit III : Approximation Methods for Stationary States
Time independent perturbation theory – non degenerate – cases – first order perturbation – Second order perturbation degenerate case – Removal of degeneracy in first order and

Unit IV: Angular Momentum and Time Dependent Perturbation

Time Dependent Perturbation Theory
First and second order – Transition amplitude – Constant perturbation – Conservation of energy – Harmonic perturbation – Adiabatic and sudden approximations.

Unit V: Relativistic Wave Equations

Books for Study

PH308 SOLID STATE PHYSICS
Credit: 4:0:0 Marks : 40+60

Unit I: Lattice Vibrations

Band Theory of Solids

Unit II: Dielectric And Ferroelectric Properties
Ferroelectricity – General properties – Dipole theory.

Unit III: Magnetic Properties
interation – Ferromagnetic domains surfaces – Bloch Wall – Antiferromagnetism –
Molecular field theory – Neel temperature – Ferrimagnetism.

Unit IV : Optical Properties
Point defects in crystals - Colour centres – Photoconductivity – Electronic Transitions in
photoconductors – Trap capture, recominations centres – General mechanism –
Luminescence – Excitation and emission – Decay mechanism – Thermo luminescence
and glow curves – Electroluminescence.

Unit V: Super Conductivity
Zero resistance – Behavior in magnetic field – Meissner effect – thermodynamics of
(qualitative) - Tunneling A.C. and D.C. Josephson effect – Type I and II superconductors
– High Tc super conductors (basic ideas)

Books for Study

PH309 NUCLEAR PHYSICS

Credit: 4:0:0  Marks : 40+60

Unit I : Nuclear Structure
Basic properties – magnetic moments – Experimental determination – Quadrupole
moments – Experimental techniques – Systems of stable nuclei – Semi empirical mass
formula of Weizsacker – Nuclear stability – Mass parabolas – liquid drop model – Shell
model.

Unit II : Nuclear Forces
Ground state of Deutron – magnetic dipole moment of Deutron – charge independence
and spin dependence of nuclear forces – Meson theory – Spin orbit and tensor forces –
Exchange forces.

Unit III : Radio Activity
Alpha emission – Geiger – Nuttal law – Gamow’s theory – Fine structure of alpha decay
– Neutrino hypothesis – Fermi’s theory of beta decay – Curie plot – Energies of beta
spectrum – Fermi and G.T. Selection rules – Non-conservation of parity – Gamma
emission – selection rules – Transition probability – Internal conversion – Nuclear
isomerism.

Unit IV : Nuclear Reactions
Energetic of Reaction – Level Widths in nuclear reaction – Nuclear Reaction cross
sections – Partial wave analysis – Compound nucleus model – Resonance Scattering –
Breit– Wigner one level formula – Optical model – Direct reactions – Stripping and pick-
up reactions – Fission and Fusion reactions: Elementary ideas of fission reaction – Theory
of fission – Elementary ideas of fusion – Controlled Thermonuclear reactions – Plasma
confinement – Fusion power.
Unit V: Particle Physics
Classification of fundamental forces and elementary particles – Isospin, strangeness – Gell-Mann Nishijima’s formula – Quark model, SU (3) Symmetry, CPT invariance in different interactions parity non conservation – K meson.

Books for Reference and Study:

PH310 SPECTROSCOPY
Credit: 4:0:0  Marks: 40+60

Unit I: Atomic And Molecular Structure

Unit II: Raman Spectroscopy
Semi classical treatment of emission and absorption of radiation: The Einstein Coefficients – Spontaneous and induced emission or radiation – Raman effect – Basic principles of Raman Scattering – Vibrational and Rotational Raman spectra – Experimental techniques of Raman spectroscopy – Molecular structural studies.

Unit III: Infrared And Microwave Spectroscopy

Unit IV: Resonance Spectroscopy - I
Unit V: Resonance Spectroscopy - II

Books for study
Unit: I
1. Quantum Mechanics Schiff, McGraw-Hill
3. Atomic Spectra and Chemical Bond Manas Chandra TMH
Unit: II
1. Quantum Mechanics Pawling and Wilson
Unit: III
1. Molecular Spectroscopy, Banwell. TMH
2. Molecular Spectra and Molecular Structure: G. Herzberg Van Nöstrand
Unit: IV
Unit: V
1. Nuclear Quadrupole Resonance T.P. Das and Hahn Supplement
3. Molecular Spectroscopy, Banwell, TMH

PH311 GENRAL PHYSICS LAB
Credit: 0:0:2 Marks : 50+50
12 experiments will be notified by the HOD from time to time

PH312 ELECTRONICS LAB - I
Credit: 0:0:2 Marks : 50+50
12 experiments will be notified by the HOD from time to time

PH313 ELECTRONICS LAB - II
Credit: 0:0:2 Marks : 50+50
12 experiments will be notified by the HOD from time to time

PH314 MICROPROCESSOR / CONTROLLER LAB
Credit: 0:0:2 Marks : 50+50
12 experiments will be notified by the HOD from time to time
ADDITIONAL SUBJECTS

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<td>PH316</td>
<td>Materials Characterization</td>
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<td>PH317</td>
<td>Magnetic Properties of Materials</td>
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<tr>
<td>PH318</td>
<td>Solid State Physics</td>
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PH315 THIN FILM TECHNOLOGY

Credit :3:0:0

Marks : 40 + 60

Unit I: Evaporation Theory
Hertz-Knudson equation – Free evaporation and effusion – Evaporation mechanism for liquids and crystalline solids– Directionality of evaporation molecules – cosine law of emission – emission from a point source

Unit II: Preparation Of Thin Films

Unit III: Deposition Monitoring and Control
Resistance monitor - Microbalance – Quartz Crystal monitor – Multiple beam interferometer – Fizeau technique – Fringes of equal chromatic order (FECO) method

Unit IV: Physical Properties Of Thin Films
Electrical properties: - Sheet resistance – Hall effect and Magnetoresistance in thin films – Oxidation – Agglomeration.
Dielectric properties: - DC conduction mechanism – Low field and high field conduction – AC conduction mechanism.
Optical properties: - Optical constants and determination – Spectro-photometer method – Antireflection coatings – Interference filters

Unit V: Applications Of Thin Films
Thin film solar cells – Magnetic head recording – Thin film amperometric and potentiometric gas sensor – Microactuator

Text book:

References:
PH316 MATERIALS CHARACTERIZATION

Credit :3:0:0

Marks : 40 + 60

Unit I: Structural Analysis

Unit II: Morphology
Electron spectroscopy for chemical analysis (ESCA) – X-Ray photoelectron spectroscopy (XPS) – Auger electron spectroscopy (AES) – Secondary ion mass spectrometry (SIMS) – Transmission electron microscopy (TEM) – Scanning transmission electron microscopy (STEM) - Rutherford backscattering spectrometry (RBS) – Atomic force microscopy - Instrumentation and result analysis

Unit III: Optical Characterization
UV – Visible - IR spectrometry - FTIR – Raman NMR – Sample handling techniques – Instrumentation and result analysis

Unit IV: Thermal Analytical Techniques

Unit V:

Text books:

PH317 MAGNETIC PROPERTIES OF MATERIALS

Credit :3:0:0

Marks : 40 + 60

Unit I: Magnetic Materials:
Unit II: Ferromagnetism:

Unit III: Magnetic Domains:

Unit IV: Antiferro And Ferrimagnetism:

Unit V: Applications Of Magnetic Materials:

Text book:
1. Cullity B.D.,”Introduction to magnetic materials” Wiley, Newyork

References:

PH318 SOLID STATE PHYSICS
Marks : 40+60

Unit I : Introduction
Basic concepts of crystallography – Reciprocal lattice – Bruilloin zone – Experimental determination by X-Ray diffraction.

Lattice Vibration:

Band Theory of Solids

Unit II: Dielectric and Ferroelectric Properties
Ferroelectricity – General properties – Dipole theory.
Unit III: Magnetic Properties

Unit IV: Optical Properties

Unit V: Super Conductivity

Books for Study
ADDITIONAL SUBJECTS

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<td>PH329</td>
<td>Introduction to Nano Science</td>
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PH 105 APPLIED PHYSICS

Credits 3 :0 :0

Unit I: Quantum Physics
Planck’s hypothesis- Wave nature of matter- De Broglie wave –De Broglie wavelength of electrons-properties of matter waves, Experimental verification of matter waves- Davisson and Germer experiment, G.P. Thomson’s experiment, Heisenberg’s uncertainty principle. Shroedinger’s wave equation (Time dependant and time independent equations)- Applications: particle in a box,

Unit II: Structure of solids
Classification of solids-Fundamental terms of crystallography-Lattice, basis, Unit cell, Crystallographic axis, primitives-Types of crystals-Bravais Lattices, miller indices-Unit cell characteristics of Simple cubic, BCC, FCC and HCP systems.

Nano Materials
Preparation of Nano Materials-Bottom up, top down approaches-Properties and applications of Carbon nano tubes

**Unit III: Dielectrics**
Basic Definitions-Electric field intensity, Electric flux density, Dielectric parameters-dielectric constant- Experimental determination of dielectric constant- Dipoles – Dipole moment- polar and non polar dielectrics, polarization- Types of polarization- Internal field-clausis mosotti equation-Dielectric loss- dielectric breakdown- dielectric properties.

**Semiconductors**
Classification of solids on the basis of band theory- Conductors, Insulators and semiconductors. Classification of semiconductors-Intrinsic and Extrinsic semiconductors - Solar cells-Light emitting diodes-Liquid crystal display

**Unit IV : Lasers**

**Fibre optics**
Principle of optical fibre-Propagation in optical fibres-Acceptance angle-Numerical aperture- Structure of optical fibres-Fibre optic materials-Classification of optical fibres-Applications-Optical fibres for communication-Fibre optic sensors-Temperature sensor

**Unit V: Acoustics**
Classification of sound, Characteristic of musical sound-Loudness- Weber and Fechner’s law- Decibel- Absorption coefficient- Reverberation time- Sabine’s formula (growth and decay), Factors affecting acoustics of buildings and their remedies
Ultrasound-classification of ultrasonic waves-properties of ultrasonic waves- ultrasonic production- Magnetostriction and piezoelectric methods, Acoustic grating, SONAR, NDT, applications in medicine and industry

**Text Book:**

**Reference Books:**
PH106 APPLIED PHYSICS

Credit: 3:0:0

Unit I Statics and Dynamics
Statics of particles-Force-Vectors-System forces-Laws of forces-Resolution of forces-concurrent forces in plane-Frictional forces-Free body diagram-Statics of rigid bodies in two dimensions-equilibrium of rigid bodies-moment of force about an axis-Supports and reactions-types of equilibrium-Kinematics-Curvilinear motion-Projectile motion-impulse and momentum-collision-work and energy-Newton’s law of motion-moment of inertia of thin rod and cylinder.

Unit II Gravity and Elasticity

Unit III Electricity and Magnetism
Atomic interpretation of ohm’s law-electrical conductivity in conductors-Wheatstone’s bridge-Carey Foster’s bridge-AC bridges-Grouping of cells-magnetism-potential due to a magnetic dipole-Gauss theorem-different types of magnetic materials-hard and soft magnetic materials-Ferrimagnetism-magnetic recording-Floppy disk-Floppy disc drive-magnetic tapes-magnetic core memory-magnetic bubble memory.

Unit IV Electromagnetism
Ampere’s law and Biot-Savart law-Electromagnetic induction-Faraday’s law-induced e.m.f in a conductor-Lenz’ law-force on moving charges in magnetic field-Hall effect-Self induction and mutual induction-Eddy currents-Induction coil-transformer-torque on a rectangular coil- Alternating currents-r.m.s value-Reactance-Phase angle -impedance-Alternating powerfactor-impedance matching-Maxwell’s equation-propagation of electromagnetic waves through conducting media.

Unit V Waves and Particles

Text book:

Reference Books:
3. Young & Freedman, University Physics, Pearson Education, 2004
PH201 ACOUSTICS AND OPTICS

Credit: 4:0:0

Unit I: Light

Unit II: Lens and Photometry

Unit III Laser and Fibre-Optics

Unit IV Musical Sounds
Motion of sound waves- Superposition of waves-Beats-Stationary waves-wave velocity-group velocity-phase velocity-Effect of pressure, temperature and humidity on the speed of sound-Frequency of vibrating string-Harmonics and overtones-Vibration of air column in pipes-Effect of diameter on pitch and quality of the note-musical sound and noises-Characteristics-Intensity of sound-Musical interval-Consonance and dissonance-Diatonic musical scale-Equally tempered scale

Unit V Acoustics of Buildings
Basic requirement for the acoustically good halls- reverberation-Sabine’s formula-absorption coefficient-Transmission of sound and transmission loss-factors affecting the architectural acoustics and their remedy-sound absorbing materials.

Text book:

References:
1. Brijlal& Subramaniam, Mcrawhill PublicationsNelkon & Parker –“Advanced Level Physics”- Arnold Keinemann
3. Young & Freedman, University Physics, Pearson Education, 2004
PH319 CLASSICAL MECHANICS

Credit: 4:0:0

Unit I : Mechanics of a System of Particles

Unit II : The Two Body Central Force Problem

Unit III : The Kinematics of Rigid Body Motion
The independent coordinates of a rigid body – orthogonal transformations – The Euler Angles – Symmetric top – Rate of change of a vector – angular velocity vector in terms of the Euler angles.
Small Oscillation
Formulation of the problem – Eigen value equation and the principal axis transformation – frequencies of free vibration – Triatomic molecule.

Unit IV : The Hamilton Equations Of Motion

Unit V Hamiltonian-Jacobi Theory
Hamilton-Jacobi equations for principle function-Harmonic Oscillator problem as an example of the Hamilton-Jacobi method-Hamilton-Jacobi equation for Hamilton’s characteristic function- Actions angle variables in the Systems with one degree of freedom- The Kepler Problem in action angle variables- Hamilton-Jacobi Theory, Geometrical Optics and Wave Mechanics

Text Books:

Reference Books:
PH320 STATISTICAL MECHANICS AND THERMODYNAMICS

Credit: 4:0:0

Unit I: Review of the Laws of Thermodynamics and their Consequences

Unit II: Statistical Description of Systems of Particles

Unit III: Simple Applications of Statistical Mechanics

Statistical Thermodynamic Properties of Solids:

Unit IV: Quantum Statistics of Ideal Gases

Unit V: Phase Transitions in Statistical Mechanics

Text Book:

Reference Books:
3. Thermodynamics and statistical mechanics - By John M. Seddon, Julian D. Gale
PH321 MATHEMATICAL PHYSICS: I

Credit: 3:1:0

Unit I : Vector Analysis

Unit II : Matrices

Unit III : Tensor Analysis

Unit IV : Second Order Linear Differential Equations and Special Functions
Sturm Liouvilile Theory – Orthogonality of eigenfunctions – Legendre-Generating functions, Laugere and Bessel functions (Differential equations and solutions only)–one dimensional and two dimensional differential equations and solutions-boundary value problem-time independent –rectangular coordinate system (Applications in heat conductions)

Unit V : Theory of Errors
Different types of errors, principle of least squares – Errors and residuals. Gaussian error curve. Binomial, Poison and Gaussian distribution and their properties Mean, Median, Mode, Dispersion, and range, Mean deviation and standard deviation – Least square and curve fitting.

Text Book:

Reference Books:
PH322 ELECTRONICS

Credit: 4:0:0

Unit I: Semiconductor Devices

Unit II: Fabrication of Integrated Circuits
Integrated circuits fabrication and characteristics – Integrated circuit technology, basic monolithic integrated circuits – epitoaxial growth, masking and etching – Diffusion of impurities – Monolithic diodes, integrated resistors, integrated capacitors and inductors monolithic layout, addition isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI) – The metal semiconductor contact.

Unit III: Linear Integrated Circuits

Unit IV: Microprocessor
Buffer register, Bus organized computers, SAP-I, Microprocessor (µP) 8086 Architecture, memory interfacing, interfacing I/O devices, Assembly language programming: Instruction classification, addressing modes, op code and openand, fetch and execute cycle, timing diagram, machine cycle, instruction cycle and T states, Data transform Logic and Branch operations-Programming examples

Unit V: Digital Electronics
Boolean Algebra – Demorgan Theorem Arithmetic circuits Karnaugh map simplifications, (synchronous and asynchronous) counters registers – Multiplexures – Demultiplexures memories (EPROM, PROM, S-RAM) – LSI, VLSI Devices (PLD, PGAS)

Text Book:

Reference Books:
1. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India
2. Digital Principles and Applications – Malvino and Leach.
PH323 MATHEMATICAL PHYSICS – II

Credit: 3:1:0

Unit I: Complex Variables

Unit II: Fourier Series and Transforms (Fourier and Laplace)
Fourier series – Dirichlet conditions – Sine and Cosine series – Half range series – Fourier Sine and Cosine transforms

Unit III: Vector Spaces

Unit IV Greens Function
Definition and construction – Symmetry properties – Expression for Green’s functions in terms of eigen functions – Green’s functions for simple second order differential operators.

Unit V: Group Theory

Text Book:

Reference Books
PH324 QUANTUM MECHANICS

Credit: 4:0:0

Unit I: Formulation of Quantum Mechanics


Unit II: Simple Applications
Solutions to square well potential – Schrodinger equation for spherically symmetric potentials – Eigenvalues and eigenfunctions of the Hamiltonian for the isotropic Harmonic oscillator – Hydrogen atom

Unit III: Approximation Methods for Stationary States

Unit IV: Angular Momentum and Time Dependent Perturbation

Time Dependent Perturbation Theory
First and second order – Transition amplitude – Constant perturbation – Conservation of energy – Harmonic perturbation – Adiabatic and sudden approximations.

Unit V: Relativistic Wave Equations

Text Book:

Reference Books:
PH 325 SOLID STATE PHYSICS

Credit: 4:0:0

Unit I : Lattice Vibrations

Band Theory of Solids

Unit II: Dielectric And Ferroelectric Properties

Unit III : Magnetic Properties

Unit IV : Optical Properties

Unit V: Super Conductivity

Text Book:
1. Introduction to Solid State Physics- Kittel, John wiley, 8th edition,2004

Reference Books:

PH326 NUCLEAR PHYSICS

Credit: 4:0:0
Unit I: Nuclear Structure

Unit II: Nuclear Forces

Unit III: Radio Activity

Unit IV: Nuclear Reactions

Unit V: Particle Physics
Classification of fundamental forces and elementary particles – Isospin, strangeness – Gell-Mann Nishijima’s formula – Quark model, SU (3) Symmetry, CPT invariance in different interactions parity non conservation – K meson.

Text Book:

Reference Books:

PH 327 SPECTROSCOPY

Credit: 4:0:0

Unit I: Atomic And Molecular Structure
Energy levels – Selection rules and intensities in dipole transition – Paschen back effect
Hydrogen ion – Hydrogen molecule – Covalent bond – Heitler – London theory – Atomic
and molecular hybrid orbitals.

**Unit II : Raman Spectroscopy**
Semi classical treatment of emission and absorption of radiation: The Einstein Coefficients –
Spontaneous and induced emission or radiation – Raman effect – Basic principles of Raman
Scattering – Vibrational and Rotational Raman spectra – Experimental techniques of Raman
spectroscopy – Molecular structural studies.

**Unit III : Infrared And Microwave Spectroscopy**
Characteristic features of pure rotational, vibrational and Rotation – Vibration spectra of
diatomic molecules – Theoretical considerations – Evaluation of molecular – constants – IR
spectra of polyatomic molecules – Experimental techniques – dipole moment studies and
molecular structural determinations – Microwave spectra of polyatomic molecules –
experimental techniques

**Unit IV : Resonance Spectroscopy - I**
NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation –
Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and
double coil methods – Pulse method – ESR basic principles – High Resolution ESR
Spectroscopy – ESR spectrometer.

**Unit V : Resonance Spectroscopy - II**
N Q R Spectroscopy – Basic Principles – Quadruple Hamiltonian Nuclear Quadrupole
energy levels for axial and nonaxial symmetry – N Q R spectrometer – chemical bonding –
molecular structural and molecular symmetry studies.
Mossbauer spectroscopy: Principles of Mossbauer spectroscopy – Chemical shift –
Quadrupole splitting – Applications.

**Text Book:**
   New Delhi, 2004

**Reference Books:**
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson
PH 328 FIBRE OPTICS AND NON-LINEAR OPTICS

Credit 4 : 0 : 0

Unit I. Optical fibre and its properties:
Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types. (Ch. 3 of book 1).

Unit II. Fiber fabrication and cable design:
Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing. (Ch. 4 of book 1).

Unit III. Optics of anisotropic media:
Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/polarizer combinations. (Ch. 18 of book 2).

Unit IV. Electro-optic and acousto-optic effects and modulation of light beams:
Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro-optic modulation, electro-optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of for a longitudinal acoustic wave in isotropic medium, calculation of for a shear wave in lithium niobate, Raman-Nath diffraction, Raman-Nath acousto-optic modulator. (Ch. 19 of book 2, Ch 16, 17 and 19 of book 3).

Unit V. Non-linear optics/processes:
Introduction, anharmonic potentials and non-linear polarization, non-linear susceptibilities and mixing coefficients, parametric and other non-linear processes, macroscopic and microscopic susceptibilities. (Ch. 20 of book 2).

Text Book:
1. The Elements of Fibre Optics: S.L. Wymer and Meardon (Regents/Prentice Hall), 1993

Reference Books:
2. Optical Electronics - Gathak & Thyagarajan, Cambridge Univ. Press, 1989
3. The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press), 1990
PH 329 INTRODUCTION TO NANOSCIENCE

Credit 4:0:0

Unit I: Introduction to Nano

Unit II: Electrical and magnetic properties
Electronic and electrical properties-One dimensional systems-Metallic nanowires and quantum conductance-Carbon nanotubes and dependence on chirality-Quantum dots-Two dimensional systems-Quantum wells and modulation doping-Resonant tunnelling-Magnetic properties Transport in a magnetic field-Quantum Hall effect. -Spin valves-Spin-tunnelling junctions-Domain pinning at constricted geometries-Magnetic vortices

Unit III: Mechanical and Optical Properties
Mechanical properties-Individual nanostructures-Bulk nanostructured materials-Ways of measuring-Optical properties-Two dimensional systems (quantum wells)-Absorption spectra-Excitons-Coupled wells and superlattices-Quantum confined Stark effect

Unit IV: Fabrication of nanoscale materials:

Unit V:
Nanodevices Background-Quantization of resistance-Single-electron transistors-Esaki and resonant tunneling diodes-Magnetic Nanodevices-Magnetoresistance-Spintronics-MEMS and NEMS

Text Book:
1. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley, 2003

Reference Books:
2. Introduction to Solid State Physics, C. Kittel, a chapter about Nanotechnology, Wiley, 2004

PH 330 PHYSICS OF NANOMATERIALS

Credit 4:0:0

Unit I: Introductory Aspects:
Department of Physics

**Unit II: Preparation of Nanomaterials:**
Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

**Unit III: General Characterization Techniques:**
Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

**Unit IV: Nano Bio**
Nano-fluidics to build silicon devices with features comparable in size to DNA, proteins and other biological molecules; Control and manipulation of microfluidic and nanofluidic processes for lab-on-a-chip devices. Role of surfaces in nanotechnology devices; surface reconstruction; dangling bonds & surfaces, Bio-Nano tubes.

**Unit V: Other Nanomaterials:**
Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

**Text Books:**

**Reference Books:**

**PH 331 ELECTRONICS LAB**

Credit: 0:0:4

12 experiments will be notified by the HOD from time to time
PH 332 ADVANCED PHYSICS LAB
Credit: 0:0:4
12 experiments will be notified by the HOD from time to time

PH 333 MICROPROCESSOR / CONTROLLER LAB
Credit: 0:0:4
12 experiments will be notified by the HOD from time to time

PH 334 COMPUTATIONAL PHYSICS
Credit: 4:0:0

Unit I: C Programming for beginners
Basic structure of C program. Different types of variables. Arrays and Pointers, use of functions and pointers to functions, elementary examples using pointers, arrays and functions.

Unit II: Modeling data: Interpolation and fitting
Lagrange and Newton interpolation methods, divided difference table. Piece wise polynomial interpolation. Error in polynomial interpolation. Least squares regression. Linear, multiple linear and nonlinear regressions

Unit III: Solutions of nonlinear equations and minimization of functions.

Unit IV: Numerical differentiation and Integration

Unit V: Solutions of ordinary differential equations

Text Books:

Reference Books:
2. Elementary Numerical Analysis. S. D. Conte and C. de Boor McGraw-Hill College (1972)
PH335 RESEARCH METHODOLOGY

Credits: 4:0:0

Unit I: Method of Research
Identification of the problem- literature survey- reference collection – Internet browsing – accessing the current status – Mode of approach to actual investigation – results and conclusion – presenting a scientific seminar- art of writing research paper and thesis

Unit II: Statistical Methods:
Correlation- comparison of two sets of data- comparison of several sets of data- Chi squared analysis of data- characteristics of probability distribution- some common probability distributions- Measurement of errors and measurement process – sampling and parameter estimation- propagation of errors- curve fitting- group averages – equations involving three constants- principle of least squares- fitting a straight line, parabola and exponentials curve- method of moments

Unit III Numerical methods

Unit IV Application of Numerical and statistical methods using Fortran Programming
Solving quadratic equations — solution of equation by Newton Raphson method - matrix diagnolization (Jacobian method) – Integration by Simpson’s rule –Fitting of a straight line using principle of least square

Unit V: MATLAB Programming
MATLAB basics- Input and output – Arithmetic- Algebra- Managing variables- Errors in input- variables and assignments- solution of simultaneous equations - vectors and matrices- functions- graphics

Text Books:
5. Computer programming FOTRAN IV- Prentice Hall

PH336 MATERIALS CHARACTERIZATION

Credit:4:0:0

Unit I: Structural Analysis

**Unit II: Compositional Analysis & Morphology**
Electron spectroscopy for chemical analysis (ESCA) – X-Ray photoelectron spectroscopy (XPS) – Auger electron spectroscopy (AES) – Secondary ion mass spectrometry (SIMS) – Transmission electron microscopy (TEM) – Scanning transmission electron microscopy (STEM) - Rutherford backscattering spectrometry (RBS) – Atomic force microscopy - Instrumentation and result analysis

**Unit III: Optical Characterization**
UV – Visible - IR spectrometry - FTIR – Raman -LASER Raman – Non Linear Raman – Photoluminescence -NMR – Sample handling techniques – Instrumentation and result analysis

**Unit IV: Thermal Analytical Techniques**

**Unit V: Electrochemical methods**

**Text books:**
3. ArulDas, Spectroscopy

**PH337 TECHNOLOGY OF THIN FILMS**

**Credits 4:0:0**

**Unit I: Vacuum system**
Categories of deposition process ,basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular , monitoring equipment –McLeod gauge, pirani, Penning , Capacitance diaphragm gauge
Evaporation – deposition mechanism, evaporation sources- tungsten-helical, hair pin, basket, molybdenum boat, process implementation, deposition condition

**Unit 2: Thin film coating techniques**
Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electroplating- potentiostat, galvanostat, pulsed plating, sol gel coating, LASER ablation, spray pyrolysis
Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity
Substrate cleaning, substrate requirements, buffer layer, metallization

Unit 3: Growth process
Adsoption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control
Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

Unit 4: Structural, Optical and electrical studies on thin films
X- Ray Diffraction studies – Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis NIR Spectroscopy - absorption and reflectance-Optical constants of a thin film by transmission and reflectance at normal incidence for a system of an absorbing thin film on thick finite transparent substrate, Photoluminescence (PL) studies – Fourier Transform Infrared Spectroscopy(FTIR)
Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

Unit 5: Thin film applications

Text Book
2. Thin Film Technology, Robert W. Berry, Peter M. Hall, Murray T. Harris, Van Nostrand company, London
3. Thin film Technology, Chopra

References:
1. An Introduction to Physics and Technology of Thin Films
   By Alfred Wagendristel, Yuming, Yu-ming Wang, World Scientific, 1994
2. Handbook of Thin-film Deposition Processes and Techniques: Principles, Methods,
PH338 MAGNETIC MATERIALS AND PROPERTIES

Credit: 4:0:0

Unit I: Magnetic Materials

Unit II: Ferromagnetism
Weiss molecular field theory – Exchange interaction – Ferromagnetic hysteresis – Easy and hard directions of magnetization – Hard and soft magnetic materials – Applications

Unit III: Magnetic Domains
Domain theory – Magnetic anisotropy – Domain walls – Magnetostatic energy – Magnetostriction – Bloch walls vs. Neel walls

Unit IV: Antiferro and Ferrimagnetism
Antiferromagnetism – Two sublattice theory – Ferrites – properties – Structure of ferrites – Applications – Garnets – magnetic bubbles

Unit V: Applications of Magnetic Materials
Magnetic behaviour of thin films – Magnetic head recording – Permanent magnets – Magneto-optics – Giant magnetoresistance – Magnetic resonance

Text book:
1. Cullity B.D., ”Introduction to magnetic materials” Wiley, Newyork

References:
3. Magnetic Materials: Fundamentals and Device Applications
   By Nicola Ann Spaldin, Published by Cambridge University Press, 2003
6. Physics of magnetism and Magnetic materials, K.H.J. Buschow, f.R. de Boer,
   Published by Springer, 2003

PH339 NANOFLUIDS

Credit: 4:0:0

Unit I: Introduction to Nanofluids

Unit II: Synthesis of Nanofluids

**Unit III : Conduction Heat transfer in Nanofluids**

**Unit IV : Theoretical modeling**
Simple Mixture Rules - Maxwell’s Approach - Particle Distributions - Particle Geometries - Symmetrical Equivalent Medium Theory - Matrix-Particle Interfacial Effects - Interfacial Thermal Assistance - Dynamic Models of Thermal Conductivity in Nanofluids - Near-Field Radiation Model

**Unit V : Convection and Boiling in Nanofluids**

**Text Books:**

**References:**

**PH340 CRYSTAL GROWTH TECHNIQUES**

**Credit: 4:0:0**

**Unit I: Fundamentals of Crystal Growth**
Importance of crystal growth – classification of crystal growth methods -Theories of nucleation – Classical theory – Gibbs Thomson equation for vapor solution and melt – energy of formation of a nucleus –Adsorption at the growth surface – Nucleation – Homogeneous and Heterogeneous nucleation – Growth surface.

**Unit II: Growth from Low Temperature Solutions**
Solution – selection of solvents – solubility and super solubility – Saturation and super saturation – Meir’s solubility diagram – Metastable zone width – measurement and its enhancement – Growth by (i) restricted evaporation of solvent, (ii) slow cooling of solution and (iii) temperature gradient methods – Growth in Gel media, Electrocrystallization.
Unit III: Growth from Flux and Hydrothermal Growth
Flux Growth – principle – choice of flux – Growth kinetics – phase equilibrium and phase
diagram – Growth techniques – solvent evaporation technique – slow cooling technique -
transport in a temperature gradient technique – Accelerated crucible rotation technique – Top
seeded solution Growth – Hydrothermal Growth.

Unit IV: Growth from Melt
Basis of melt growth – Heat and transfer – Growth techniques – conservative processes –
Bridgman – Stockbarger method – pulling from the melt – Czochralski method – cooled seed –
Kyropoulos method – Non- conservative processes – zone refining – vertical, horizontal
floatzone methods –Skull melting Process - Vernueil method – flame fusion, plasma and arc
image methods.

Unit V: Growth from Vapour
Basic principle – physical vapour deposition – Evaporation and Sublimation processes –
sputtering – chemical vapour Deposition – Advantages and disadvantages – chemical vapour
transport – Fundamentals – Growth by chemical vapour transport Reaction .

Text Books:
   (1986)
2. Elwell. D and Scheel. H. J, crystal growth from High Temperature solutions,

Reference books:-
1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle

PH341 SOLID STATE IONICS

Unit I: Crystal structure
Crystalline Solids- Space Lattice – the basis and crystal structure; crystal translational
vectors, symmetry operation, Primitive lattice cell and unit cell, symmetry elements.
Fundamental types of lattices- atomic packing,atomic radius, lattice constant and density,
crystal structures; other cubic structure- type of bonding – ionic bonding – energy of
formation of NaCl Molecule; Madelung constant- potential energy of diagram of ionic
molecule- calculation of repulsive exponent – Born- Haber cycle – characteristics of ionic
bond

Unit II  Theoretical aspects of Solid Electrolytes
Phenomenological Models : Hubermann’s Theory – Rice-Strassler and Toomb’s theory – Welch and Dienes Theory

**Unit III : Diffusion Process in Ionic Crystals**

**Unit IV**
Transport Properties of Ionic Conductors:
Definition of Conductivity and Transference number – Equation of flow of charged particles-measurement of Conductivity- Determination of Transference Number – Interrelation among diffusion coefficient, mobility and ionic conductivity
Electrochemistry of mixed ionic-electronic conductor :- Thermodynamics of electronic and ionic charge carriers- carrier concentration – disorder and conductivity types- Experimental methods to separate ionic and electronic conductivity parameter:- emf method of transport number determination- Determination of small electrionic transport numbers-The permeation technique (static)- The polarized cell technique (static) Ther polarized cell technique (dynamic)- The permeation technique (dynamic)

**Unit V: Superionic Solids and Applications**
Types of Superionic solids : oxide ion- fluoride ion – silver and copper ion – lithium ion-sodium and potassium ion – proton – thin film solid electrolytes

**Text Books:**

**References :**

**PH342 BATTERY AND ITS CHARACTERIZATIONS**

Credit 4:0:0

Department of Physics 358
Unit I: Operation of a Battery
Chemistry in cells – Cell Discharge and Charge – Choice of a Battery: Primary, Secondary-
Energy or Power – Battery Temperature – Shelf life – Energy efficiency and Recharge rate –
Battery Life – Fuel cells – principle and working – Electrode material – membrane -
electrolyte

Unit II : Types of Primary Batteries
Aluminium and magnesium based Leclanche Cells – Zin-Mercuric oxide, Zinc- Cadmium
Oxide, Zinc-Silver oxide Battery – Metal-air batteries – Primary Lithium Cells – Button and
coin cells – Cylindrical and Prismatic cells – Cells with Liquid Positive electrodes

Types of Secondary Batteries: Lead-acid cells – Alkaline cells: Ni-Cd, Ni-MH, Zn-MnO₂,
Zn-NiO – Zn-Silver oxide Rechargeable lithium ion battery : Intercalation electrodes and
lithium metal cells – Replating of Lithium – The lithium ion battery – Lithium polymer
battery- High temperature Lithium Battery – ZEBRA battery

(Principle and operation of each type of the cell)

Unit III: Theoretical Background
The electrical double layer and the formation of electric potential at interfaces –
Thermodynamics of galvanic cells – Current flow in an electrochemical cell – Battery
characteristics and performance criteria : Nominal Voltage, Nominal Capacity, Specific
capacity – Specific energy- Volt-ampere characteristics (load Characteristic) – Open circuit
voltage

Unit IV: Practical consideration of Battery
Solvants and supporting electrolytes- Oxygen Removal – Instrumentation – Working
electrodes : Mercury electrode- Solid electrodes; Rotating disc and Ring-disk electrode-
Carbon electrode; glassy – carbon electrode, Carbon paste electrode- carbon-fibre electrode –
Metal electrode – Chemically modified electrodes ; Self assembly monolayers – sol-gel
encapsulation of reactive species – electrocatalytic modified electrode – preconcentrating
electrode – permselective coating- conducting polymer – Microelectrode – Diffusion at
microelectrode – Configuration of microelectrode – composite electrode

Unit V: Characterization techniques:
Cyclic voltammetry – Linear Sweep Voltammetry- Chronocoulometry-
Chronopotentiometry- Electrochemical Impedance Spectroscopy

Lithium Battery and its characterization: Case study of Lithium batteries giving
emphasise to Specific capacity, Power density, Open circuit Voltage, Charge-discharge
cycling performance and Depth of discharge

Text Books:
1. Understanding Batteries, R.M.Dell and D.A.J.Rand, Royal Society of Chemistry
   (2001)
References:

PH343 RENEWABLE ENERGY SOURCES

Credits 2:0:0

Unit I: Basic Concepts of Energy Sources

Unit II: Solar Energy

Unit III: Wind-Energy

Unit IV: Energy from Bio-Mass

Unit V: Energy from Other Sources

Text Book:

References:
PH344 ASTROPHYSICS

Credits 2:0:0

Unit I: The Solar System (Fundamental Ideas)

Unit II: The Stars

Unit III: Telescopes and Detectors
Optical Telescopes – Invisible Astronomy: The Hubble Space Telescope

Unit IV: The Milky Way Galaxy

Unit-V: The Universe

Text Book:
1. Introductory Astronomy And Astrophysics, Fourth Edition, ZEILIK, GREGORY

References:
ADDITIONAL SUBJECTS

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<th>Code</th>
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<td>09PH201</td>
<td>Thin Films Technology For Engineers</td>
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<td>09PH 202</td>
<td>Basic Science Of Sound, Light And Signals</td>
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<td>09PH 203</td>
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<td>09PH 301</td>
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09PH101 APPLIED PHYSICS LAB

Credit: 0:0:2

Course Objective:

- To train engineering students on basis of measurements and the instruments
- To give practical training on basic Physics experiments which are useful to engineers
- To equip the students with practical knowledge in electronic, optics, and heat experiments

Course outcome:
Demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments.

List of experiments:

1. Rigidity Modulus of the wire - Torsional Pendulum
2. Young’s Modulus of a beam- Non-uniform bending
3. Thermal Conductivity of a bad conductor-Lee’s Disc
4. Radius of curvature of a lens – Newton’s Rings
5. Refractive Index of Prism-Spectrometer
6. Wavelength of mercury source- Spectrometer Grating method
7. Coefficient of Viscosity of a liquid by Poiseullie’s method
8. Frequency determination of a tuning fork- Melde’s string
9. Particle size measurement-Laser diffraction method
10. Discharge of a capacitor
11. Thickness of a glass plate- Single optic lever
12. Characteristics of Zener diode
13. Efficiency of Solar cell
14. Ultrasonic interferometer
HoD can choose any 10 experiments from the above list at the beginning of the course in each Semester.

**09PH201 THIN FILMS TECHNOLOGY FOR ENGINEERS**

**Credits 3:0:0**

**Course Objective:**
This is degree level course useful for students who projects on synthesis of VLSI, solar cells and MEMS
- To gain knowledge on vacuum systems
- To learn about various coating techniques
- To learn about the various characterization techniques of thin films
- To gain knowledge on application of thin films

**Course outcome:**
Demonstrate and execute the process of thin film for various applications

**Unit I: Vacuum system**
Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular -McLeod gauge, pirani gauge, Penning gauge

**Unit II: Thin film coating techniques**
Evaporation – deposition mechanism, Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electro plating- sol gel coating, LASER ablation, spray pyrolysis

**Unit III: Growth process**
Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control
Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

**Unit IV: Structural, Optical and electrical studies on thin films**
X- Ray Diffraction studies – Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis Spectroscopy - absorption and Transmittance
Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

**Unit V: Thin film applications**

**Text Books:**
1. Thin Film Fundamentals by Goswami  2003 New Age International Ltd.
2. Thin-film deposition: principles and practice
   By Donald L. Smith, McGraw-Hill Professional, 1995
Reference Books:

09PH 202 BASIC SCIENCE OF SOUND, LIGHT AND SIGNALS

Credits 3:0:0

Course Objective:
This is degree level course useful for students who study visual communications and other related programmes

- To gain knowledge on lens system and photometry
- To understand the concept colour theory and aberrations
- To gain knowledge on sound waves and its properties
- To understand the basic concepts of signal processing

Course outcome:
Demonstrate the knowledge on sound, light and signals

Unit I : Lens system, photometry and colour theory
Cardinal points of an optical system, Coaxial lens system- equivalent focal length and cardinal points, refraction through a thick lens.
Measurement of light- standard candle, Secondary standards, Inverse square law, Intensity of illumination and Lambert’s law, Units of illumination, Brightness of a surface and illumination, Photometer- Lummer and Brodhum photometer
Natural light, three colour theory-mixing of colours

Unit II: Resolution and Aberrations
Rayleigh’s criterion of resolution- resolving power of a grating, prism- resolving power of a telescope, microscope
Aberrations or defect of a lens, Chromatic aberration – longitudinal and lateral Achromatism of lenses, spherical aberration- minimization of spherical aberration, coma, Astigmatism

Unit III : Sound Waves
Unit IV: Acoustics

Unit V: Signals
Characterization and Classification of signals- examples of signals – multi channel - multidimensional – continuous versus discrete-analog versus discrete-concept of frequency – concept of signal processing-advantage of digital signal processing with analog signal processing

Text Books:

Reference Books:

09PH 203 MATERIAL SCIENCE FOR ENGINEERS

Credits: 3:0:0

Course Objective:
This is degree level course useful for any branch of engineering students

- To gain knowledge on solid state materials
- To understand the conducting and semiconducting properties of materials
- To understand the magnetic properties of materials
- To learn the latest development on new materials

Course outcome:
Demonstrate the knowledge on material properties

Unit I: Introduction To Crystallography
Introduction--crystallography – crystal planes and crystal direction – crystal symmetry – Bravias lattices – Miller indices – Simple crystal structures – unit cell characteristics of SC, BCC, FCC & HCP – Method of determination of crystal structures—X-ray diffraction method -- crystal defects or imperfections.
Unit II: Conducting Materials

Unit III: Semiconducting Materials

Unit IV: Magnetic Materials

Unit V: New Materials

Text Books:

Reference Books:

09PH 301 MEDICAL RADIATION DOSIMETRY
Credit 4:0:0
Course Objective:

This is an advanced level course useful for students who do M.Phil or Ph.D in the field of Medical or Radiation Physics

- To learn the basic concepts of radiation
- To understand the interaction of radiation with matter
- To understand Kema, dose activity
- To gain knowledge on dosimetry systems

Course outcome:
Demonstrate knowledge on radiation and dosimetry systems

Unit I: Basic Radiation Physics

Unit II: Interaction of Radiation with matter
Types of indirectly ionizing radiation - Photon beam attenuation – Types of photon interactions - Types of electron interactions - Types on neutron interactions - Photo electric effect - Coherent scattering - Compton effect - Pair production - Photo nuclear disintegration - Effect following radiation interaction.

Unit III: Radiation Quantities and Units
Radiometric, interaction, protection and dosimetric quantities - Particle and energy fluence - Linear and mass attenuation coefficient - Stopping power – Linear energy transfer - Absorbed dose - Kerma – Exposure – Activity - Equivalent dose - Effective dose - Electronic or charged particle equilibrium – Bragg gray cavity theory.

Unit IV: Radiation Detection
Properties of dosimeters - Methods of radiation detection - Ionization chamber dosimetry system - Proportional counters - Geiger Muller counters - Semi conductor detector - Solid and liquid scintillation counters - Film dosimetry – Thermoluminiscnet dosimetry - Calorimetry - Chemical dosimetry

Unit V: Calibration of Photon and Electron beams.
Calibration chain - Ionization chambers - Electro meter and power supply – Phantoms - Chamber signal corrections for influence quantities - Calibration of mega voltage photon beams based and mega voltage electron beams based on standard national and international protocols .

Text Books:
Reference Books:
1. Treatment Planning in Radiation Oncology by FM. Khan and RA. Potish, Williams & Wilkins, 1998
2. Radiation Detection and Measurement by GF. Knoll, Published by Wiley, 2000
4. Radiation therapy Physics by WR. Hendee and GS. Ibbott, J. Wiley, 2004

09PH302 RADIATION TREATMENT PLANNING
Credits: 4:0:0

Course Objective:
This is an advanced level course useful for students who do M.Phil or Ph.D in the field of Medical or Radiation Physics

- To gain knowledge on radiotherapy machines
- To understand the interaction of photon beam on matter
- To learn about the clinical treatment planning
- To gain knowledge on electron beam therapy and advanced radiotherapy treatment methods

Course outcome:
Demonstrate overall knowledge on radiotherapy treatment planning

Unit I: Radiotherapy Machines
X-rays and Gamma rays - Linear accelerator-Components of modern linacs - Injection system - RF power generation system - Accelerating wave guide - Microwave power transmission - Auxiliary system - Electronic beam transport - Linac treatment head - Production of photon and electron beams from linac - Beam collimation - Cobalt-60 versus linac - Radiation therapy simulators.

Unit II: Physical aspects of External photon beams
Photon beam sources - Inverse square law - Penetration of photon beams into phantom or patient - Surface dose - Build up - Skin sparing effect - Percentage depth dose - Tissue air ration - Back scattering factor - Tissue phantom ratio - Tissue maximum ratio - Scatter air ratio - Total scatter factor - Isodose distribution in water phantom - Isodose charts and factors effecting - Correction of irregular counters - Missing tissue compensation - Correction of tissue inhomogeneity – Clarkson’s method - Dose calculation.

Unit III: Clinical treatment planning in photon beams and recent advances

Unit IV: Physical aspects of Electron beam therapy
Production of electron beams - Interaction of electron with matter - Range concept - Percentage depth dose - Electron energy specification - Scattering power - Rapid dose fall off - Electron shielding - Dose prescription and thumb rule - Field inhomogeneity - Dose build up - Photon contamination - Back scatter – Collimation - Virtual SSD - Oblique incidence

**Unit V: Advanced radiotherapy treatment methods**

Treatment planning system - Imaging in radiotherapy - Image fusion - CT simulation - Basics of 3-Dimensional conformal therapy - Beams eye view - Digitally reconstructed radiograph - 3-D Conformal Radiotherapy – Plan evaluation methods - Dose volume histograms - Treatment evaluation – Introduction to Intensity Modulated Radiotherapy and Image Guided Radiotherapy - Stereotactic Radiosurgery and Stereotactic Radiotherapy- Tomotherapy - Particle beam therapy.

**Text Books:**

**Reference Books:**
1. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
3. Radiation therapy Physics, WR. Hendee and GS. Ibbott, J. Wiley, 2004

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**09PH303 CONDENSED MATTER PHYSICS**

**Credit 4:0:0**

**Course Objective:**
- To gain fundamental knowledge on crystal structure
- To understand the experimental determination of crystal structure
- To gain knowledge on the free electron theory of metals
- To gain knowledge on defects and diffusion theory

**Course outcome:**
Demonstrate overall fundamental knowledge on condensed matter

**Unit I : Crystal Structure**

Two dimensional lattices: Bravais Lattice – Enumeration of two dimensional lattices – lattices with bases – primitive cells – Wigner Seitz cells - Symmetries : The space group – Translation and point groups

Three dimensional lattices: Monoatomic lattices: Simple cubic- Face centered cubic- body centred cubic – Hexagonal – Hexagonal close packed – diamond

Classification of Lattices by symmetry – 14 bravais lattices and seven crystal systems – Symmetries of lattices with bases : -32crystallographic point groups – 230 distinct lattices:
Unit II: Experimental determination of crystal structures
Theory of scattering of crystals – Experimental methods – Further features of scattering experiments – Surfaces and interfaces – Geometry of interfaces, experimental observation and creation of interfaces- LEED -FIM- STM- AFM

Unit III: Basics of crystal physics
Forces between atoms – Cohesive energy of ionic crystals – the Born Haber cycle – the atomic packing theory – the Laue and Bragg’s X-ray diffraction theory – Ewald construction – the reciprocal lattice and its important properties – diffraction intensity – the powder, Laue and rotation/oscillation methods of x – ray diffraction.

Unit IV: Free electron theory of metals

Unit V: Defects in solids and diffusion theory

Text Books:

Reference books:

09PH304 GENERAL PHYSICS LAB

Credits: 0:0:2

Course Objective:
• To give practical training on basic Physics experiments which are useful to other disciplines such as chemistry /Biology
• To equip the students with practical knowledge in electricity, optics, magnetism and ultrasonics
• To train students on measurement and instrumentation techniques
Course outcome:
Demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments

List of Experiments:

1. Thickness measurement of thin samples
2. Particle size determination
3. Wavelength determination using spectrometer
4. Electrical conductivity measurement – Four Probe method
5. Hall effect
6. B-H curve – hysteresis
7. Constant deviation spectrometer
8. Ultrasonic interferometer
9. Vacuum measurements
10. IV characterization of photo cell
11. Thermal Conductivity measurement
12. Calibration of thermocouple

HoD can choose any 10 experiments from the above list at the beginning of the course in each Semester.
DEPARTMENT OF PHYSICS
LIST OF REVISED AND NEW SUBJECTS

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject Name</th>
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<td>Thermodynamics and Statistical mechanics</td>
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<td>10PH204</td>
<td>Optics and photonics</td>
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<td>Vacuum and Thin film technology</td>
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<td>10PH207</td>
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<tr>
<td>10PH309</td>
<td>Computational Physics</td>
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**10PH202 MECHANICS & PROPERTIES OF MATTER**

Credit: 4:0:0

**Course Objectives**
- To Know about the Basic laws of Physics
- To learn about the properties of matter in different conditions

**Course Outcome**
Find the solution for simple problems in day to day life and this course explains the properties of matters.

**Unit I : Gravitation**
Kepler’s laws – Newton’s deductions from Kepler’s laws – Newton’s law of gravitation – Determination of gravitational constant – Law of Gravitation and theory of relativity – Gravitational potential at a point distant r from a body – Escape Velocity – Potential and Field intensity due to a solid sphere at a point inside the sphere and outside the sphere – Earth quakes – Seismic waves and Seismographs

**Unit II : Projectile and Collision**

**Unit III : Elasticity**
Poisson’s Ratio – Torsional pendulum – Cantilever – loaded at the free end – loaded uniformly.


**Unit IV: Bending of Beams**
Bending of beams – Expression for bending moment – Uniform bending – Determination of Young’s modulus by Uniform and Non Uniform bending using pin and microscope – Cantilever – Expression for depression at loaded end of cantilever

**Unit V: Flow of liquids**

**Surface Tension**: Definition and dimensions of surface tension – Angle of contact at liquid-solid interface – Rise of liquid in capillary tube – Experimental determination of surface tension.

**Text Books**

**Reference Books**

**10PH203 THERMODYNAMICS AND STATISTICAL MECHANICS**

**Credit**: 4:0:0

**Course Objectives**:
- To learn about the different laws in thermodynamics
- To know the basic principles of statistical mechanics
- To learn the application of thermodynamics of a wide variety of physical systems

**Course Outcome**
Students can acquire skill in the basic principles of thermodynamics & statistical mechanics and its application to realistic problems.

**Unit I : Laws of Thermodynamics**


**Unit II : Statistical Basis of Thermodynamics**

Statistical basis – Probability – Probability and frequency – Basic rules of probability theory – Permutations and combinations - Macrostate and microstate – Thermodynamic probability – Fluctuations and their dependence on n - Constraints on a system – static and dynamic system – Life time of a Microstate and Macrostate – Concept of a cell in a component

**Unit III : Universal Laws in Statistical Mechanics**


**Unit IV : Phase Transitions in Statistical Mechanics**

General remarks on the problem of phase transitions – Non ideal classical gas – Calculation of partition function for low densities – Equation of state and virial coefficients – The Vander – Waal’s equation – Phase transitions of the second kind – ferromagnetism

**Unit V : Quantum Statistics:**


**Text Books**


**Reference Books**


**10PH204 OPTICS AND PHOTONICS**

Credit: 4:0:0
Course Objectives:

- To impart basic knowledge pertaining to optics, this will help the students to understand about the working principles of the optical instruments.
- Understanding of LASER and fiber optics will help to study the behavior of materials.
- Nonlinear optics and photonics help to understand the special optical characteristics of materials

Course Outcome:

- The students will be able to study the optical characteristics of materials with the basic knowledge about the instruments used.

Unit I: Geometrical optics
Refractive index, optical path, total internal reflection, refraction at a concave surface, lenses, refraction through a lens, effective focal length of two thin lenses separated by a finite distance, power of a lens, spherical and chromatic aberrations, condition for achromatism of two thin lenses separated by a finite distance, Huygens eyepiece and Ramsden eyepiece.

Unit II: Interference
Nature of light, Huygens principle, phase difference and path difference, Young’s double slit experiment, analytical treatment of interference, interference fringes, Fresnel’s biprism, thin film interference(reflected light), wedge shaped thin films, Newton’s rings, Michelson interferometer, thickness and wavelength measurements using Michelson interferometer.

Unit III: Diffraction and Polarization
Fresnel and Fraunhoffer diffractions, Fraunhoffer diffraction at double slits, Fraunhoffer diffraction at many slits, plane diffraction grating, wavelength using grating, Polarization, Brewster’s law, double refraction, Nicol prism, elliptically and circularly polarizes light, quarter wave plate, half wave plate, Babinets compensator, dichroism, optical activity.

Unit IV: Laser and Nonlinear optics
Introduction to nonlinear optics, second, third and higher harmonic generation, four wave mixing, parametric oscillators, birefringence.

Unit V: Photonics and Fibre Optics
Introduction to photonics, concept of photon, photon statistics, interaction of photons and atoms, Propagation mechanism in optical fibers, acceptance angle, numerical aperture, fractional index, types of optic fibers and modes of propagation, Attenuation, Application in communication.

Text books
2. Textbook of optics, N. Subrahmanyam and Brijlal, chand publications, 1985
4. An Introduction to Fiber optics, Ghatak and Thyagarajan, 1998
Reference books
3. The Elements of Fiber Optics, S L Wymer Meardon, Prentice Hall, 1993

10PH205 VACUUM AND THIN FILM TECHNOLOGY

Credit: 4:0:0

Course Objectives
- This course introduces students to the theory and practice of high vacuum systems as well as thin film deposition
- Students will study the physical behaviour of gases and the technology of vacuum systems including system operation and design.
- To learn the Thin film deposition techniques including evaporation and sputtering techniques

Course Outcome
- Students understand the application of thin film technologies in fabricating optical coatings such as mirror, antireflective, and dielectric filter coatings

Unit I: Properties of gases at low pressures
Introduction - The concept of vacuum - degrees of vacuum - Gas Pressure – unit of measurements - velocity distribution of gas molecules – energy distribution.

Unit II: Pumps and pumping systems

Unit III: Measurement of Vacuum

Unit IV: Thin Film Growth Process

**Unit V: Thin Film Deposition Techniques**

**Text Books**

**Reference Books**

**10PH206 PROPERTIES OF MATTER - LAB**

*Credit: 0:0:2*

**Course Objective:**
- To equip the students with practical knowledge in properties of matter experiments

**Course outcome:**
- Demonstrate the practical skills in measurements and instrumentation techniques of some properties of matter experiments.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

**10PH207 HEAT AND OPTICS LAB**

*Credit: 0:0:2*

**Course Objectives:**
- To train the students on Heat and Optics experiments to understand the basic concepts.
• To equip the students with practical knowledge in heat and Optics experiments

Course outcome:
• Demonstrate the practical skills in measurements and instrumentation techniques of some Heat and Optics experiments.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

10PH301 ELECTROMAGNETISM

Credit: 4:0:0

Course Objectives:
The course aims to provide
• To learn the basics of electricity and magnetism and equations governing them.
• To acquire knowledge of fundamentals of magnetism
• To know the Maxwell’s equations
• To learn about the electromagnetic waves.

Course outcome:
• Students can know about the use the fundamental concept of electricity and magnetism in day to day life

Unit I : Fundamentals of electromagnetism

Unit II: Boundary value problems in electrostatics
Method of images – Point charge in the presence of grounded conducting sphere – Point charge in the presence of charged, insulated, conducting sphere – Point charge near a conducting sphere at fixed potential – Green function for the sphere, general solution for the potential – Orthogonal functions and expansions – Laplace equations in spherical coordinates – Legendre equations and Legendre polynomials – Addition theorem for spherical harmonics – Multipole expansions – Boundary value problem with dielectrics

Unit III : Magnetism
Theories of magnetic field, magnetic induction – Biot Savart Law - Faraday’s laws – flux density, field strength and magneto motive force – Ampere’s law – energy stored in a magnetic field – volume distribution of current and Dirac Delta – magnetic vector potential – Analogies between electric and magnetic fields – equation of continuity for time varying fields – inconsistency of Ampere’s law

Unit IV : Maxwell’s equations, and conservation laws
Maxwell’s displacement current – Maxwell’s equations – Vector and scalar potentials – Gauge transformations – Lorentz Gauge – Coulomb Gauge – Green functions for wave equations – Derivations of the equations of macroscopic electromagnetism – Poynting’s theorem and conservation of energy and momentum for a system of charged particles and...
electromagnetic fields – Poynting’s theorem in linear dissipative media with losses – magnetic monopoles – Discussion of Dirac quantization conditions

**Unit V: Electromagnetic Waves**
Solution for free space conditions – wave equation of a conducting medium – conductors and dielectrics – Poynting’s theorem – interpretation of $E \times B$ – average and complex Poynting Vector – power loss in a plane conductor
Waves between parallel planes – transverse electric and magnetic waves, characteristics – Bessel function – wave impedance and characteristic impedance – charged particle equation of motion – force and energy – wave propagation in plasma – equivalent volume and surface integrals – frequency response of dielectric materials

**Text Books**

**Reference Books**

10PH302 QUANTUM PHYSICS

**Credit:** 4:0:0

**Course Objectives:**
The course aims to provide
- Basic understanding of quantum theory
- To learn about the formulation of quantum mechanics
- To learn about the solutions of Schrödinger equations in one dimensional problems
- To gain knowledge on the approximation method used for solving stationary states problems

**Course outcome:**
- Execute the use of quantum theory to various problems in atomic and molecular scale

**Unit I Quantum Theory**

**Unit II: Formulation of Quantum Mechanics**
Schrödinger wave equation –Time independent and time dependent equations – Physical Interpretation of Wave Function– Normalisation of wave function- Expectation values -
Probability current density -- Operator formalism – Eigenvalues and Eigenfunctions-
Linear vector spaces -- Dirac’s Bra and ket notations.

Unit III : Some Applications
Solutions to square well potential – Energy levels for one dimensional square well potential – Infinitely high sides, finite sides, a single step barrier, finite potential barrier – Tunnel effect, Bloch waves in a periodic potential, Kronig –Penny periodic potential

Unit IV : Approximation Methods for Stationary States

Unit V: Angular Momentum and Time Dependent Perturbation

Text Book:

Reference Books:

10PH303 CONDENSED MATTER PHYSICS

Credit: 4:0:0

Course Objectives:
• The course aims to provide fundamental physics behind different materials we commonly see in the world around us.
• To study the materials and their properties using different theoretical and experimental methods.
• The class will demonstrate the link between microscopic structure and bulk properties in a variety of systems in hard and soft condensed matter.

Course outcome:
• The students will be able to understand how different kinds of matter are described mathematically and how material properties can be predicted based on microscopic structure.

Unit I: Conducting materials
Introduction, Free electron theory of solids, Electron energies in metals and Fermi energy, Density of states, Band theory of solids, Effective mass of electron and concept of hole, Expression for electrical conductivity of conductors, Different types of conducting materials-zero resistivity, low resistivity and high resistivity materials.
Unit II: Semiconducting materials
Introduction, Structure and bonding in elemental, compound semiconductors, direct and indirect bandgap semiconductors, Intrinsic and extrinsic semiconductors, carrier concentration in n-type semiconductors and variation of Fermi level with temperature and concentration of donor atoms and carrier concentration in p-type and variation of Fermi level with temperature and concentration of donor atoms semiconductors, Hall effect and its applications.

Unit III: Superconducting materials
Superconductors-mechanism of superconductors, Effects of magnetic field, Meissner Effect, Thermal properties, Type I and Type II Superconductors, London Equations, BCS theory, Quantum tunnelling, Josephson’s Tunneling, Theory of DC Josephson Effect, New superconductors.

Unit IV: Dielectric Properties
The Microscopic concept of polarization, Internal field or local field in liquids and solids, Clausius mosotti relation, Ferroelectricity, Dipole theory of ferroelectricity, piezoelectricity, properties of dielectrics in alternating fields, the complex dielectric constants and dielectric loss, effects of dielectrics.

Unit V: Magnetic Properties
Quantum theory of Paramagnetism, Paramagnetism of ionic crystals, Rare earth ions Ferromagnetism, Weiss theory, Temperature dependence of magnetism, Exchange interaction, Ferromagnetic domains surfaces, Bloch Wall, Antiferromagnetism, Molecular field theory, Neel temperature, Ferrimagnetism.

Text Books
1. Introduction to Solid State Physics – Charles Kittel. 7th edition 2000

Reference Books
2. Complete guide to semiconductor devices – Kwok Kwok Ng, 2nd Edition 2002

10PH304 NANODEVICES

Credit: 4:0:0

Course objectives:
When a student completes this course, she/he should understand nanotechnology by being able to:

- Recognize state of the art developments in the field of nanotechnology; be knowledgeable in common themes across nano based sensors and devices
- Understand the basic concepts of the quantum confinement in nano device fabrication and the working of such devices.
- Be knowledgeable in the various modern technologies used in nano devices and sensors.
• Be knowledgeable in Semiconductor based, bio based and Photonics based sensors and its electronic properties of such nanostructure devices.
• Explain the effect of the reduced dimensionality on the electronic charge transport.

Course Outcome
• The students understands the operating principle of various nanodevices and its single atom manipulation

Unit I: Electronic Nanodevices
Background, Quantum layers, dots and wires, Electronic level modification of 0D, 1D, 2D - Quantization of resistance, Esaki and resonant tunneling diodes, Mott-wannier excitons - molecular electronics, information storage, molecular switching, Schottky devices.

Unit II: Quantum Structures and Devices.

Unit III: Micro and nano-sensors
Fundamentals of sensors, biosensor, micro fluids, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry

Unit IV: Sensor for bio-medical applications
Cardiology, Neurology and as diagnostic tool, Biosensors. Clinical Diagnostics, generation of biosensors, immobilization, characteristics, applications, conducting Polymer based sensor, DNA Biosensors, optical sensors. Biochips

Unit V: Magnetic Nanodevices
Magnetoresistance, Spintronics, MEMS and NEMS - Fabrication, Modeling Applications MEMS and NEMS, Packaging and characterization of sensors, Method of packaging at zero level, dye level and first level Sensors. Photonic Nanodevices-Semiconductor quantum dots, Photonic crystals, Metamaterials

Text Books:
2. Between Technology & Science: Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.

Reference Books
1. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)
5. MEMS & MOEMS Technology and Applications- P. Rai Choudhury
6. Processing Technologies- Gandhi
10PH305 NANO PHYSICS LAB

Credit: 0:0:4

Course Objectives:
- Train the students to operate advanced equipments and to understand the basic concepts of Nanotechnology
- To equip the students with practical knowledge about Nano Materials

Course outcome:
- Demonstrate the practical skill on measurements and instrumentation techniques of some Nano physics experiments.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

10PH306 RADIATION PHYSICS

Credit: 4:0:0

Course Objectives
- To review the basic physics principles of atomic and nuclear physics
- To study the basics of radiation physics and interaction of radiation with matter
- To know about the basic counting statistics, calibration and methods of measuring radiation
- To understand the sources of radiation in the environment and their applications

Course Outcome
- The students will become familiar with the basics of radiation physics and their sources in the environment and their applications and their methods of detection.

Unit I: Review of Physical Principles

Unit II: Radioactivity and interaction of radiation with matter
Unit III: Methods of measuring radiation

Unit IV: Counting statistics and calibration of instruments

Unit V: Radiation in the environment and their applications

Text Books

Reference Books
2. Introduction to Health Physics, Herman Cember, Pergamon Press, 1976

10PH307 SPECTROSCOPY

Credit: 4:0:0

Course Objectives
- To learn the atomic and molecular structure.
- To understand the different Spectroscopic techniques
- To know the application of spectroscopic techniques

Course Outcome
- Students can understand the usage of different spectroscopic techniques to determine the molecular structure and constants.

Unit I: Atomic And Molecular Structure

Unit II : Infrared And Microwave Spectroscopy

Unit III : Raman Spectroscopy
Absorption and emission of radiation - Einstein Coefficients – Classical and Quantum theory of Raman Scattering – Rotational Raman spectra : Linear, symmetric top, spherical and asymmetric top molecules – Vibrational Raman spectra – Experimental techniques: Raman spectrometer, Fiber coupled Raman spectrometer, – Molecular structural studies.

Unit IV : Resonance Spectroscopy - I
Transform NMR– ESR: Principle – Basic requirements of X-Band ESR - Balanced bridge ESR Spectrometer

Unit V : Resonance Spectroscopy - II

Text Book:

Reference Books:
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson
10PH308 NANOFLUIDS

Credit: 4:0:0

Course Objectives

- To know the basics of nanofluids
- To learn the nanofluid synthesis methods
- To understand the basics of conductive and convective heat transfer
- To learn the application of nanofluids

Course Outcome

- Students can understand the basics and industrial application of nanofluids

Unit I: Introduction to Nanofluids


Unit II: Synthesis of Nanofluids


Unit III: Conduction Heat Transfer in Nanofluids


Unit IV: Convection in Nanofluids


Unit V: Pool Boiling and Application of Nanofluids

Fundamentals of Boiling : Nukiyama curve - Nucleate boiling –Experimental study of Pool Boiling of Water-Al₂O₃ Nanofluids – Applications of nanofluids: Vehicle cooling , Transformer cooling, Biomedical applications

Text Book:


Reference Books:


**10PH309 COMPUTATIONAL PHYSICS**

**Credit:** 3:0:0

**Course Objectives**
- To learn Curve fitting, Modeling data and partial differential equations
- To know the basics of Matlab

**Course Outcome**
- Students can apply the numerical methods to solve scientific problems and able to solve the problems using Matlab programming.

**Unit I: Solutions of nonlinear equations and minimization of functions.**

**Unit II: Modeling data: Interpolation and fitting**
Lagrange and Newton interpolation methods, divided difference table, Least squares regression, Linear, multiple linear and nonlinear regressions

**Unit III: Numerical differentiation and Integration**
Divided difference method for differentiation, Newton-Cotes formula, Higher order derivatives, Midpoint, Trapezoidal, rectangular and Simpson's rules.

**Unit IV: Solutions of ordinary differential equations**

**UNIT V: Matlab Programming**

**Text Books:**

**Reference Books:**
2. Elementary Numerical Analysis. S. D. Conte and C. de Boor McGraw-Hill College (1972)

PHYSICS
ADDITIONAL SUBJECT

<table>
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<tr>
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<tr>
<td>10PH212</td>
<td>Applied Physics</td>
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10PH201 - ENGINEERING PHYSICS

Credits: 2:0:0

Course Objectives:
- To help to prepare the Engineering students, a stronger foundation in the classical physics and Dynamics of particles
- Greater emphasis through on the role of reference frames in Newton’s laws, force laws
- A clear analysis of the concepts of Heat, Energy and laws of Thermodynamics (quantitatively).
- To provide the understanding of concepts of electricity and magnetism.

Course Outcome:
Student understands the classical portions of the Electricity and Magnetism and special momentum to Electromagnetic introduction.

Unit I Particle Dynamics

Unit II Heat And Thermodynamics
Heat And Work, The First, Second and Third laws Of Thermodynamics, Some Applications

Unit III Magnetism

Unit IV Electrostatics
Electric Field And Electric Intensity, Electrostatic Potential, Gauss’s Theorem, Applications Of Gauss’s Theorem, Mechanical Force Experienced By Unit Area Of A Charged Field, Electrostatic Potential At A Point Due To A Dipole

Unit V : Electromagnetic Induction

Text Books:
2. Electricity & Magnetism, Brijlal & Subramaniam S. Chand and Co 2004
**Reference Books:**

1. University Physics, Sears and Zemansky –Pearson Addison Wesly, 2007
2. Fundamentals of Physics, an introductory course, David G. Martindale, Robert W. Heath, D.C. Heath, Canada, 1987
4. Electricity and Magnetism, William C. Robertson, NSTA press, 2005

**10PH 212- APPLIED PHYSICS**

**Credits: 3:0:0**

**Course Objectives:**
- To help to prepare the Engineering students, a stronger foundation on various topics on physics.
- To provide the understanding of concepts and the application of physical principles.

**Course Outcome:**
Student understands the concepts of matter, wave motion and electricity.

**Unit I Elasticity**

**Moment of Inertia**

**Unit II: Wave Motion**
Simple harmonic motion, equation of motion of SHM, velocity of wave on a string, standing waves, Laws of transverse vibration of a string on Melde’s string, Transverse and longitudinal waves, interference and principle of superposition, Newton’s Rings, Polarization of waves – Polarizer and analyzer.

**Unit III: Acoustics and Ultrasonics**

**Ultrasonics**
- Introduction - ultrasonic production- Magnetostriction and piezoelectric methods, Applications - Acoustic grating, SONAR, NDT, Ultrasonic scanner.

**Unit IV: Lasers**

**Unit V: Electricity**
Electric current and charge density, Drift speed, Ohm’s law, temperature dependence of resistivity, battery and emf, energy transfer in an electric circuit, Kirchhoff’s laws,
combination of resistors in series and parallel, Applications – Carey Foster bridge, potentiometer.

**Text Books:**

**Reference Books**
DEPARTMENT
OF PHYSICS
## ADDITIONAL SUBJECTS

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<td>10PH209</td>
<td>Introduction to Magnetism and Electromagnetism</td>
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<td>10PH210</td>
<td>Condensed matter Physics</td>
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<td>10PH211</td>
<td>Vacuum and Thin film Technology</td>
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<tr>
<td>10PH310</td>
<td>Particle Physics</td>
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### 10PH208 QUANTUM PHYSICS

**Credit: 4:0:0**

**Course Objective:**
The course aims
- To provide basic understanding of quantum theory
- To learn about the formulation of quantum mechanics
- To learn about the solutions of Schrödinger equations in one dimensional problems
- To gain knowledge on the approximation method used for solving stationary states problems

**Course outcome:**
- Execute the use of quantum theory to various problems in atomic and molecular scale

**Unit I: Quantum Theory**
Introduction to Quantum theory of Radiation and Photons, Wien’s Radiation Law & Rayleigh Jean’s Law- Important application of Quantum theory of Radiation- Photo-electric effect- Compton effect- Bohr’s theory of atomic structure.

**Unit II: Waves and Particles**

**Unit III: Formulation of Quantum Mechanics**
Schrödinger wave equation –Time independent and time dependent equations – Physical Interpretation of Wave Function– Normalisation of wave function- Expectation values - Probability current density – Eigenvalues and Eigenfunctions

**Unit IV: Eigenvalue Problems**
Solutions to square well potential – Energy levels for one dimensional square well potential – Infinitely high sides, finite sides, a single step barrier, finite potential barrier – Tunnel effect. Linear Harmonic Oscillator

**Unit V: Applications in Nano Science**
Applications of low-dimensional semiconductor structures, confined states in quantum wells, wires and dots, density of states in quantum wells, wires and dots, quantum Hall effect, semiconductor laser actions

Text Book:

Reference Books:
4. Quantum theory of solids Eoin P. O'Reilly CRC Press 2002

10PH209 INTRODUCTION TO MAGNETISM AND ELECTROMAGNETISM

Credit: 4:0:0

Course Objective:
The course aims
- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell’s equations
- To learn about the electromagnetic waves.

Course outcome:
- Students can know about the use the fundamental concept of electricity and magnetism in day to day life

Unit I : Magnetic Field and Magnetic Forces
Magnetism – Magnetic Field – Magnetic field lines and magnetic flux – Motion of charged particles in a magnetic field – Thomson’s measurement of e/m – Applications of motion of charged particles – Magnetic force on a current carrying conductor – Force and torque on a current loop – The direct current motor – The Hall effect

Unit II : Sources of magnetic field

Unit III : Electromagnetic Induction

Unit IV: Maxwell’s equations, and conservation laws
Maxwell’s displacement current – Maxwell’s equations – Vector and scalar potentials – Gauge transformations – Lorentz Gauge – Coulomb Gauge – Green functions for wave equations – Derivations of the equations of macroscopic electromagnetism – Poynting’s theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields – Poynting’s theorem in linear dissipative media with losses – magnetic monopoles – Discussion of Dirac quantization conditions

Unit V: Electromagnetic Waves
Maxwell’s equations and the wave equations for electromagnetic waves – Plane electromagnetic waves and the speed of electromagnetic waves – Energy in electromagnetic waves – Momentum in electromagnetic waves – Speed of light – Electromagnetic waves in matter – Sinusoidal electromagnetic waves – Standing electromagnetic waves – Radiation from an antenna

Text Books

Reference Books

10PH210 CONDENSED MATTER PHYSICS
Credit: 4:0:0

Course Objective:
- The course aims to provide fundamental physics behind different materials we commonly see in the world around us.
- To study the materials and their properties using different theoretical and experimental methods.
- The class will demonstrate the link between microscopic structure and bulk properties in a variety of systems in hard and soft condensed matter.

Course outcome:
- The students will be able to understand how different kinds of matter are described mathematically and how material properties can be predicted based on microscopic structure.
Unit I: Conducting materials
Introduction, Free electron theory of solids, Electron energies in metals and Fermi energy, Density of states, Band theory of solids, Effective mass of electron and concept of hole, Expression for electrical conductivity of conductors, Different types of conducting materials- zero resistivity, low resistivity and high resistivity materials.

Unit II: Semiconducting materials
Introduction, Structure and bonding in elemental, compound semiconductors, direct and indirect bandgap semiconductors, Intrinsic and extrinsic semiconductors, carrier concentration in n-type semiconductors and variation of Fermi level with temperature and concentration of donor atoms and carrier concentration in p-type and variation of Fermi level with temperature and concentration of donor atoms semiconductors, Hall effect and its applications.

Unit III: Superconducting materials
Superconductors-mechanism of superconductors, Effects of magnetic field, Meissner Effect, Type I and Type II Superconductors, BCS theory, Quantum tunnelling, Josephson’s Tunneling, Theory of DC Josephson Effect, New superconductors, Applications - Superconducting magnets, Levitated trains.

Unit IV: Dielectric Properties
The Microscopic concept of polarization, different polarization mechanisms, Internal field or local field in liquids and solids, Clausius mosotti relation, properties of dielectrics in alternating fields, the complex dielectric constants and dielectric loss, effects of dielectrics.

Unit V: Magnetic Properties
Introduction- magnetic permeability, magnetization, electric current in atoms( Bohr Magneton), magnetic moment due to electron spin and nuclear spin, Types of Magnetic materials ( dia, para, ferro, antiferro & ferrimagnets), Temperature dependence of magnetism, ferromagnetic domain theory, Bloch Wall, Neel temperature.

Text Books

Reference Books
2. Complete guide to semiconductor devices – Kwok Kwok Ng, 2nd Edition 2002

10PH211 VACUUM AND THIN FILM TECHNOLOGY
Credit: 4:0:0

Course Objectives
• This course introduces students to the theory and practice of high vacuum systems as well as thin film deposition
• Students will study the physical behaviour of gases and the technology of vacuum systems including system operation and design.
• To learn the Thin film deposition techniques including evaporation and sputtering techniques

Course Outcome
• Students understand the application of thin film technologies in fabricating optical coatings such as mirror, antireflective, and dielectric filter coatings

Unit I: Vacuum Pumps and Measurements

Unit II: Thin film coating techniques
Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electro plating- potentiostat, galvanostat, sol gel coating, LASER ablation, spray pyrolysis. Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, electrical conductivity Substrate cleaning, buffer layer, metallization.

Unit III: Growth process
Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch

Unit IV: Structural, Optical and electrical studies on thin films

Unit V: Langmuir- Blodgett Films
Monolayer materials ( dyes, Polymers) – Mixed monolayers – Film deposition: deposition principles, first layer effects and epitaxy, defects – Experimental techniques, post deposition treatments - structure of multilayer films: organization in long-chain materials.

Text Books
3. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D.
Reference Books
6. An Introduction to Physics and Technology of Thin Films

10PH310 PARTICLE PHYSICS
Credit : 4:0:0

Course Objective:
- To obtain knowledge on fundamental particles and the fundamental interaction.
- To understand the working principle of accelerators.

Course Outcome:
Students can apply their knowledge on particles and accelerators to solve theoretical and practical problems.

Unit I : Introduction To Particle Physics

Unit II : Particle Accelerators
Unit III: Elementary Particle Dynamics
The four forces – Quantum Electrodynamics – Quantum Chromodynamics – Invariance principles and conservation laws – Invariance in classical mechanics and in quantum mechanics – Parity – Pion Parity – Charge Conjugation – Positronium decay – Time Reversal invariance – CPT Theorem – Symmetries, groups and conservation laws – Angular momentum – Addition of angular momentum – spin \( \frac{1}{2} \) - Flavor symmetries – Discrete symmetries – Symmetry groups – \( O(3), SU(2), SU(3), \) and \( SU(6) \)

Unit IV: Relativistic Kinematics

Unit V: The Four Fundamental Interactions

Text Books

Reference Books
1. Introduction to particle physics, M.P.Khanna, New Delhi: Prentice-Hall of India
3. Introduction to Unitary Symmetry :Lichtenberg (Addison Wesley, Reading)
## ADDITIONAL SUBJECTS
for M.Sc Elective, M.Phil, Ph.D and B.Tech Programs

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<td>Introduction to Nano Structured Materials</td>
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### 11PH201 APPLIED PHYSICS

**Credits 3:0:0**

**Course Objective:**
Students will be able to
- Get knowledge on the basic concepts of quantum mechanics and its applications
- Understand the working principle of various lasers and its application in fibre optics
- Study the principles of acoustics and applications of ultrasonic waves
• Get more knowledge on engineering materials and its applications

Course Outcome:
Students applies physics principles of latest technology to solve practical problems of real world

Unit I: Quantum Physics
Shrodinger’s time independent wave equation , Applications: particle in a box, Zero point energy and overtones, SEM and its applications

Unit II : Lasers

Unit III: Fibre optics
Principle of optical fibre-Propagation in optical fibres-Acceptance angle-Numerical aperture- V number, Structure of optical fibres- -Types of optical fibres based on material, mode and refractive index, Attenuation, Applications-Optical fibres for communication-Fibre optic sensors-Temperature sensor, Fibre endoscope.

Unit IV: Acoustics and Ultrasonics
Classification of sound, Characteristic of musical sound-Loudness- Weber and Fechner’s law- Decibel- Absorption coefficient- Reverberation time-Sabines formula(No derivation),Factors affecting acoustics of buildings and their remedies
Ultrasonics-classification of ultrasonic waves-properties of ultrasonic waves- ultrasonic production- Magnetostriction and piezoelectric methods, Acoustic grating, SONAR, NDT.

Unit V: Materials
Solar cells-Light emitting diodes-Liquid crystal display, Superconductors-Miessner effect, Type I and Type II superconductors, Superconducting magnets, SQUIDS

Text Book:

Reference Books:
5. G.Aruldhas, Engineering Physics, PH1 Learning, 2010
11PH202 - ENGINEERING PHYSICS

Credits: 2:0:0

Course Objectives:
• To help to prepare the Engineering students, a stronger foundation in the classical physics and Dynamics of particles
• Greater emphasis on the role of reference frames in Newton’s laws, force laws
• To provide the understanding of concepts of oscillations, waves and electric fields.
• A clear analysis of the concepts of Heat, Energy and laws of Thermodynamics (quantitatively)

Course Outcome:
Student understands and applies knowledge on Newtonian mechanics, waves and electric field concepts to practical problems. Students will accomplish problem solving skills along with the ability to apply mathematics related to mechanics, waves and fields

Unit I: Newtonian mechanics
Newton’s first law, force, mass, Inertial reference frames Newton’s second law, a free body diagram, some particular forces - gravitational force, normal force, frictional force, tension, Newton’s third law, problems applying Newton’s laws

Unit II: Oscillations
Simple harmonic motion, Linear oscillator, energy, torsion pendulum, simple harmonic motion and uniform circular motion, damped harmonic motion in forced oscillations and resonance

Unit III: Waves
Transverse and longitudinal waves, sinusoidal wave, equation of a travelling wave, wave speed on stretched string, superposition of waves, interference of waves, phasors, standing waves, melodies’ string experiment

Unit IV: Heat
Temperature, heat capacity and specific heat, heat of transformation, work associated with volume change, first law of thermodynamics, application of first law, one way processes, calculation entropy change, second law of thermodynamics

Unit V: Electric fields
Electric field, field due to a point charge, field due to an electric dipole, force on a point charge in an electric field, Millikan oil drop experiment, ink jet printing, Gauss law, application of Gauss’s law, electric potential, equipotential surfaces

Text Book

Reference Books:
1. University Physics, Sears and Zemansky – Pearson Addison Wesly, 2007
3. Fundamental of Physics, Allan Giambattista, Betty McCarthy Richardson, Robert C Richardson, Tata McGraw Hill Education Private Limited, 2008

11PH203 ASTROPHYSICS
Credits 2:0:0

Course Objectives:
- To give the students an awe inspiring idea about our space and its surroundings
- To provide with a fundamental understanding about the stars and their properties
- The students will have a firsthand knowledge of the instruments used to explore the cosmos
- To give an overview of the giant scale structure of the universe such as galaxy and clusters of galaxies
- To know about the origin and fate of the universe

Course Outcome:
The students will become clear about our cosmic surroundings, the processes that take place in it, and the forces that control it and their origin and their fate.

Unit I: The Solar System (Fundamental Ideas)

Unit II: The Stars

Unit III: Telescopes and Detectors

Unit IV: The Milky Way Galaxy
Interstellar Matter - The Shape and Size of the Galaxy – The Rotation and Spiral Structure of Galaxy – The Center of Galaxy – Stellar Populations – Different types of Galaxies – The Cosmological Distance Scale

Unit-V: The Universe

Text Books:

Reference Books:
11PH204 INTRODUCTION TO NANOSTRUCTURED MATERIALS

Credits 3:0:0

Course Objectives:
• To understand the concept of nanoscale materials
• To learn the electrical, magnetic mechanical and optical properties of nanostructured materials
• To know about the methods used for synthesis of nanoscale materials
• To expose the students to the nano devices

Course Outcome:
Students can understand the importance of nanostructured materials and their properties and applications

Unit I: Introduction to Nano

Unit II: Electrical and magnetic properties
Electronic and electrical properties-One dimensional systems-Metallic nanowires and quantum conductance -Carbon nanotubes and dependence on chirality -Quantum dots -Two dimensional systems -Quantum wells and modulation doping -Resonant tunnelling -Magnetic properties Transport in a magnetic field -Quantum Hall effect. -Spin valves -Spin-tunnelling junctions -Domain pinning at constricted geometries -Magnetic vortices

Unit III: Mechanical and Optical Properties
Mechanical properties -Individual nanostructures -Bulk nanostructured materials-Ways of measuring -Optical properties -Two dimensional systems (quantum wells)-Absorption spectra -Excitons -Coupled wells and superlattices -Quantum confined Stark effect

Unit IV: Fabrication of nanoscale materials:

Unit V: NanoDevices
Nanodevices Background -Quantization of resistance -Single-electron transistors -Esaki and resonant tunneling diodes -Magnetic Nanodevices -Magnetoresistance --Spintronics-MEMS and NEMS

Text Book:
Introduction to Nanotechnology, Charles P.Poole, Jr. and Frank J.Owens, Wiley, 2003

Reference Books:
2. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004

11PH205 NANO PHYSICS LAB
Course Objectives:
Students will be able
- To get practical skill on various deposition techniques to prepare thin films and grow crystals having nanostructures
- Get practical training on some basic characterization techniques of nanostructure thin films and crystals

Course Outcome:
The student will be able to:
- Apply the practical knowledge to fabricate novel nano devices to solve research problems
  1. Synthesis of nano materials by vacuum deposition method
  2. Synthesis of nanoparticles by chemical method
  3. Laser particle size analyzer
  4. Spray deposition
  5. Spin Coating
  6. Electro deposition
  7. Electro spinning method
  8. Growth of single crystals from melt
  9. Growth of single crystals from solution
  10. Growth of single crystals from vapour
  11. Spectra of atoms and molecules
  12. LASER particle analyzer
  13. XRD analysis
  14. UV- visible spectrophotometer

11PH301 CLASSICAL MECHANICS

Course Objectives:
Students will be able
- To increase in the conceptual understanding of classical mechanics and develop their problem solving skills
- To gain more experience and increased ability with the mathematics associated with Classical Mechanics

Course Outcome:
The student will be able to:
- Apply the techniques and results of classical mechanics to real world problems
- Effectively communicate problems and their solutions relevant to classical mechanics
- Apply physics principles to novel situations

Unit I : Mechanics of a System of Particles
Constraints – Generalized co-ordinates – D’Alembert’s principle and Lagrange’s equations, Non-conservation force-Rayleigh’s dissipation function. Hamilton’s Principle – Calculus of
variation, Deduction of Largrange’s equations from Hamilton’s Principle, applications of Lagrange’s equation of motion

Unit II : The Two Body Central Force Problem

Unit III : The Kinematics of Rigid Body Motion
The independent coordinates of a rigid body – orthogonal transformations – The Euler Angles – Symmetric top – Rate of change of a vector – angular velocity vector in terms of the Euler angles.

Small Oscillation
Formulation of the problem – Eigen value equation and the principal axis transformation – frequencies of free vibration – Triatomic molecule.

Unit IV : The Hamilton Equations Of Motion
Legendre Transformations and the Hamilton equation of motion – Cyclic coordinates – Routh’s procedure and oscillations about steady motion – Derivation of Hamilton’s equations from variational principle – The equations of canonical transformation – Examples of canonical transformation, Poisson brackets, invariance of Poisson brackets with respect to canonical transformation

Unit V Hamiltonian-Jacobi Theory
Hamilton-Jacobi equations for principle function-Harmonic Oscillator problem as an example of the Hamilton-Jacobi method-Hamilton-Jacobi equation for Hamilton’s characteristic function- Actions angle variables in the Systems with one degree of freedom- The Kepler Problem in action angle variables- Hamilton-Jacobi Theory, Geometrical Optics and Wave Mechanics

Text Books:

Reference Books:

11PH302 STATISTICAL MECHANICS AND THERMODYNAMICS

Credits: 4:0:0
Course Objectives:
- To derive mathematical relations which connect different experiment properties of macroscopic systems in equilibrium systems containing many molecules.
- To provide the molecular theory or interpretation of equilibrium properties of macroscopic systems

Course Outcome:
- Students will understand the laws of thermodynamics and their consequences.
Students will know about the applications of Statistical mechanics and phase transitions in statistical mechanics

Unit I: Review of the Laws of Thermodynamics and their Consequences

Unit II: Statistical Description of Systems of Particles

Unit III: Simple Applications of Statistical Mechanics


Unit IV: Quantum Statistics of Ideal Gases

Unit V: Phase Transitions in Statistical Mechanics

Text Book:

Reference Books:

11PH303 MATHEMATICAL PHYSICS I

Credits 3:1:0

Course Objectives:
• To review the basics of vector analysis and move on to the advanced level treatment of Vectors
• To give the students enough problems in matrices so as to prepare them for competitive exams
• To impart on the students the elementary knowledge about Tensors
• To enable the students to solve the first and second order differential equations and have a sound knowledge about special functions
• To give an basic understanding about the theory of probability and theory of errors.

Course Outcome:
The students will be enabled to write all the competitive exams containing Mathematical Physics as a part of their syllabus. They will be imparted with a good understanding of fundamentals of Maths which will be essential for advanced level physics.

Unit I: Vector Analysis

Unit II: Matrices

Unit III: Tensor Analysis

Unit IV: Second order linear differential equations and special functions
Ordinary differential equations of second order – Problems from physics – Partial Differential Equations – Legendre Differential equation, generating functions and polynomials – orthogonality of Legendre’s Polynomials - Bessel’s equation, generating functions and polynomials – Hermite Equation, functions and polynomials – Laguerre equation and polynomials with properties

Unit V: Probability and Theory of errors
Text Books:

Reference Books:

11PH304 ELECTRONICS

Credits: 4:0:0
Course Objectives:
• To learn about the different semiconductor devices
• To understand the concept of manufacturing of resistors, diodes, capacitors and inductors in a chip for various applications
• To get a knowledge about the operational amplifiers and to know the architecture and functioning of 8086 microprocessor
• To acquire the knowledge about the Boolean algebra and different memories

Course Outcome:
Students will learn about the semiconductor devices, IC manufacturing, different types of operational amplifiers, microprocessors and Boolean theorems.

Unit I: Semiconductor Devices

Unit II: Fabrication of Integrated Circuits
Integrated circuit technology - Basic monolithic integrated circuits - epitaxial growth - masking and etching – Diffusion of impurities – Monolithic diodes, integrated resistors, integrated capacitors and inductors - monolithic circuit layout - additional isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI) – The metal semiconductor contact.

Unit III: Linear Integrated Circuits

Unit IV: Microprocessor
Buffer register, Bus organized computers, Microprocessor (μP) 8086 Architecture, memory interfacing, interfacing I/O devices, Assembly language programming: Instruction classification, addressing modes, op code and openand, fetch and execute cycle, timing diagram, machine cycle, instruction cycle and T states - Programming examples

Unit V: Digital Electronics

Academic Information
Boolean Algebra – Demorgan Theorem Arithmetic circuits - Karnaugh map simplifications, (synchronous and asynchronous) counters registers – Multiplexures – Demultiplexures memories (EPROM, PROM, S-RAM)

Text Books:

Reference Books:
1. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India, 2009

11PH305 QUANTUM MECHANICS I

Credits 3:0:0

Course Objectives:
Students will be able to
• understand the general formulation of quantum mechanics
• Solve eigenvalue equations for specific physical problems
• Understand the operator concept of angular momentum, ladder operators and applications
• Get knowledge on the theoretical aspects of perturbation of atoms due to electric and magnetic fields
• Understand the theory of many electron systems

Course Outcome:
Students will attain ability to get
• Improved mathematical skills necessary to solve differential equations and eigenvalue problems using the operator formalism
• Quantum mechanical solution of simple systems such as the harmonic oscillator and a particle in a potential well.
• Solutions to perturbation problems and many electron systems

Unit I General formalism of quantum mechanics
Linear Vector Space- Linear Operator- Eigen Functions and Eigen Values- Hermitian Operator- Postulates of Quantum Mechanics- Simultaneous Measurability of Observables- General Uncertainty Relation- Dirac’s Notation- Equations of Motion; Schrodinger, Heisenberg and Dirac representation- momentum representation.

Unit II Energy Eigen value problems
Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom

Unit III Angular Momentum
The document contains a detailed course outline for a course in Quantum Mechanics, covering topics such as orbital angular momentum, spin angular momentum, total angular momentum, commutation relations, ladder operators, matrix representations, and addition of angular momenta. It also includes a section on approximate methods, many-electron atoms, and a section on physical optics.

The text books and reference books are listed at the end of the document, along with the credits and course objectives. The course is divided into units, covering topics such as geometrical optics, superposition of waves, polarization, and interference and diffraction.

Unit V: Fourier Optics
Fourier Transforms- One- and Two-Dimensional Transforms- Dirac Delta Function- Optical Applications- Spectra and Correlation

Text Books:

Reference Book:

11PH307 MATHEMATICAL PHYSICS II
Credits: 3:1:0

Course Objectives:
- To impart a thorough knowledge about elements of complex analysis
- To train the students in Fourier, series and Transforms and enable them to solve physics problems
- To give an understanding about integral Transforms and to understand Green’s function and its applications to physics problems.
- To grasp the idea of group theory and its implications.
- To have a thorough knowledge about numerical methods.

Course Outcome:
The students will be enabled to write all the competitive exams containing Mathematical Physics as a part of their syllabus. They will be imparted with a good understanding of fundamentals of Maths which will be essential for advanced level physics.

Unit I : Complex Variables

Unit II : Fourier Series and Fourier Transforms

Unit III : Laplace Transforms and Green’s Function
Definition of Laplace Transforms – Properties – Laplace transform of special functions - Applications to differential equations and boundary value problems - Definition and
construction of Green’s Function – Symmetry properties – Expression for Green’s functions in terms of eigen functions – Green’s functions for simple second order differential operators.

**Unit IV : Group Theory**

**Unit V : Numerical Methods**

**Text Books:**

**Reference Books:**

**11PH308 SPECTROSCOPY I**

**Credits 3:0:0**

**Course Objectives:**
- To learn the atomic and molecular structure.
- To understand the different Spectroscopic techniques
- To know the application of spectroscopic techniques

**Course Outcome:**
- Students can understand the usage of different spectroscopic techniques to determine the molecular structure and constant

**Unit I: Atomic and Molecular Structure**

**Unit II: Microwave Spectroscopy**
Rotation of molecules- Diatomic Molecules- Intensities of Spectral Lines- Effect of Isotope Substitution- Non-rigid Rotator- Polyatomic Molecules- Techniques and Instrumentation

**Unit III: Infra-red Spectroscopy**
Vibration of Diatomic Molecules- Anharmonic Oscillator- Vibrating Rotator- Vibration-Rotation Spectrum of Carbon Monoxide-Breakdown of Born-Oppenheimer Approximation-Vibration of Polyatomic Molecules- Vibration-Rotation Spectra of Polyatomic Molecules-
Techniques and Instrumentation

**Unit IV: Raman Spectroscopy**
Quantum Theory of Raman Effect- Classical Theory- Molecular Polarizability-Rotational Raman Spectra-Vibrational Raman Spectra-Polarization of Light and Raman Effect- Structural Determination- Techniques and Instrumentation

**Unit V: Electronic Spectroscopy**

**Text Books:**

**Reference Books:**

11PH309 ELECTRO MAGNETIC THEORY

**Credits 4:0:0**

**Course Objectives:**
The course aims to provide
- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell’s equations
- To learn about the electromagnetic waves.

**Course outcome:**
- Students can know about the use the fundamental concept of electricity and magnetism in day to day life

**Unit I: Electro Statics**
Electric field, Gauss Law – Scalar potential – Multipole expansion of electric fields – The Dirac Delta function – Poisson’s equation – Laplace’s equation – Green’s theorem – Uniqueness theorem – Formal solution of electrostatic boundary value problems with Green function – electrostatic potential energy and energy density. Electrostatics in matter- Polarization and electric displacement vector- Electric field at the boundary of an interface- Clausius - Mossotti equation

**Unit II: Magneto Statics**

**Unit III: Time Varying Fields**

**Unit IV: Plane Electromagnetic Waves**
Plane wave in a non conducting medium – Boundary conditions – Reflection and refraction of e.m. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting or dissipative medium.

**Unit V: Electrodynamics**

**Text Books:**

**Reference Books:**

**11PH310 QUANTUM MECHANICS II**

**Credit: 3:0:0**

**Course Objectives:**
Students will be able to
- understand time dependent perturbation theory using quantum mechanics
- get knowledge on theory of scattering and induced emission and absorption of radiation
- Understand the formation of relativistic wave equation
- Get knowledge on the formulation of quantum field theory

**Course Outcome:**
Students will attain ability to get
- Understanding of advanced quantum mechanical concepts on perturbation, scattering and radiation
- Quantum mechanical solution of relativistic problems and quantum fields

**Unit I Time Dependent Perturbation Theory**

**Unit II Scattering Theory** Scattering Amplitude - Expression in terms of Green’s Function - Born Approximation and Its validity- Partial wave analysis - Phase Shifts - Scattering by coulomb and Yukawa Potential.

**Unit III Theory of Radiation (Semi Classical Treatment)** Einstein’s Coefficients-Spontaneous and Induced Emission of Radiation from Semi Classical Theory-Radiation Field

**Unit IV Relativistic Wave Equation** Klein Gordon Equation-Plane Wave Equation-Charge and Current Density-Application to the Study of Hydrogen Like Atom-Dirac Relativistic Equation for a Free Particle-Dirac Matrices -Dirac Equation in Electromagnetic Field - Negative Energy States.

**Unit V Quantum Field Theory** Quantization of Wave Fields- Classical Lagrangian Equation-Classical Hamiltonian Equation - Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations-Quantization of Electromagnetic Field Energy and Momentum.

**Text Books:**
2. Quantum Mechanics – G Aruldhas - Prentice Hall of India 2006

**Reference Books:**
1. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005

**11PH311 NUCLEAR PHYSICS**

**Credits: 4:0:0**

**Course Objectives:**
- To make the students understand the constituent particles and the forces existing inside the nucleus
- To give an idea about the nuclear reaction and nuclear reactors
- To give a brief idea about the elementary particles

**Course Outcome:**
Students will understand about the structure of nucleus and the forces inside the nucleus. They learn about fission and fusion reactions and conditions for the controlled nuclear reaction which are applied in the reactors.

**Unit I : Nuclear Structure**

**Unit II : Nuclear Forces**

**Unit III : Radio Activity**

**Unit IV : Nuclear Reactions**

**Unit V : Particle Physics**
Classification of fundamental forces and elementary particles – Isospin, strangeness – Gell-Mann Nishijima’s formula – Quark model, SU (3) Symmetry, CPT invariance in different interactions parity non conservation – K meson.

**Text Books:**

**Reference Books:**

**11PH312 SPECTROSCOPY II**

**Credits: 3:0:0**

**Course Objectives:**
• To understand the different Spectroscopic techniques
• To know the application of spectroscopic techniques

**Course Outcome:**
• Students can understand the usage of different spectroscopic techniques to the structural and chemical analysis of molecules

**Unit I: NMR Spectroscopy**
NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation – Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and double coil methods – Pulse method

**Unit II: ESR Spectroscopy**
ESR basic principles – High Resolution ESR Spectroscopy – Double Resonance in ESR- ESR spectrometer.

**Unit III: Nuclear Quadruple Resonance Spectroscopy**
Unit IV: Mossbauer Spectroscopy  
Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe$^{2+}$ compounds. Isomer shift, quadruple splitting, hyperfine interaction, instrumentations and applications.

Unit V: Mass Spectroscopy  
Introduction- ion production- fragmentation- ion analysis- ion abundance- common functional groups- high resolution mass spectroscopy- instrumentation and application.

Text Books:

Reference Books:

**Unit IV : Optical Properties**

**Unit V: Super Conductivity**

**Text Book:**
1. Introduction to Solid State Physics- Kittel, John wiley, 8th edition, 2004

**Reference Books:**

**11PH 314 PHYSICS OF NANOMATERIALS**

**Credits 4:0:0**

**Course objectives:**
Students will be able to
- Understand the theoretical concepts of nanomaterials
- Gain knowledge on preparation and characterization techniques
- Get knowledge on bio and other nanomaterials

**Course Outcome:**
Students will be able to
- Apply the knowledge to prepare and characterize novel nanomaterials

**Unit: I Introductory Aspects**

**Unit II: Preparation of Nanomaterials**
Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

**Unit III : General Characterization Techniques**
Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

**Unit IV : Nano Bio**
Nano-fluidics to build silicon devices with features comparable in size to DNA, proteins and other biological molecules; Control and manipulation of microfluidic and nanofluidic
processes for lab-on-a-chip devices. Role of surfaces in nanotechnology devices; surface
reconstruction;dangling bonds&surfaces,Bio-Nano tubes.

Unit V: Other Nanomaterials
Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles,
Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

Text Books:
   (American Chemical Society).
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsoy,
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and

Reference Books:
   Cambridge Univ. Press, 1996
2. Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall
   (MIT Press).1996
3. Physics of Low-Dimension Semiconductors: J.H. Davies ,Cambridge Univ. Press,
   1998.
4. Advances in Solid State Physics (Vo.41) : B. Kramer (Ed.) (Springer), 2003

11PH315 PHOTONICS

Credits: 4:0:0

Course Objectives:
• To learn various processes involving in the development of laser.
• To understand the various applications using lasers
• To know the working and fabrication of optical fibers

Course Outcome:
• Students can understand the fabrication and application of various lasers and optical fiber.

Unit I: Properties of Gaussian Beams
The paraxial wave equation, Gaussian beams, the ABCD law for Gaussian beams, Gaussian
beam modes of laser resonators. Higher order Gaussian beam modes. Diffraction theory of
laser resonators, unstable resonators for high power lasers.

Unit II: Lasers
Quantum theory of laser: Lasers – Einstein A-B Coefficients, round trip gain, matrix method,
He-Ne laser, Ruby, Nd:YAG, Nd:glass lasers, liquid lasers and dye laser amplifiers. Theory of
Qswitching and mode locking process, devices for Q-switching and mode locking, high power
CO2 laser, Ti:Saphire laser. Theory of semiconductor lasers and devices. Laser, Applications:

Unit III: Nonlinear Optics-I
Introduction to nonlinear optics, nonlinear polarization and wave equation, second harmonic
generation, phase matching, three-wave mixing, parametric amplifications, oscillations, tuning
of parametric oscillators, nonlinear susceptibilities, nonlinear susceptibility tensor, nonlinear
materials
Unit IV: Nonlinear Optics-II
Propagation of light through isotropic medium, propagation light through anisotropic medium, theory of electro-optic, magneto-optic and acousto-optic effects and devices, integrated optical devices and techniques.

Unit V: Fiber Optics

Text Books:

Reference Books:
2. The Elements of Fibre Optics: S.L. Wymer and Meardon (Regents/Prentice Hall), (1993)

11PH316 THIN FILM TECHNOLOGY

Credits 4:0:0

Course Objectives:
Students will be able to
- Gain knowledge on vacuum systems, Thin film coating techniques
- Understand the growth process of thin film
- Study on characterization techniques and thin film applications

Course Outcome:
Students will be able to
- Apply the knowledge of thin film coating techniques to prepare thin films by various methods
- do characterization studies on thin films and fabricate thin film devices

Unit I: Vacuum system
Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular, monitoring equipment – McLeod gauge, pirani, Penning, Capacitance diaphragm gauge - Evaporation – deposition mechanism, evaporation sources- tungsten-helical, hair pin, basket, molybdenum boat, process implementation, deposition condition

Unit 2: Thin film coating techniques
Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electro plating- potentiostat, galvanostat, pulsed plating, sol gel coating, LASER ablation, spray Pyrolysis-Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity - Substrate cleaning, substrate requirements, buffer layer, metallization
Unit 3: Growth process
Adsoption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control - Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

Unit 4: Structural, Optical and electrical studies on thin films
X-Ray Diffraction studies - Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis NIR Spectroscopy - absorption and reflectance-Optical constants of a thin film by transmission and reflectance at normal incidence for a system of an absorbing thin film on thick finite transparent substrate, Photoluminescence (PL) studies –Fourier Transform Infrared Spectroscopy(FTIR) - Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

Unit 5: Thin film applications

Text Books:

Reference Books:

11PH317 NANODEVICES

Credits: 4:0:0
Course objectives:
• To learn the various modern technologies used in nano devices and sensors.
• To know about the Semiconductor, bio and Photonics based sensors and its electronic properties of such nanostructure devices.
• To understand the effect of the reduced dimensionality on the electronic charge transport.

Course Outcome:
The students understands the operating principle of various nanodevices and its single atom manipulation

Unit I: Electronic Nanodevices
Background, Quantum layers, dots and wires, Electronic level modification of 0D, 1D, 2D - Quantization of resistance, Esaki and resonant tunneling diodes, Mott-wannier excitons - molecular electronics, information storage, molecular switching, Schottky devices.

**Unit II: Quantum Structures and Devices.**

**Unit III: Micro and nano-sensors**
Fundamentals of sensors, biosensor, micro fluids, Sensors for aerospace and defense: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Integration of sensor with actuators and electronic circuitry

**Unit IV: Sensor for bio-medical applications**
Cardiology, Neurology and as diagnostic tool, Biosensors. Clinical Diagnostics, generation of biosensors, immobilization, characteristics, applications, conducting Polymer based sensor, DNA Biosensors, optical sensors. Biochips

**Unit V: Magnetic Nanodevices**
Magnetoresistance, Spintronics, MEMS and NEMS - Fabrication, Modeling Applications MEMS and NEMS, Packaging and characterization of sensors, Method of packaging at zero level, dye level and first level Sensors. Photonic Nanodevices-Semiconductor quantum dots, Photonic crystals, Metamaterials

**Text Books:**
2. Between Technology & Science: Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.2007

**Reference Books:**
1. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng, Talylor and Francis, 2003

**11PH318 RADIATION PHYSICS**

**Credits: 4:0:0**

**Course Objectives:**
- To review the basic physics principles of atomic and nuclear physics
- To study the basics of radiation physics and interaction of radiation with matter
- To know about the basic counting statistics, calibration and methods of measuring radiation
- To understand the sources of radiation in the environment and their applications

**Course Outcome:**
• The students will become familiar with the basics of radiation physics and their sources in the environment, their methods of detection and the application of different types of radiations.

Unit I : Review of Physical Principles

Unit II : Radioactivity and interaction of radiation with matter

Unit III : Methods of measuring radiation

Unit IV : Counting statistics and calibration of instruments
Uncertainty in the measuring process – Various types of distribution - Error Propagation – Accuracy of counting measurements – Significance of data from statistical view point - Calibration and standards – Source calibration – Neutron sources – X-ray machines – Calibration of detection equipment

Unit V : Radiation in the environment and their applications
Types of radiation sources – Natural radiation sources – Artificial sources of radiation – Applications of radiations – Medical applications – Industrial applications – Radiation in food processing industry – Agricultural applications – Isotope hydrology – Miscellaneous applications

Text books:

Reference Books:
11PH319 CRYSTAL GROWTH TECHNIQUES

Credits: 4:0:0

Course Objectives:

- To study the basic knowledge about the nucleation mechanism involved in crystal growth
- To understand the broad areas of crystal growth methods such as melt, solution, vapour transport.
- To understand some of the advanced crystal growth systems such as CVD and PVD

Course Outcome:

Students can understand the different techniques used for growing crystals

Unit I: Fundamentals of Crystal Growth
Importance of crystal growth – classification of crystal growth methods -Theories of nucleation – Classical theory – Gibbs Thomson equation for vapor solution and melt energy of formation of a nucleus – Adsorption at the growth surface – Nucleation – Homogeneous and Heterogeneous nucleation – Growth surface.

Unit II: Growth from Low Temperature Solutions
Solution – selection of solvents – solubility and super solubility – Saturation and super saturation – Meir’s solubility diagram – Metastable zone width – measurement and its enhancement – Growth by (i) restricted evaporation of solvent, (ii) slow cooling of solution and (iii) temperature gradient methods – Growth in Gel media, Electrocrystallization.

Unit III: Growth from Flux and Hydrothermal Growth

Unit IV: Growth from Melt

Unit V: Growth from Vapour

Text Books:
Reference books:-

11PH320 RESEARCH METHODOLOGY

Credits: 4:0:0

Course Objectives:
Students will be able
• To gain knowledge on various research tools available for carrying out research
• To gain understanding on numerical and statistical methods to solve research problems
• To solve simple statistical and numerical problems using C++ programming

Course Outcome:
The student will be able to:
• Apply various techniques for practical problems
• Apply numerical and statistical problem solving skills and computer programming skills to solve research problems

Unit I: Structural Characterization
Production and properties of X-rays, X-ray analysis: X-ray diffraction; Effect of texture, particle size, micro and macro strain on diffraction lines. Scanning electron microscopy: construction, interaction of electrons with matter, modes of operation, image formation, Atomic probe microscopy and scanning tunneling microscopy: principles and practice

Unit II: Optical characterization

Unit III: Statistical Methods:
Correlation- comparison of two sets of data- comparison of several sets of data- Chi squared analysis of data- characteristics of probability distribution- some common probability distributions- Measurement of errors and measurement process – sampling and parameter estimation- propagation of errors- curve fitting- group averages – equations involving three constants- principle of least squares- fitting a straight line, parabola and exponentials cur vemethod of moments

Unit IV Numerical methods

Unit V Application of Numerical and statistical methods using C++ Programming
Solving quadratic equations — solution of equation by Newton Raphson method – matrix diagonalization (Jacobian method) – Integration by Simpson’s rule – Fitting of a straight line using principle of least square
Text Books:

Reference Books :
1. B.K.Sharma, Spectroscopy Goel publishing house, 2007

11PH321 MATERIAL CHARACTERIZATION

Credits: 4:0:0

Course Objectives:
- To know about the Microscopic and Spectroscopic methods
- To understand the analysis of materials using electron microscopy and optical methods
- To learn the instrumentations of Thermal, Electrical, Mechanical and Magnetic methods of characterization.

Course Outcome:
- Students can understand various methods available for characterizing the materials.

Unit I: Microscopic methods

Unit II: Spectroscopic Methods
Principles and Instrumentation for UV-Vis-IR, FTIR Spectroscopy, Raman Spectroscopy, NMR, XPS, AES and SIMS-proton induced X-Ray Emission spectroscopy (PIME) – Rutherford Back Scattering (RBS) analysis – application.

Unit III: Electron Microscopy And Optical Characterisation
SEM, EDAX, EPMA, TEM, STEM working principle and Instrumentation- sample preparation- data collection, processing and analysis- Photoluminiscence-light-matter interaction- instrumentation- Electroluminescence-instrumentation-Applications

Unit IV: Thermal Analysis
Unit V: Electrical, Mechanical & Magnetic Analysis

Text books:

Reference Books:

11PH322 RENEWABLE ENERGY SOURCES

Credits 4:0:0

Course Objectives:
• To give an overview of the energy problem faced by the current generation
• To highlight the limitations of conventional energy sources that affect the climate
• To underline the importance of renewable energy sources
• To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources.

Course Outcome:
The students will understand the problems of conventional energy sources. They will realize the importance of renewable energy sources and try to find solutions to non-conventional energy sources by research.

Unit I: Basic Concepts of Energy Sources

Unit II: Solar Energy

Unit III: Wind-Energy

Unit IV: Energy from Bio-Mass

**Unit-V: Energy from Other Sources**

**Text Books:**

**Reference Books:**

**11PH323 ELECTRONICS LAB**

**Credits:** 0:0:2

**Course Objectives:**
Students will be able
- To get practical skill on basic electronic experiments.

**Course Outcome:**
The student will be able to:
- Apply the practical skill on electronic circuits to various applications.

1. Study the static and drain characteristics of a JFET.
2. Study the characteristics of UJT.
3. Operational amplifier – characteristics
4. Construction of adder, subtracter, differentiator and integrator circuits using the given OP – Amp.
7. Construction of an A/D and D/A converter circuit and study its performance.
8. Construction of a half-adder , full-adder ,half- subtracter and full- subtracter using logic gates.
11. Construction of a low-pass, high pass filter circuits and study its output performance.
12. IC 555-Timer – Study of waveforms
13. Study of flip – flops – using ICs
14. Decade counter using J-K flip flop

11PH324 GENERAL PHYSICS LAB

Credits: 0:0:2

Course Objectives
Students will be able
- To get practical skill on basic optical, electrical and electronic experiments.
- To understand the advance experiments on properties of matter.

Course Outcome
The student will be able to:
- Apply the knowledge on basic Physics experiments to solve practical problems.
1. Young’s modulus – Cornu’s method
2. Zener diode characteristics, Photodiode characteristics & Solar cell characteristics
3. Ultrasonic interferometer - Velocity of sound in liquids using ultrasonics
4. Constant deviation spectrometer - Cauchy’s Constant and dispersive power of a prism
5. Hall effect in semiconductors (Determination of Hall coefficient, mobility and type of charge carriers)
6. Diffraction using He-Ne laser/diode laser
7. To determine the dielectric constant of liquids and solids
8. Refractive index of liquids – using He-Ne laser/diode laser
10. Stefan's constant - To determine Stefan's constant
11. Dielectric constant by Lecher Wire
12. Fraunhoffer lines - identification of elements
13. Anderson bridge (AC) - determination of inductance.
15. Clausius – Mossotti equation using sugar solution (Determination of Polarisation.)

11PH325 MICROPROCESSOR / CONTROLLER LAB

Credits: 0:0:2

Course Objectives:
Students will be able
- To understand the architecture of microprocessors and methodology of programming.

Course Outcome:
The student will be able to:
- Write simple program using microprocessor for practical Applications.
1. Arithmetic operation using 8086
2. Addition and subtraction of two 16 bit numbers using 8086
3. One’s compliment of a 16 bit number
4. Computing Boolean expression
5. Program to short numbers in ascending and descending order
6. Matrix addition
7. Factorial
9. Sum of numbers in a word array
10. Calculating the length of the string
11. Up down counter
12. String operation
13. Rolling display
14. Timer interface
15. parallel interface
16. Interfacing a stepper motor with 8086
17. Programmable interrupt controller
18. Stepper motor using microcontroller
19. Rolling display using microcontroller
20. Arithmetic operations using microcontroller

11PH326 ADVANCED PHYSICS LAB -I

Credits: 0:0:2

Course Objectives:
Students will be able
- To get practical skills on advance experiments on optics, electricity and magnetism.

Course Outcome:
The student will be able to:
- Apply the knowledge on advance Physics experiments to solve Research problems.
1. Study of magnetic hysteresis - B-H Curve
2. Determination of Brewster’s angle & estimation of refractive index of a given transparent material.
3. “e” by Millikan oil drop method.
4. Determination of Rydberg constant using Hydrogen discharge tube.
5. Polarizability of Liquids
6. Four Probe Method – Determination of resistivity of semiconductor at different temperatures, determination of band gap
7. Michelson Interferometer
8. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne - Laser
9. Diamagnetic and paramagnetic susceptibility of solids
10. Band gap determination by photoconductivity
11. Photosensitive devices
12. Young’s modules – elliptical fringe method
13. Young’s modules – Hyperbolic fringe method
14. Frank - Hertz Experiment.

11PH327 COMPUTATIONAL PHYSICS LAB

Credits: 0:0:2

Course Objectives:
Students will be able
- To gain programming skills to solve simple problems using C++ Programming.
- To solve simple statistical and numerical problems using C++ programming.
Course Outcome:
The student will be able to:

- Apply the programming skills to solve practical problems.
- Apply numerical and statistical problem solving skills and computer programming skills to solve research problems.

1. Ascending and descending order of numbers and characters, arithmetic mean, mode and variance
2. Matrix addition, subtraction, multiplication, transpose and inverse of a matrix
4. Evaluating a root of non-linear equation by Newton-Raphson method using external function
5. Program to solve system of linear equations using simple Gaussian elimination method
6. Program for straight line fit using the method of least squares for a table of data points
7. Program for polynomial curve fitting (real life examples such as rain water, temperature etc.)
8. Program to integrate any function or tabulated data using trapezoidal rule
9. Program to integrate any function or tabulated data using Simpson’s rule
10. Program to compute the solution of a first order differential equation of type y’=f(x,y) using the fourth order Runge-Kutta method
11. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
12. Program to compute the interpolation value at a specified point, given a set of data points using Newton’s interpolation representation
13. Program to calculate and print the mean, variance and standard deviation of set of N numbers
14. Program to solve the quadratic equation
15. Program to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list

11PH328 ADVANCED PHYSICS LAB -II

Credits 0:0:2

Course Objectives:
Students will be able

- To get practical skill on various deposition techniques to prepare thin films and grow crystals
- Get practical training on some basic characterization techniques of thin films and crystals

Course Outcome:
The student will be able to:

- Apply the practical knowledge to fabricate novel devices to solve research problems

1. Physical vapour deposition – Measurement of pressure
2. Physical vapour deposition – Measurement of thickness
3. Spray deposition technique
4. Spin Coating technique
5. Electro deposition method
6. Electro spinning method  
7. Growth of single crystals from melt  
8. Growth of single crystals from solution  
9. Growth of single crystals from vapour  
10. Spectra of atoms and molecules  
11. LASER particle analyzer  
12. XRD analysis  
13. UV- visible spectrophotometer  
14. Photo luminance studies
## LIST OF SUBJECTS AND SYLLABI

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<td>12PH327</td>
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<td>Radiation Physics</td>
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<td>General Physics Lab</td>
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<td>Microprocessor / Controller Lab</td>
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<td>12PH336</td>
<td>Nano Physics Lab</td>
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Course Objective:
- To impart knowledge on the basic concepts of quantum mechanics and its applications
- To understand the working principle of various lasers and its application in fibre optics
- To study the principles of acoustics and applications of ultrasonic waves
- To get more knowledge on engineering materials and its applications

Course Outcome:
- To apply physics principles of latest technology to solve practical problems of real world

Unit I

Unit II

Unit III
FIBRE OPTICS: Principle of optical fibre-Propagation in optical fibres-Acceptance angle-Numerical aperture-V number, Structure of optical fibres- Types of optical fibres based on material, mode and refractive index, Loss in Optical fibres, Applications: Optical fibres for communication- Fibre optical sensor (Pressure and Temperature sensors) - Medical applications – Fibre endoscope.

Unit IV

Unit V

Text Book

Reference Books
6. G. Aruldhas, Engineering Physics, PHI Learning, 2010

12PH202 APPLIED PHYSICS LAB
Credit: 0:0:2

Course Objective:
- To train engineering students on basis of measurements and the instruments
- To give practical training on basic Physics experiments which are useful to engineers
- To equip the students with practical knowledge in electronic, optics, and heat Experiments

Course outcome:
- To demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments.

LIST OF EXPERIMENTS:
1. Rigidity Modulus of the wire - Torsional Pendulum
2. Young’s Modulus of a beam- Non-uniform bending
3. Thermal Conductivity of a bad conductor-Lee’s Disc
4. Radius of curvature of a lens – Newton’s Rings
5. Refractive Index of Prism-Spectrometer
6. Wavelength of mercury source- Spectrometer Grating method
7. Coefficient of Viscosity of a liquid by Poiseullie's method
8. Frequency determination of a tuning fork- Melde’s string
9. Particle size measurement-Laser diffraction method
10. Discharge of a capacitor
11. Thickness of a glass plate- Single optic lever
12. Characteristics of Zener diode
13. Efficiency of Solar cell
14. Ultrasonic interferometer

HoD can choose any 10 experiments from the above list at the beginning of the course in each Semester.

12PH203 ENGINEERING PHYSICS
Credits: 3:0:0

Course Objective
- To help to prepare the Engineering students, a stronger foundation in the classical physics and dynamics of particles
- Greater emphasis on the role of reference frames in Newton’s laws, force laws
- To provide the understanding of concepts of oscillations, waves and electric fields.
- A clear analysis of the concepts of Heat, Energy and laws of Thermodynamics (quantitatively)

Course Outcome
• To understand and apply knowledge on Newtonian mechanics, waves and electric field concepts to practical problems.
• To accomplish problem solving skills along with the ability to apply mathematics related to mechanics, waves and fields

Unit I
NEWTONIAN MECHANICS: Force, mass, free body diagram, Newton’s laws of motion, problems applying Newton’s laws, orbital velocity- geostationary, escape velocity – launching of satellites

Unit II
OSCILLATIONS: Simple harmonic motion- torsion pendulum – experiment to find the rigidity modulus, damped harmonic motion forced oscillations and resonance

Unit III
WAVES: Transverse and longitudinal waves, equation of a travelling wave, wave speed on stretched string, superposition of waves, interference of waves, phasors, standing waves, Meldes’ string experiment

Unit IV
INTERFERENCE OF LIGHT WAVES: Interference of light, coherent sources, young’s double slit experiment, analytical treatment of interference, Newton’s rings experiment.

Unit V
TRANSMISSION OF HEAT: Modes of transmission of heat, thermal conductivity, Rectilinear flow of heat along a bar, determination of thermal conductivity – for good (Forbe’s Method) and bad conductors (Lee’s disc), Applications- bimetallic thermometers, thermoelectric thermometer.

Text Book

Reference Books
1. University Physics, Sears and Zemansky –Pearson Addison Wesly, 2007
3. Fundamental of Physics, Allan Giambattista, Betty McCarthy Richardson, Robert C Richardson, Tata McGraw Hill Education Private Limited, 2008

12PH204 MECHANICS & PROPERTIES OF MATTER
Credit: 4:0:0

Course Objective
• To know about the Basic laws of Physics
• To learn about the properties of matter in different conditions

Course Outcome
• To find the solution for simple problems in day to day life and this course explains the properties of matters.
Unit I
GRAVITATION: Kepler’s laws – Newton’s deductions from Kepler’s laws – Newton’s law of gravitation – Determination of gravitational constant by Cavendish method – Law of Gravitation and theory of relativity – Gravitational potential at a point distant r from a body – Escape Velocity – Potential and Field intensity due to a solid sphere at a point inside the sphere and outside the sphere – Earth quakes – Seismic waves and Seismographs

Unit II

Unit III


Unit IV
BENDING OF BEAMS: Bending of beams – Expression for bending moment – Uniform bending – Determination of Young’s modulus by Uniform and Non Uniform bending using pin and microscope – Experiment: Determination of Young’s modulus by Cantilever

Unit V

Text Books

Reference Books
12PH205 PROPERTIES OF MATTER AND WAVES LAB

Credits: 0:0:2

Course Objective:
- To train the students on Properties of matter and waves to understand the basic concepts.
- To equip the students with practical knowledge in properties of matter and waves experiments

Course Outcome:
- Demonstrate the practical skill on measurements and instrumentation techniques of some physics experiments.

LIST OF EXPERIMENTS:
1. Torsion pendulum - Moment of Inertia of the disc
2. Moment of inertia of a Fly wheel
3. Rigidity modulus -- Torsion pendulum with cylindrical masses
4. To study the motion of a spring and calculate the spring constant and the value of g
5. Compound pendulum – Determine g and k
6. Young’s modulus – Cantilever depression (Mirror and Microscope)
7. Young’s modulus – Cantilever oscillations (Hooke’s Law)
8. Young’s modulus --Non uniform bending--Using pin and microscope
9. Young’s modulus --Uniform bending- Using pin and microscope
10. Surface tension --Capillary rise method
11. Comparison of viscosities of two liquids --Poiseuille’s method
12. Viscosity – Stoke’s method
13. Melde’s string arrangement -- Frequency determination
15. Ultrasonic interferometer-- Determination of velocity of sound

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

12PH206 THERMODYNAMICS AND STATISTICAL MECHANICS

Credits: 4:0:0
Course Objective

• To learn about the different laws in thermodynamics
• To know the basic principles of statistical mechanics
• To learn the application of thermodynamics of a wide variety of physical systems

Course Outcome

• To acquire skill in the basic principles of thermodynamics & statistical mechanics and its application to realistic problems.

Unit I


Unit II

STATISTICAL BASIS OF THERMODYNAMICS: Statistical basis – Probability – Probability and frequency – Basic rules of probability theory – Permutations and combinations - Macrostate and microstate – Thermodynamic probability – Fluctuations and their dependence on n - Constraints on a system – static and dynamic system – Life time of a Microstate and Macrostate – Concept of a cell in a component

Unit III


Unit IV

PHASE TRANSITIONS IN STATISTICAL MECHANICS: General remarks on the problem of phase transitions – Non ideal classical gas – Calculation of partition function for low densities – Equation of state and virial coefficients – The Vander – Waal’s equation – Phase transitions of the second kind – ferromagnetism

Unit V


Text Books


Reference Books

2. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale,
12PH207 OPTICS AND PHOTONICS

Credit: 4:0:0

Course Objective
- To impart basic knowledge pertaining to optics, this will help the students to understand about the working principles of the optical instruments.
- To understand of LASER and fiber optics will help to study the behavior of materials.
- To understand the special optical characteristics of materials in Nonlinear optics and photonics

Course Outcome:
- To study the optical characteristics of materials with the basic knowledge about the instruments used.

Unit I
GEOMETRICAL OPTICS: Refractive index, optical path, total internal reflection, refraction at a concave surface, lenses, refraction through a lens, effective focal length of two thin lenses separated by a finite distance, power of a lens, spherical and chromatic aberrations, condition for achromatism of two thin lenses separated by a finite distance, Huygens eyepiece and Ramsden eyepiece.

Unit II
INTERFERENCE: Nature of light, Huygens principle, phase difference and path difference, Young’s double slit experiment, analytical treatment of interference, interference fringes, Fresnel’s biprism, thin film interference (reflected light), wedge shaped thin films, Newton’s rings, Michelson interferometer, thickness and wavelength measurements using Michelson interferometer.

Unit III
DIFFRACTION AND POLARIZATION: Fresnel and Fraunhoffer diffractions, Fraunhoffer diffraction at double slits, Fraunhoffer diffraction at many slits, plane diffraction grating, wavelength using grating, Polarization, Brewster’s law, double refraction, Nicol prism, elliptically and circularly polarizes light, quarter wave plate, half wave plate, Babinet’s compensator, dichroism, optical activity.

Unit IV
LASER AND NONLINEAR OPTICS: Principle and production of laser, Einstein’s coefficients (expression for energy density), requisites of laser system, Nd-YAG laser, He-Ne laser, CO₂ laser, semiconductor laser. Introduction to nonlinear optics, second, third and higher harmonic generation, four wave mixing, parametric oscillators, birefringence.

Unit V
PHOTONICS AND FIBRE OPTICS: Introduction to photonics, concept of photon, photon statistics, interaction of photons and atoms, Propagation mechanism in optical fibers, acceptance angle, numerical aperture, fractional index, types of optic fibers and modes of propagation, Attenuation, Application in communication.

Text Books
2. Textbook of optics, N. Subrahmanyam and Brijlal, chand publications, 1985
4. An Introduction to Fiber optics, Ghatak and Thyagarajan, 1998

Reference Books
3. The Elements of Fiber Optics, S L Wymer Meardon, Prentice Hall, 1993

12PH208 HEAT AND OPTICS LAB

Credits: 0:0:2

Course Objective:
- To train the students on Optics and Heat experiments to understand the basic concepts.
- To equip the students with practical knowledge in Optics and heat experiments

Course outcome:
- Demonstrate the practical skill on measurements and instrumentation techniques of some physics experiments.

LIST OF EXPERIMENTS:
1. Spectrometer -- i-d curve
2. Spectrometer -- Dispersive power of a prism & Cauchy’s constants
3. Spectrometer -- Diffraction grating -- Normal incidence method
4. Resolving power of a telescope
5. Refractive index of a liquid -- Travelling Microscope method
6. Newton’s rings -- Radius of curvature of a convex lens
7. Air wedge -- Thickness of a thin wire
8. Tolonsky method -- Thickness of thin film
9. Thickness of thin plates -- Single optic lever
10. Polarimeter
11. Laser diffraction method -- Particle size measurement
12. Numerical aperture for fiber optic cable
13. Specific heat capacity of liquid -- Newtons law of cooling
14. Specific heat capacity -- Joule's calorimeter -- half-time correction
15. 16. Lee's disc -- Thermal conductivity of a bad conductor
16. Measurement of specific latent heat of fusion of ice

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

12PH209 THIN FILMS TECHNOLOGY FOR ENGINEERS

Credits 3:0:0

Course Objective:
- To gain knowledge on vacuum systems
- To learn about various coating techniques
- To learn about the various characterization techniques of thin films
- To gain knowledge on application of thin films

Course Outcome:
- To demonstrate and execute the process of thin film for various applications
Unit I
VACUUM SYSTEM:
Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular -McLeod gauge, pirani gauge, Penning gauge

Unit II
THIN FILM COATING TECHNIQUES: Evaporation – deposition mechanism, Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electro plating- sol gel coating, LASER ablation, spray pyrolysis

Unit III
GROWTH PROCESS: Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control, Epitaxy- semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

Unit IV
STRUCTURAL, OPTICAL AND ELECTRICAL STUDIES ON THIN FILMS: X-Ray Diffraction studies – Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis Spectroscopy - absorption and Transmittance Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

Unit V

Text Books
1. Thin Film Fundamentals by Goswami 2003 New Age International Ltd.

Reference Books

12PH210 ASTROPHYSICS

Credits 3:0:0

Course Objectives:
• To give the students an awe inspiring idea about our space and its surroundings
• To provide with a fundamental understanding about the stars and their properties
• The students will have a firsthand knowledge of the instruments used to explore the cosmos
To give an overview of the giant scale structure of the universe such as galaxy and clusters of galaxies
To know about the origin and fate of the universe

Course Outcome:
- The students will become clear about our cosmic surroundings, the processes that take place in it, and the forces that control it and their origin and their fate.

Unit I

Unit II

Unit III

Unit IV

Unit-V

Text Books

Reference Books

12PH211 INTRODUCTION TO NANOSTRUCTURED MATERIALS

Credits 3:0:0

Course Objective:
- To understand the concept of nanoscale materials
- To learn the electrical, magnetic mechanical and optical properties of nanostructured materials
- To know about the methods used for synthesis of nanoscale materials
• To expose the students to the nano devices

Course Outcome:
• Students can understand the importance of nanostructured materials and their properties and applications

Unit I

Unit II
ELECTRICAL AND MAGNETIC PROPERTIES: Electronic and electrical properties- One dimensional systems-Metallic nanowires and quantum conductance -Carbon nanotubes and dependence on chirality -Quantum dots -Two dimensional systems -Quantum wells and modulation doping -Resonant tunnelling -Magnetic properties Transport in a magnetic field -Quantum Hall effect. -Spin valves -Spin-tunnelling junctions -Domain pinning at constricted geometries -Magnetic vortices

Unit II
MECHANICAL AND OPTICAL PROPERTIES: Mechanical properties -Individual nanostructures -Bulk nanostructured materials-Ways of measuring-Optical properties-Two dimensional systems (quantum wells)-Absorption spectra -Excitons -Coupled wells and superlattices -Quantum confined Stark effect

Unit IV

Unit V
NANODEVICES: Nanodevices Background -Quantization of resistance -Single-electron transistors -Esaki and resonant tunneling diodes -Magnetic Nanodevices -Magnetoresistance – Spintronics-MEMS and NEMS

Text Book
1. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley, 2003

Reference Books
2. Introduction to Solid State Physics, C. Kittel, a chapter about Nanotechnology, Wiley, 2004

12PH212 MATERIAL SCIENCE FOR ENGINEERS

Credits: 3:0:0

Course Objective:
• To gain knowledge on solid state materials
• To understand the conducting and semiconducting properties of materials
• To understand the magnetic properties of materials
• To learn the latest development on new materials
Course outcome:
• To demonstrate the knowledge on material properties

Unit I
INTRODUCTION TO CRYSTALLOGRAPHY: Introduction--crystallography – crystal planes and crystal direction – crystal symmetry – Bravias lattices – Miller indices – Simple crystal structures – unit cell characteristics of SC, BCC, FCC & HCP – Method of determination of crystal structures—X-ray diffraction method – crystal defects or imperfections.

Unit II

Unit II

Unit IV

Unit V

Text Books

Reference Books:
12PH213 VACUUM AND THIN FILM TECHNOLOGY

Credits: 4:0:0

Course Objective:
• To introduces students to the theory and practice of high vacuum systems as well as thin film deposition
• To study the physical behaviour of gases and the technology of vacuum systems including system operation and design.
• To learn the Thin film deposition techniques including evaporation and sputtering techniques

Course Outcome:
• Students understand the application of thin film technologies in fabricating optical coatings such as mirror, antireflective, and dielectric filter coatings

Unit I

Unit II

Unit III

Unit IV

Unit V
Text Books

Reference Books

12PH214 BASIC SCIENCE OF SOUND, LIGHT AND SIGNALS

Credits 3:0:0
Course Objective:
- To gain knowledge on lens system and photometry
- To understand the concept colour theory and aberrations
- To gain knowledge on sound waves and its properties
- To understand the basic concepts of signal processing

Course outcome:
- Demonstrate the knowledge on sound, light and signals

Unit I:
LENS SYSTEM, PHOTOMETRY AND COLOUR THEORY: Cardinal points of an optical system, Coaxial lens system- equivalent focal length and cardinal points, refraction through a thick lens. Measurement of light- standard candle, Secondary standards, Inverse square law, Intensity of illumination and Lambert’s law, Units of illumination, Brightness of a surface and illumination, Photometer- Lummer and Brodhun photometer Natural light, three colour theory-mixing of colours

Unit II
RESOLUTION AND ABERRATIONS: Rayleigh’s criterion of resolution- resolving power of a grating, prism- resolving power of a telescope, microscope Aberrations or defect of a lens, Chromatic aberration – longitudinal and lateral Achromatism of lenses, spherical aberration- minimization of spherical aberration, coma, Astigmatism

Unit III

Unit IV

Unit V
SIGNALS: Characterization and Classification of signals- examples of signals – multi channel - multidimensional – continuous versus discrete-analog versus discrete-concept of frequency – concept of signal processing-advantage of digital signal processing with analog signal processing

Text Books:

Reference Books:

12PH215 NANO PHYSICS LAB

Credits: 0:0:2

Course Objective:
- To get practical skill on various deposition techniques to prepare thin films and grow Crystals having nanostructures
- To get practical training on some basic characterization techniques of nanostructure thin films and crystals

Course Outcome:
- To apply the practical knowledge to fabricate novel nano devices to solve research Problems

LIST OF EXPERIMENTS:
1. Synthesis of nano materials by vacuum deposition method
2. Synthesis of nanoparticles by chemical method
3. Laser particle size analyzer
4. Spray deposition
5. Spin Coating – sol gel
6. Electro deposition
7. Electro spinning method
8. Sputtering technique
9. Growth of single crystals from solution
10. Growth of single crystals from vapour
11. Spectra of atoms and molecules
12. XRD analysis
13. UV-visible spectrophotometer
14. Photoluminescence spectra

HoD can choose any 10 experiments from the above list at the beginning of the course in each Semester.

**12PH216 NUCLEAR PHYSICS FOR ENGINEERS**

Credits: 3:0:0

**Course Objectives:**
- To make the students understand the constituent particles and the forces existing inside the nucleus
- To give an idea about the nuclear reaction and nuclear reactors
- To give a brief idea about the elementary particles

**Course Outcome:**
- Students will understand about the structure of nucleus and the forces inside the nucleus. They learn about fission and fusion reactions and conditions for the controlled nuclear reaction which are applied in the reactors.

**Unit I**

**PROPERTIES OF ATOMIC NUCLEI**
- Introduction
- Nuclear Size
- Nuclear Mass
- Nuclear stability, binding energy
- Nuclear mass defect and packing fraction
- Separation energy of the last nucleon with mass number
- Weizacker Semi-empirical mass formula
- Angular momentum of the nucleus
- Nuclear Magnetism
- Parity
- Isotopic Spin

**Unit II**

**NUCLEAR MODELS**
- Introduction
- Degenerate Gas Model
- Liquid Drop Model
- α-particle model
- Shell Model
- Collective Model
- Optical Model

**Unit III**

**PARTICLE DETECTORS AND ACCELERATORS**
- Ionization chambers
- Proportional chambers
- Geiger Muller Counter
- Semiconductor detector
- Scintillation counter
- Cloud chamber
- Bubble Chamber
- Classification of particle accelerators
- The Cyclotron
- The betatron
- Synchrocyclotron
- Linear Accelerators
- The Large Electron Positron Collider
- The Large Hadron Collider

**Unit IV**

Unit V

Text Books
1. Elements of nuclear Physics, M.L.Pandya and R.P.S. Yadav, Kedar Nath Ram Nath Publications, Meerut
2. Nuclear Physics, D.L.Dayal

Reference Books

12PH301 CLASSICAL MECHANICS

Credits: 4:0:0

Course Objective:
• To increase in the conceptual understanding of classical mechanics and develop their problem solving skills
• To gain more experience and increased ability with the mathematics associated with Classical Mechanics

Course Outcome:
• To apply the techniques and results of classical mechanics to real world problems
• Effectively communicate problems and their solutions relevant to classical mechanics
• To apply physics principles to novel situations

Unit I

Unit II
Unit III

Unit IV
THE HAMILTON EQUATIONS OF MOTION: Legendre Transformations and the Hamilton equation of motion – Cyclic coordinates – Routh’s procedure and oscillations about steady motion – Derivation of Hamilton’s equations from variational principle – The equations of canonical transformation – Examples of canonical transformation, Poisson brackets, invariance of Poisson brackets with respect to canonical transformation

Unit V
HAMILTONIAN-JACOBI THEORY: Hamilton-Jacobi equations for principle function- Harmonic Oscillator problem as an example of the Hamilton-Jacobi method-Hamilton-Jacobi equation for Hamilton’s characteristic function- Actions angle variables in the Systems with one degree of freedom- The Kepler Problem in action angle variables- Hamilton-Jacobi Theory, Geometrical Optics and Wave Mechanics

Text Books

Reference Books

12PH302 STATISTICAL MECHANICS AND THERMODYNAMICS
Credits: 4:0:0

Course Objective:
- To derive mathematical relations which connect different experiment properties of macroscopic systems in equilibrium systems containing many molecules.
- To provide the molecular theory or interpretation of equilibrium properties of macroscopic systems

Course Outcome:
- Students will understand the laws of thermodynamics and their consequences.
- Students will know about the applications of Statistical mechanics and phase transitions in statistical mechanics

Unit I
Nernst’s Heat Theorem and third law – Consequences of third law – Nernst’s - Gibb’s phase rule – Chemical potential

Unit II

Unit III


Unit IV

Unit V

Text Book

Reference Books

12PH303 MATHEMATICAL PHYSICS I

Credits 3:1:0

Course Objective:
- To review the basics of vector analysis and move on to the advanced level treatment of Vectors
• To give the students enough problems in matrices so as to prepare them for competitive exams
• To impart on the students the elementary knowledge about Tensors
• To enable the students to solve the first and second order differential equations and have a sound knowledge about special functions
• To give an basic understanding about the theory of probability and theory of errors.

Course Outcome:
• The students will be enabled to write all the competitive exams containing Mathematical Physics as a part of their syllabus. They will be imparted with a good understanding of fundamentals of Maths which will be essential for advanced level physics.

Unit I

Unit II

Unit III

Unit IV
LINEAR DIFFERENTIAL EQUATIONS: Linear differential equations of second order with constant and variable coefficients – Homogeneous equations of Euler type – Equations reducible to homogeneous form – method of variation of parameter - Problems

Unit V
Text Books

Reference Books

12PH304 ELECTRONICS

Credits: 4:0:0

Course Objective:
- To learn about the different semiconductor devices
- To understand the concept of manufacturing of resistors, diodes, capacitors and inductors in a chip for various applications
- To get a knowledge about the operational amplifiers and to know the architecture and functioning of 8085 microprocessor
- To acquire the knowledge about the Boolean algebra and different memories

Course Outcome:
- Students will learn about the semiconductor devices, IC manufacturing, different types of operational amplifiers, microprocessors and Boolean theorems.

Unit I
SEMICONDUCTOR DEVICES: Uni-Junction Transistor – Characteristics – Application:

Unit II
FABRICATION OF INTEGRATED CIRCUITS: Integrated circuit technology- Basic monolithic integrated circuits- epitaxial growth – masking and etching – Diffusion of impurities – Monolithic diodes, integrated resistors, integrated capacitors and inductors - monolithic circuit layout- additional isolation methods, large scale integration (LSI), medium scale integration (MSI) and small scale integration (SSI) – The metal semiconductor contact.

Unit III

Unit IV
MICROPROCESSOR: Buffer register, Bus organized computers, Microprocessor (μP) 8085 Architecture, memory interfacing, interfacing I/O devices, Assembly language programming:
Instruction classification, addressing modes, op code and operand, fetch and execute cycle, timing diagram, machine cycle, instruction cycle and T states –Programming examples

Unit V

DIGITAL ELECTRONICS: Boolean Algebra – Demorgan Theorem Arithmetic circuits - Karnaugh map simplifications, (synchronous and asynchronous) counters registers – Multiplexures – Demultiplexures memories (EPROM, PROM, S-RAM)

Text Books

Reference Books
1. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India, 2009

12PH305 QUANTUM MECHANICS I

Credits 4:0:0

Course Objective:
- To understand the general formulation of quantum mechanics
- To Solve eigenvalue equations for specific physical problems
- To Understand the operator concept of angular momentum, ladder operators and applications
- To Get knowledge on the theoretical aspects of perturbation of atoms due to electric and magnetic fields
- Understand the theory of many electron systems

Course Outcome:
- Improved mathematical skills necessary to solve differential equations and eigenvalue problems using the operator formalism
- Quantum mechanical solution of simple systems such as the harmonic oscillator and a particle in a potential well.
- Solutions to perturbation problems and many electron systems

Unit I

GENERAL FORMALISM OF QUANTUM MECHANICS:
Linear vector space- Linear operator- Eigenfunctions and Eigenvalues - Normalisation of wave function-Probability current density - Hermitian operator- Postulates of quantum mechanics- Simultaneous measurability of observables- General uncertainty relation- Dirac’s notation- Expectation values - Equations of motion; Schrodinger, Heisenberg and Dirac representation- Momentum representation.

Unit II

ENERGY EIGEN VALUE PROBLEMS: Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom

Unit III
ANGULAR MOMENTUM: Orbital angular momentum-Spin angular momentum-Total angular momentum operators- Commutation relations of total angular momentum with components-Ladder operators- Commutation relation of $J_z$ with $J_x$ and $J_y$ - Eigen values of $J^2$, $J_z$ - Matrix representation of $J^2$, $J_x$, $J_y$ and $J_z$ - Addition of angular momenta - Clebsch Gordon coefficients(no derivation) – properties.

Unit IV
APPROXIMATE METHODS: Time independent perturbation theory in non-degenerate case-Ground state of helium atom-Degenerate case-Stark effect in hydrogen – Spin-orbit interaction-Variation method & its application to hydrogen molecule- WKB approximation

Unit V

Text Books

Reference Books
2. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005

12PH306 PHYSICAL OPTICS

Credits: 4:0:0

Course Objective:
- To learn the working of various optical elements like lenses and mirrors.
- To understand the properties of light as a wave

Course Outcome:
- Students demonstrate the usage of various optical elements like lenses and mirrors.
- Students apply the properties of light on research oriented problems.

Unit I

Unit II
SUPERPOSITION OF WAVES: Addition of Waves of same Frequency- Addition of Waves of Different Frequency- Group Velocity- Anharmonic Periodic Waves- Fourier Series

Unit III
POLARIZATION: Linear Polarization- Circular and Elliptical Polarization- Polarizers-Malus’s Law- Dichroism- Birefringence- Polarization by Scattering and Reflection-Brewster’s Law- Wave plates- Full- Wave, Half-Wave and Quarter-Wave Plates- Optical Activity
Unit IV

Unit V
FOURIER OPTICS: Fourier Transforms- One- and Two-Dimensional Transforms- Dirac Delta Function- Optical Applications- Spectra and Correlation

Text Books

Reference Book

12PH307 MATHEMATICAL PHYSICS II
Credits: 3:1:0

Course Objective:
- To impart a thorough knowledge about elements of complex analysis
- To train the students in Fourier, series and Transforms and enable them to solve physics problems
- To give an understanding about integral Transforms and to understand Green’s function and its applications to physics problems.
- To grasp the idea of group theory and its implications.
- To have a thorough knowledge about numerical methods

Course Outcome:
- The students will be enabled to write all the competitive exams containing Mathematical Physics as a part of their syllabus. They will be imparted with a good understanding of fundamentals of Maths which will be essential for advanced level physics.

Unit I

Unit II
FOURIER SERIES AND FOURIER TRANSFORMS:

Unit III

Unit IV

Unit V

Text Books

Reference Books

12PH308 SPECTROSCOPY I

Credits 4:0:0

Course Objective:
- To learn how these spectroscopic techniques are used in atomic and molecular structure determination
- To understand the principles and the theoretical framework of different Spectroscopic techniques
- To know the instrumental methods of different spectroscopic techniques

Course Outcome:
- Students can understand how spectroscopic studies in different regions of the spectrum probe different types of molecular transitions

Unit I
ATOMIC SPECTROSCOPY: Quantum states of an electron in an atom- Electronic angular momentum- The spectrum of Hydrogen, Helium and Alkaline atoms- The Building –Up

Unit II
MICROWAVE SPECTROSCOPY: Width of spectral lines- Rotation of molecules- Diatomic Molecules- Intensities of Spectral Lines- Effect of Isotopic substitution- Non-rigid Rotator- Polyatomic Molecules- Techniques and Instrumentation

Unit III

Unit IV
RAMAN SPECTROSCOPY: Classical and Quantum Theory of Raman Effect- Rotational Raman Spectra -Vibrational Raman Spectra - Polarization of Light and Raman Effect- Structural Determination from Raman and I.R spectroscopy - Techniques and Instrumentation

Unit V

Text Books

Reference Books

12PH309 ELECTROMAGNETIC THEORY

Credits 4:0:0

Course Objective:
• To learn the basics of electricity and magnetism and equations governing them.
• To acquire knowledge of fundamentals of magnetism
• To know the Maxwell’s equations
• To learn about the electromagnetic waves.

Course outcome:
• Students apply the fundamental concept of electricity and magnetism in day to day life and solving problems in physics

Unit I
**ELECTRO STATICS:** Electric field, Gauss Law – Scalar potential – Multipole expansion of electric fields – The Dirac Delta function – Poisson’s equation – Laplace’s equation – Green’s theorem – Uniqueness theorem – electrostatic potential energy and energy density. Electrostatics in matter- Polarization and electric displacement vector- Electric field at the boundary of an interface - Clausius - Mossotti equation.

**Unit II**

**Unit III**

**Unit IV**
**PLANE ELECTROMAGNETIC WAVES:** Plane wave in a non conducting medium – Boundary conditions – Reflection and refraction of e.m. waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting or dissipative medium.

**Unit V**

**Text Books**

**Reference Books**

**12PH310 QUANTUM MECHANICS II**

**Credit:** 4:0:0

**Course Objective:**
- To understand time dependent perturbation theory using quantum mechanics
- To get knowledge on theory of scattering and induced emission and absorption of radiation
- To understand the formation of relativistic wave equation
- To get knowledge on the formulation of quantum field theory

**Course Outcome:**
- To understanding of advanced quantum mechanical concepts on perturbation, scattering and radiation
- To quantum mechanical solution of relativistic problems and quantum fields
Unit I

Unit II
SCATTERING THEORY: Scattering Amplitude - Expression in terms of Green’s Function - Born approximation and its validity- Partial wave analysis - Phase Shifts - Scattering by coulomb and Yukawa Potential.

Unit III

Unit IV

Unit V
QUANTUM FIELD THEORY: Quantization of Wave Fields- Classical Lagrangian Equation- Classical Hamiltonian Equation - Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations- Quantization of Electromagnetic Field Energy and Momentum.

Text Books
2. Quantum Mechanics -- G Aruldhas - Prentice Hall of India 2006

Reference Books
1. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005

12PH311 NUCLEAR AND PARTICLE PHYSICS

Credits: 4:0:0

Course Objective:
- To make the students understand the constituent particles and the forces existing inside the nucleus
- To give an idea about the nuclear reaction and nuclear reactors
- To give a brief idea about the elementary particles

Course Outcome:
Students will understand about the structure of nucleus and the forces inside the nucleus. They learn about fission and fusion reactions and conditions for the controlled nuclear reaction which are applied in the reactors.

Unit I

Unit II

Unit III

Unit IV

Unit V
PARTICLE PHYSICS: Classification of fundamental forces and elementary particles – Isospin, strangeness – Gell- Mann Nishijima’s formula – Quark model, SU (3) Symmetry, CPT invariance in different interactions parity non conservation – K meson.

Text Books

Reference Books

12PH312 SPECTROSCOPY II

Credits: 4:0:0
Course Objective:
- To understand the different Spectroscopic techniques
- To know the application of spectroscopic techniques

Course Outcome:
- Students understand the usage of different spectroscopic techniques to the structural and chemical analysis of molecules

Unit I
NMR SPECTROSCOPY: NMR – Basic principles – Classical and Quantum mechanical description – Bloch equation – Spin – Spin and spin lattice relaxation times – Experimental methods – Single Coil and double coil methods – Pulse method

Unit II
ESR SPECTROSCOPY: ESR basic principles – High Resolution ESR Spectroscopy – Double Resonance in ESR- ESR spectrometer.

Unit III

Unit IV
MOSSBAUER SPECTROSCOPY: Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe²⁺ compounds. Isomer shieft, quadruple splitting, hyperfine interaction, instrumentations and applications.

Unit V
MASS SPECTROSCOPY: Introduction- ion production- fragmentation- ion analysis- ion abundance- common functional groups- high resolution mass spectroscopy- instrumentation and application.

Text Books

Reference Books
5. Understanding Mass spectra-A basic approach Smith, R.M and Busch,K.L Newyork, John Wiely& sons inc. (1999),

12PH313 SOLID STATE PHYSICS

Credits: 4:0:0

Course Objective:
• To get knowledge on band theory of solids
• To understand theoretical aspects of dielectric magnetic and optical properties of solids
• To gain knowledge on the principle of super conductivity

**Course Outcome:**
• To apply the theory of solids to solve practical problems

**Unit I**
**LATTICE VIBRATIONS:** Elastic vibration – Mono atomic lattice – Linear diatomic lattice – optic and acoustic modes – infrared absorption – localized vibration – quantization of lattice vibration – Phonon momentum. (photon-phonon interaction)


**Unit II**

**Unit III**

**Unit IV**

**Unit V**
**SUPER CONDUCTIVITY:** Zero resistance – Behavior in magnetic field – Meissner effect – thermodynamics of super conductive materials – Electro dynamics – London equations – B.C.S. theory (qualitative) - Tunneling A.C. and D.C. Josephson effect – Type I and II superconductors – High Tc super conductors (basic ideas)

**Text Book**
1. Introduction to Solid State Physics- Kittel, John wiley, 8th edition,2004

**Reference Books**

**12PH314 PHYSICS OF NANOMATERIALS**

**Credits 4:0:0**

**Course Objective:**
To understand the theoretical concepts of nanomaterials
To gain knowledge on preparation and characterization techniques
To get knowledge on bio and other nanomaterials

Course Outcome:
- Students apply the knowledge to prepare and characterize novel nanomaterials

Unit I
**INTRODUCTION TO NANO:** Basic concepts of nano materials – Density of states of 1, 2 and 3D quantum well, wire, dot-Shrodinger wave equation for quantum wire, Quantum well, Quantum dot-Formulation of super lattice- Quantum confinement- Quantum cryptography

Unit II
**FABRICATION OF NANOSCALE MATERIALS:** Top-down versus Bottom-up - Thin film deposition - Epitaxial growth - CVD, MBE, plasma - Lithographic, photo, e-beam - Etching - Synthesis - Colloidal dispersions - Atomic and molecular manipulations - Self assembly - Growth modes, Stransky-Krastinov etc – Ostwald ripening

Unit III
**ELECTRICAL AND MAGNETIC PROPERTIES:** Electronic and electrical properties - One dimensional systems - Metallic nanowires and quantum conductance - Carbon nanotubes and dependence on chirality - Quantum dots - Two dimensional systems - Quantum wells and modulation doping - Resonant tunnelling - Magnetic properties - Transport in a magnetic field - Quantum Hall effect - Spin valves - Spin-tunnelling junctions - Domain pinning at constricted geometries - Magnetic vortices

Unit IV
**MECHANICAL AND OPTICAL PROPERTIES:** Mechanical properties - Hardness - Nanoindentation - Individual nanostructures - Mechanical properties - Bulk nanostructured materials - Ways of measuring - Optical properties - Two dimensional systems (quantum wells) - Absorption spectra - Excitons - Coupled wells and superlattices - Quantum confined Stark effect

Unit V
**NANODEVICES:** Background - Quantization of resistance - Single-electron transistors - Esaki and resonant tunneling diodes - Magnetic Nanodevices - Magnetoresistance - Spintronics - MEMS and NEMS

Text Book
1. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley, 2003

Reference Books
2. Introduction to Solid State Physics, C. Kittel, a chapter about Nanotechnology, Wiley, 2004

**12PH315 PHOTONICS**

Credits: 4:0:0

Course Objective:
- To learn various processes involving in the development of laser.
- To understand the various applications using lasers
- To know the working and fabrication of optical fibers

Course Outcome:
To understand the fabrication and application of various lasers and optical fiber.

Unit I
PROPERTIES OF GAUSSIAN BEAMS: The paraxial wave equation, Gaussian beams, the ABCD law for Gaussian beams, Gaussian beam modes of laser resonators. Higher order Gaussian beam modes. Diffraction theory of laser resonators, unstable resonators for high power lasers.

Unit II

Unit III
NONLINEAR OPTICS-I: Introduction to nonlinear optics, nonlinear polarization and wave equation, second harmonic generation, phase matching, three-wave mixing, parametric amplifications, oscillations, tuning of parametric oscillators, nonlinear susceptibilities, nonlinear susceptibility tensor, nonlinear materials

Unit IV
NONLINEAR OPTICS-II: Propagation of light through isotropic medium, propagation light through anisotropic medium, theory of electro-optic, magneto-optic and acousto-optic effects and devices, integrated optical devices and techniques.

Unit V

Text Books

Reference Books
2. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), (1993)

12PH316 THIN FILM TECHNOLOGY

Credits 4:0:0

Course Objective:
- To gain knowledge on vacuum systems, Thin film coating techniques
- To understand the growth process of thin film
- To study on characterization techniques and thin film applications

Course Outcome:
- To apply the knowledge of thin film coating techniques to prepare thin films by various methods
- To do characterization studies on thin films and fabricate thin film devices

Unit I
VACUUM SYSTEM: Categories of deposition process, basic vacuum concepts, pumping systems- rotary, diffusion and turbo molecular, monitoring equipment – McLeod gauge, pirani, Penning, Capacitance diaphragm gauge - Evaporation – deposition mechanism, evaporation sources- tungstenhelical, hair pin, basket, molybdenum boat, process implementation, deposition condition

Unit II
THIN FILM COATING TECHNIQUES: Molecular beam epitaxy, sputtering - dc, rf, magnetron, chemical vapour deposition, electro plating- potentiostat, galvanostat, pulsed plating, sol gel coating, LASER ablation, spray Pyrolysis-Substrate materials, material properties – surface smoothness, flatness, porosity, mechanical strength, thermal expansion, thermal conductivity, resistance to thermal shock, thermal stability, chemical stability, electrical conductivity -Substrate cleaning, substrate requirements, buffer layer, metallization

Unit III
GROWTH PROCESS: Adsorption, surface diffusion, nucleation, surface energy, texturing, structure development, interfaces, stress, adhesion, temperature control - Epitaxy-semiconductor devices, growth monitoring, composition control, lattice mismatch, surface morphology

Unit IV
STRUCTURAL, OPTICAL AND ELECTRICAL STUDIES ON THIN FILMS: X- Ray Diffraction studies – Bragg’s law – particle size – Scherrer’s equation – crystal structure – UV Vis NIR Spectroscopy - absorption and reflectance-Optical constants of a thin film by transmission and reflectance at normal incidence for a system of an absorbing thin film on thick finite transparent substrate, Photoluminescence (PL) studies – Fourier Transform Infrared Spectroscopy (FTIR) - Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density

Unit V

Text Books

Reference Books
12PH317 NANODEVICES

Credits: 4:0:0

Course Objective:
- To learn the various modern technologies used in nano devices and sensors.
- To know about the Semiconductor, bio and Photonics based sensors and its electronic properties of such nanostructure devices.
- To understand the effect of the reduced dimensionality on the electronic charge transport.

Course Outcome:
- To apply the operating principle of various nanodevices and its single atom manipulation

Unit I
ELECTRONIC NANODEVICES: Background, Quantum layers, dots and wires, Electronic level modification of 0D, 1D, 2D - Quantization of resistance, Esaki and resonant tunneling diodes, Mott-wannier excitons - molecular electronics, information storage, molecular switching, Schottky devices.

Unit II

Unit III

Unit IV
SENSOR FOR BIO-MEDICAL APPLICATIONS: Cardiology, Neurology and as diagnostic tool, Biosensors. Clinical Diagnostics, generation of biosensors, immobilization, characteristics, applications, conducting Polymer based sensor, DNA Biosensors, optical sensors. Biochips

Unit V
MAGNETIC NANODEVICES: Magnetoresistance, Spintronics, MEMS and NEMS - Fabrication, Modeling Applications MEMS and NEMS, Packaging and characterization of sensors, Method of packaging at zero level, dye level and first level Sensors. Photonic Nanodevices-Semiconductor quantum dots, Photonic crystals, Metamaterials

Text Books
2. Between Technology & Science: Exploring an emerging field knowledge flows & networking on the nanoscale by Martin S. Meyer.2007
Reference Books
1. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng , Talylor and Francis,2003

12PH318 QUANTUM PHYSICS

Credit: 4:0:0

Course Objective:
- To understand quantum theory and to learn about the formulation of quantum mechanics
- To learn about the solutions of Schrödinger equations in one dimensional problems
- To gain knowledge on the approximation method used for solving stationary states problems

Course outcome:
- To execute the use of quantum theory to various problems in atomic and molecular scale

Unit I

Unit II

Unit III
SOME APPLICATIONS: Solutions to square well potential – Energy levels for one dimensional square well potential – Infinitely high sides, finite sides, a single step barrier, finite potential barrier –Tunnel effect, Bloch waves in a periodic potential, Kronig –Penny periodic potential

Unit IV

Unit V

**Text Book**

**Reference Books**

**12PH319 ELECTROMAGNETISM**

**Credit: 4:0:0**

**Course Objective:**
- To learn the basics of electricity and magnetism and equations governing them.
- To acquire knowledge of fundamentals of magnetism
- To know the Maxwell’s equations
- To learn about the electromagnetic waves.

**Course outcome:**
- To apply the fundamental concept of electricity and magnetism in day to day life

**Unit I**

**Unit II**
**BOUNDARY VALUE PROBLEMS IN ELECTROSTATICS:** Method of images – Point charge in the presence of grounded conducting sphere – Point charge in the presence of charged, insulated, conducting sphere – Point charge near a conducting sphere at fixed potential – Green function for the sphere, general solution for the potential – Orthogonal functions and expansions – Laplace equations in spherical coordinates – Legendre equations and Legendre polynomials – Addition theorem for spherical harmonics – Multipole expansions – Boundary value problem with dielectrics

**Unit III**
**MAGNETISM:** Theories of magnetic field, magnetic induction – Biot Savart’s Law - Faraday’s laws – flux density, field strength and magneto motive force – Ampere’s law – energy stored in a magnetic field – volume distribution of current and Dirac Delta – magnetic vector potential – Analogies between electric and magnetic fields – equation of continuity for time varying fields – inconsistency of Ampere’s law

**Unit IV**

Unit V


Text Books

Reference Books

12PH320 RENEWABLE ENERGY SOURCES

Credits 4:0:0

Course Objective:
- To give an overview of the energy problem faced by the current generation
- To highlight the limitations of conventional energy sources that affect the climate
- To underline the importance of renewable energy sources
- To give a thorough knowledge about various renewable energy technology and to give a glimpse of cutting edge research technology that is happening place in the field of renewable energy sources.

Course Outcome :
- The students will understand the problems of conventional energy sources. They will realize the importance of renewable energy sources and try to find solutions to non-conventional energy sources by research.

Unit I


Unit II

Unit III

Unit IV

Unit-V

Text Books

Reference Books

12PH321 SPECTROSCOPY

Credit: 4:0:0

Course Objective:
- To learn the atomic and molecular structure.
- To understand the different Spectroscopic techniques
- To know the application of spectroscopic techniques

Course Outcome:
- To understand the usage of different spectroscopic techniques to determine the molecular structure and constants.

Unit I

Unit II

Unit III

Unit IV

Unit V

Text Book

Reference Books
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson

12PH322 CONDENSED MATTER PHYSICS

Credit: 4:0:0
Course Objective:
- To provide fundamental physics behind different materials we commonly see in the world around us.
- To study the materials and their properties using different theoretical and experimental methods.
- The class will demonstrate the link between microscopic structure and bulk properties in a variety of systems in hard and soft condensed matter.

Course outcome:
- The students will be able to understand how different kinds of matter are described mathematically and how material properties can be predicted based on microscopic structure.

Unit I

Unit II
SEMICONDUCTING MATERIALS: Introduction, Structure and bonding in elemental, compound semiconductors, direct and indirect bandgap semiconductors, Intrinsic and extrinsic semiconductors, carrier concentration in n-type semiconductors and variation of Fermi level with temperature and concentration of donor atoms and carrier concentration in p-type and variation of Fermi level with temperature and concentration of donor atoms semiconductors, Hall effect and its applications.

Unit III
SUPERCONDUCTING MATERIALS: Superconductors-mechanism of superconductors, Effects of magnetic field, Meissner Effect, Thermal properties, Type I and Type II Superconductors, London Equations, BCS theory, Quantum tunnelling, Josephson’s Tunneling, Theory of DC Josephson Effect, New superconductors.

Unit IV
DIELECTRIC PROPERTIES: The Microscopic concept of polarization, Internal field or local field in liquids and solids, Clausius mosotti relation, Ferroelectricity, Dipole theory of ferroelectricity, piezoelectricity, properties of dielectrics in alternating fields, the complex dielectric constants and dielectric loss, effects of dielectrics.

Unit V
MAGNETIC PROPERTIES: Quantum theory of Paramagnetism, Paramagnetism of ionic crystals, Rare earth ions Ferromagnetism, Weiss theory, Temperature dependence of magnetism, Exchange interaction, Ferromagnetic domains surfaces, Bloch Wall, Antiferromagnetism, Molecular field theory, Neel temperature, Ferrimagnetism.

Text Books
1. Introduction to Solid State Physics – Charles Kittel.7th edition 2000

Reference Books
12PH323 RADIATION TREATMENT PLANNING

Credits: 4:0:0

Course Objective:
- To gain knowledge on radiotherapy machines
- To understand the interaction of photon beam on matter
- To learn about the clinical treatment planning
- To gain knowledge on electron beam therapy and advanced radiotherapy treatment methods

Course outcome:
- To demonstrate overall knowledge on radiotherapy treatment planning

Unit I
RADIOTherAPY MACHinEs: X-rays and Gamma rays - Linear accelerator-Components of modern linacs - Injection system - RF power generation system - Accelerating wave guide - Microwave power transmission - Auxiliary system - Electronic beam transport - Linac treatment head - Production of photon and electron beams from linac - Beam collimation - Cobalt-60 versus linac - Radiation therapy simulators.

Unit II
PHYSICAL ASPECTS OF EXTERNAL PHOTON BEAMS: Photon beam sources - Inverse square law - Penetration of photon beams into phantom or patient - Surface dose - Build up - Skin sparing effect - Percentage depth dose - Tissue air ration – Back scattering factor - Tissue phantom ratio - Tissue maximum ratio - Scatter air ratio - Total scatter factor - Isodose distribution in water phantom - Isodose charts and factors effecting – Correction of irregular counters - Missing tissue compensation - Correction of tissue inhomogeneity – Clarkson’s method - Dose calculation.

Unit III

Unit IV

Unit V
Text Books

Reference Books
1. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
3. Radiation therapy Physics, WR. Hendee and GS. Ibbott, J. Wiley, 2004

12PH 324 MEDICAL RADIATION DOSIMETRY

Credits 4:0:0

Course Objective:
- To learn the basic concepts of radiation
- To understand the interaction of radiation with matter
- To understand Kema, dose activity
- To gain knowledge on dosimetry systems

Course outcome:
- To demonstrate knowledge on radiation and dosimetry systems

Unit I

Unit II
INTERACTION OF RADIATION WITH MATTER: Types of indirectly ionizing radiation - Photon beam attenuation – Types of photon interactions - Types of electron interactions-Types on neutron interactions - Photo electric effect – Coherent scattering - Compton effect - Pair production - Photo nuclear disintegration - Effect following radiation interaction.

Unit III
RADIATION QUANTITIES AND UNITS: Radiometric, interaction, protection and dosimetric quantities - Particle and energy fluence - Linear and mass attenuation coefficient - Stopping power – Linear energy transfer – Absorbed dose - Kerma – Exposure – Activity - Equivalent dose - Effective dose - Electronic or charged particle equilibrium – Bragg gray cavity theory.

Unit IV
RADIATION DETECTION: Properties of dosimeters - Methods of radiation detection - Ionization chamber dosimetry system - Proportional counters - Geiger Muller counters - Semi conductor detector - Solid and liquid scintillation counters - Film dosimetry – Thermoluminouscent dosimetry - Calorimetry - Chemicaladosimetry

Unit V
CALIBRATION OF PHOTON AND ELECTRON BEAMS: Calibration chain - Ionization chambers - Electro meter and power supply – Phantoms – Chamber signal corrections for influence quantities - Calibration of mega voltage photon beams based and mega voltage electron beams based on standard national and international protocols .

Text Books

Reference Books
1. Treatment Planning in Radiation Oncology by FM. Khan and RA. Potish, Williams & Wilkins, 1998
2. Radiation Detection and Measurement by GF. Knoll, Published by Wiley, 2000
4. Radiation therapy Physics by WR. Hendee and GS. Ibbott, J. Wiley, 2004

12PH325 RESEARCH METHODOLOGY

Credits: 4:0:0

Course Objective:
• To gain knowledge on various research tools available for carrying out research
• To gain understanding on numerical and statistical methods to solve research problems
• To solve simple statistical and numerical problems using C++ programming

Course Outcome:
• To apply various techniques for practical problems
• To apply numerical and statistical problem solving skills and computer programming skills to solve research problems

Unit I
STRUCTURAL CHARACTERIZATION: Production and properties of X-rays, X-ray analysis: X-ray diffraction; Effect of texture, particle size, micro and macro strain on diffraction lines. Scanning electron microscopy: construction, interaction of electrons with matter, modes of operation, image formation, Atomic probe microscopy and scanning tunneling microscopy: principles and practice

Unit II

Unit III
STATISTICAL METHODS: Correlation- comparison of two sets of data- comparison of several sets of data- Chi squared analysis of data- characteristics of probability distribution-some common probability distributions- Measurement of errors and measurement process – sampling and parameter estimation- propagation of errors- curve fitting- group averages – equations involving three constants- principle of least squares- fitting a straight line, parabola and exponentials curve method of moments

Unit IV

Unit V
APPLICATION OF NUMERICAL AND STATISTICAL METHODS USING C++ PROGRAMMING: Solving quadratic equations — solution of equation by Newton Raphson method – matrix diagonalization (Jacobian method) – Integration by Simpson’s rule – Fitting of a straight line using principle of least square

Text Books

Reference Books
1. B.K.Sharma, Spectroscopy Goel publishing house, 2007

12PH326 MATERIAL CHARACTERIZATION

Credits: 4:0:0

Course Objective:
- To know about the Microscopic and Spectroscopic methods
- To understand the analysis of materials using electron microscopy and optical methods
- To learn the instrumentations of Thermal, Electrical, Mechanical and Magnetic methods of characterization.

Course Outcome:
- To understand various methods available for characterizing the materials.

Unit I

Unit II
SPECTROSCOPIC METHODS: Principles and Instrumentation for UV-Vis-IR, FTIR Spectroscopy, Raman Spectroscopy, NMR, XPS, AES and SIMS-proton induced X-Ray Emission spectroscopy (PIME) – Rutherford Back Scattering (RBS) analysis – application.

Unit III
ELECTRON MICROCOPY AND OPTICAL CHARACTERISATION: SEM, EDAX, EPMA, TEM, STEM working principle and Instrumentation- sample preparation- data collection, processing and analysis- Photoluminiscence-light-matter interaction-instrumentation- Electroluminescence-instrumentation-Applications

Unit IV

Unit V

Text books

Reference Books

12PH327 CRYSTAL GROWTH TECHNIQUES

Credits: 4:0:0

Course Objective:
+ To study the basic knowledge about the nucleation mechanism involved in crystal growth
+ To understand the broad areas of crystal growth methods such as melt, solution, vapour transport.
+ To understand some of the advanced crystal growth systems such as CVD and PVD

Course Outcome:
+ Students can understand the different techniques used for growing crystals

Unit I

Unit II

Unit III

Unit IV

Unit V

Text Books

Reference books

12PH328 RADIATION PHYSICS

Credits: 4:0:0

Course Objectives:
• To review the basic physics principles of atomic and nuclear physics
• To study the basics of radiation physics and interaction of radiation with matter
• To know about the basic counting statistics, calibration and methods of measuring radiation
• To understand the sources of radiation in the environment and their applications

Course Outcome:
• The students will become familiar with the basics of radiation physics and their sources in the environment, their methods of detection and the application of different types of radiations.

Unit I

Unit II
RADIOACTIVITY AND INTERACTION OF RADIATION WITH MATTER:

Unit III

Unit IV

Unit
RADIATION IN THE ENVIRONMENT AND THEIR APPLICATIONS: Types of radiation sources – Natural radiation sources – Artificial sources of radiation – Applications of radiations – Medical applications – Industrial applications – Radiation in food processing industry – Agricultural applications – Isotope hydrology – Miscellaneous applications

Text books

Reference Books

12PH329 NANOFLOUIDS
Course Objective:
- To know the basics of nanofluids
- To learn the nanofluid synthesis methods
- To understand the basics of conductive and convective heat transfer
- To learn the application of nanofluids

Course Outcome:
- Students can understand the basics and industrial application of nanofluids

Unit I

Unit II

Unit III

Unit IV

Unit V

Text Book

Reference Books
3. Heat transfer Principles and applications, Binay K. Dutta, Prentice – Hall of India
12PH330 ELECTRONICS LAB

Credits: 0:0:2

Course Objective:
- To get practical skill on basic electronic experiments.

Course Outcome:
- To apply the practical skill on electronic circuits to various applications.

LIST OF EXPERIMENTS:

1. Study the static and drain characteristics of a JFET.
2. Study the characteristics of UJT.
3. Operational amplifier – characteristics
4. Construction of adder, subtractor, differentiator and integrator circuits using the given OP – Amp.
7. Construction of an A/D and D/A converter circuit and study its performance.
8. Construction of a half-adder, full-adder, half-subtractor and full-subtractor using logic gates.
11. Construction of a low-pass, high pass filter circuits and study its output performance.
12. IC 555-Timer – Study of waveforms
13. Study of flip – flops – using ICs
14. Decade counter using J-K flip flop
15. Arithmetic operation using 8086
16. Addition and subtraction of two 16 bit numbers using 8086
17. One’s compliment of a 16 bit number
18. Computing Boolean expression
19. Program to sort numbers in ascending and descending order
20. Interfacing a stepper motor with 8086

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

**12PH331 GENERAL PHYSICS LAB**

**Credits: 0:0:2**

**Course Objective:**
- To get practical skill on basic optical, electrical and electronic experiments.
- To understand the advance experiments on properties of matter.

**Course Outcome:**
- To apply the knowledge on basic Physics experiments to solve practical problems.

**LIST OF EXPERIMENTS:**

1. Young’s modulus – Cornu’s method
2. Zener diode characteristics, Photodiode characteristics & Solar cell characteristics
3. Ultrasonic interferometer - Velocity of sound in liquids using ultrasonics
4. Constant deviation spectrometer - Cauchy’s Constant and dispersive power of a prism
5. Hall effect in semiconductors (Determination of Hall coefficient, mobility and type of charge carriers)
6. Diffraction using He-Ne laser/diode laser
7. To determine the dielectric constant of liquids and solids
8. Refractive index of liquids – using-He-Ne laser/diode laser
10. Stefan's constant - To determine Stefan's constant
11. Dielectric constant by Lecher Wire.
12. Fraunhofer lines-identification of elements
14. Determination of ‘h’-photoelectric effect.
15. Clausius – Mossotti equation using sugar solution (Determination of Polarisation.)
HoD can give any 10 relevant experiments at the beginning of the course in each semester.

**12PH332 MICROPROCESSOR / CONTROLLER LAB**

**Credits:** 0:0:2

**Course Objective:**
- To understand the architecture of microprocessors and methodology of programming.

**Course Outcome:**
- Student will be able to write simple program using microprocessor for practical Applications.

**LIST OF EXPERIMENTS:**
1. Arithmetic operation using 8086
2. Addition and subtraction of two 16 bit numbers using 8086
3. One’s compliment of a 16 bit number
4. Computing Boolean expression
5. Program to short numbers in ascending and descending order
6. Matrix addition
7. Factorial
8. Sum of numbers in a word array
9. Calculating the length of the string
10. Up down counter
11. String operation
12. Rolling display
13. Timer interface
14. Interface a stepper motor with 8086
15. Programmable interrupt controller
16. Stepper motor using microcontroller
17. Rolling display using microcontroller
18. Arithmetic operations using microcontroller

HoD can give any 10 relevant experiments at the beginning of the course in each semester.
12PH333 ADVANCED PHYSICS LAB –I

Credits: 0:0:2

Course Objective:
- To get practical skills on advance experiments on optics, electricity and magnetism.

Course Outcome:
- Student will be able to apply the knowledge on advance Physics experiments to solve Research problems.

LIST OF EXPERIMENTS:

1. Study of magnetic hysteresis - B-H Curve
2. Determination of Brewster’s angle & estimation of refractive index of a given transparent material.
3. “e” by Millikan oil drop method.
4. Determination of Rydberg constant using Hydrogen discharge tube.
5. Polarizability of Liquids
6. Four Probe Method – Determination of resistivity of semiconductor at different temperatures, determination of band gap
7. Michelson Interferometer
8. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne - Laser
9. Diamagnetic and paramagnetic susceptibility of solids
10. Band gap determination by photoconductivity
11. Photosensitive devices
12. Young’s modules – elliptical fringe method
13. Young’s modules – Hyperbolic fringe method
14. Frank - Hertz Experiment.

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

12PH334 COMPUTATIONAL PHYSICS LAB

Credits: 0:0:2

Course Objective:
- To gain programming skills to solve simple problems using C++ Programming.
- To solve simple statistical and numerical problems using C++ programming.
Course Outcome:
- To apply the programming skills to solve practical problems.
- To apply numerical and statistical problem solving skills and computer programming skills to solve research problems.

LIST OF EXPERIMENTS:
1. Ascending and descending order of numbers and characters, arithmetic mean, mode and variance
2. Matrix addition, subtraction, multiplication, transpose and inverse of a matrix
3. Evaluating a root of non-linear equation by Newton-Raphson method using external function
4. Program to solve system of linear equations using simple Gaussian elimination method
5. Program for straight line fit using the method of least squares for a table of data points
6. Program for polynomial curve fitting (real life examples such as rainwater, temperature etc.,)
7. Program to integrate any function or tabulated data using trapezoidal rule
8. Program to integrate any function or tabulated data using Simpson’s rule
9. Program to compute the solution of a first order differential equation of type \( y' = f(x, y) \) using the fourth order Runge-Kutta method
10. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
11. Program to compute the interpolation value at a specified point, given a set of data points using Newton’s interpolation representation
12. Program to calculate and print the mean, variance and standard deviation of set of N Numbers
13. Program to solve the quadratic equation
14. Program to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

12PH335 ADVANCED PHYSICS LAB –II

Credits 0:0:2

Course Objective:
- To get practical skill on various deposition techniques to prepare thin films and grow Crystals having nanostructures
- To get practical training on some basic characterization techniques of nanostructure thin films and crystals
Course Outcome:
- To apply the practical knowledge to fabricate novel nano devices to solve research problems

LIST OF EXPERIMENTS:

1. Synthesis of nano materials by vacuum deposition method
2. Synthesis of nanoparticles by chemical method
3. Particle size analyzer
4. Spray deposition
5. Spin Coating – sol gel
6. Electro deposition
7. Electro spinning method
8. Sputtering technique
9. Growth of single crystals from solution
10. Growth of single crystals from vapour
11. Spectra of atoms and molecules
12. XRD analysis
13. UV-visible spectrophotometer
14. Photoluminescence spectra

HoD can give any 10 relevant experiments at the beginning of the course in each semester.

12PH336 NANO PHYSICS LAB

Credit: 0:0:4

Course Objective:
- To train the students to operate advanced equipments and to understand the basic concepts of Nanotechnology
- To equip the students with practical knowledge about Nano Materials

Course outcome:
- To demonstrate the practical skill on measurements and instrumentation techniques of some Nano physics experiments.

LIST OF EXPERIMENTS:

1. Synthesis of nano materials by vacuum deposition method
2. Synthesis of nanoparticles by chemical method
3. Laser particle size analyzer
4. Spray deposition
5. Spin Coating – sol gel
6. Electro deposition
7. Electro spinning method
8. Sputtering technique
9. Growth of single crystals from solution
10. Growth of single crystals from vapour
11. Spectra of atoms and molecules
12. XRD analysis
13. UV-visible spectrophotometer
14. Photoluminescence spectra

HoD can give any 10 relevant experiments at the beginning of the course in each semester.
LIST OF SUBJECTS

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<td>13PH202</td>
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13PH201 APPLIED PHYSICS

Credits: 3:0:0

Objective:
- To impart knowledge on the basic concepts of quantum mechanics and its applications
- To understand the working principle of various lasers and its application in fibre optics
- To study the principles of acoustics and applications of ultrasonic waves
- To get more knowledge on engineering materials and its applications

Outcome:
- To apply physics principles of latest technology to solve practical problems of real world

Unit I

Unit II

Unit III
FIBRE OPTICS: Principle of optical fibre- Structure of optical fibres-Propagation in optical fibres- Acceptance angle and acceptance cone-Numerical aperture-V number, Types of optical fibres based on material, mode and refractive index, Losses in Optical fibres - Applications: Optical fibres for communication- Fibre endoscope.

Unit IV

Unit V

Text Book
Reference Books
1. John W. Jewett, Jr., Raymond A. Serway - Physics for Scientists and Engineers with Modern Physics, Cengage Learning India Private Ltd, 2008
13PH202 APPLIED PHYSICS LAB

Credits 0:0:2

Objective:
- To train engineering students on basis of measurements and the instruments
- To give practical training on basic Physics experiments which are useful to engineers
- To equip the students with practical knowledge in electronic, optics, and heat experiments

Outcome:
- To demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments.

The faculty conducting the Laboratory will prepare a list of experiments [10/5 for 2/1 credit] and get the approval of HoD and notify it at the beginning of each semester.