Code No.	Subject Name	Credits
	PHYSICS DIVISION	
PH101 PH102	Applied Physics Applied Physics Lab	2:0:2 0:0:2

PH101 APPLIED PHYSICS

Credit: 2: 0: 2
Marks: (40+50) + (60+50)

Unit I : Laser
Spontaneous and stimulated emission of radiation - population inversion – Ruby laser, He-Ne laser, Co_2 laser, semi-conductor laser, Nd-YAG laser – applications – medical and engineering – computer peripherals – CD ROM – 3D profiling.

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

Unit II : Properties of Materials
Semi Conductor materials – materials preparation – Zone refining and Czocharalski methods. Hall effect and its application – junction devices – zener diode, tunnel diode, LED and solar cell.

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
Bragg Ionisation Spectrometer, Laue method – powder method – review of fundamental laws of radioactivity – induced radio activity – particle accelerators – synchrocyclotron – betatron.

Text Book

1. Rajendran V., Marikani A., 'Applied Physics for Engineers' III Ed. TMH Publishing Co. Ltd., 2001

Reference Books

1. Laud B.B. Laser and Non Linear Optics, Wiley Eastern Ltd., 1991
2. Krane K.S., Introductory Nuclear Physics, John Wiley & Sons, 1988
3. Sze S.M., Physics of semiconductor devices, Wiley, 1982

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.
3. Rigidity Modulus Determination – Torsional Pendulum Method.
4. Thickness Measurement – Single Optic Lever Method.
5. Thickness Measurement – Air Wedge Method.
6. Wave Length of Light – Laser Grating Method.
7. Radius of Curvature Measurement – Newton's Rings Method.
8. Refractive Index of Prism – Spectrometer Method.
9. Wave Length Determination Of Mercury Source – Spectrometer Grating.
10. Determination of Energy Loss In Ferrites – Hystersis Method.
11. Efficiency of Solar Cell.
12. Determination of Energy Band Gap In Germanium Diode – Reverse Current Saturation Method.
13. Characteristic Study Of Junction Transistor.
14. Characteristic Study Of Zener Diode.
15. Logic Gates – Using IC's.

PH103 APPLIED PHYSICS

Credit: 3:0:0 **Marks 40 + 60**

UNIT I : Optics

Lasers: Introduction – Interaction of radiation with matter (Quantum Mechanical View) – Metastable state – Active medium – Population and thermal equilibrium - Conditions for light amplification – Population inversion – Negative absorption – Pumping – The principle pumping schemes – Optical resonator – Laser beam characteristics - Kinds of lasers – He-Ne, CO_2, Nd-Yag & Semiconductor laser – Applications – Laser welding and cutting.

Fibre Optics: Introduction – Optical fibres – Propagation of light through a cladded fibre – Modes of propagation – Types of optical fibres – Materials – V-number – Optical waves in communication – Advantages.

UNIT II : Electric Field and Maxwell's Equation

Introduction – Electric field – The line integral of a vector field – The curl of a vector field – Stoke's theorem – Ampere's law – Poisson's equation – Laplace's equation – Current & continuity equation – Faraday's law – Displacement current – Absence of magnetic change.

Maxwell's Equation: Introduction – Maxwell's equation – The wave equation, Hertz's discovery. Plane electromagnetic waves – Transverse nature of electromagnetic waves. The poynting vector - Momentum and Radiation pressure.

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

Introduction – Sound – Reflection of sound waves – Defects due to reflected sound – Absorption of sound – Sabine's formula – Reverberation theory – Eyring's equation – Acoustic design of a Hall – Common acoustical defects – Acoustical materials.

Ultrasonics: Introduction - Generation of ultrasonic waves – Properties of ultrasonic waves – Determination of wavelength and velocity – Applications.

UNIT V : Elements of Thermodynamics:

Introduction – Concept of temperature – Heat – Thermodynamics – Terminology – Work Heat in thermodynamics – Comparison of Heat and work – Internal energy – Law of conservation of energy – First law of thermodynamics – Applications of the first law – Heat engine – The carnot cycle – Heat pump – Second law of thermodynamics – Entropy - Third law of thermodynamics.

Text Book

1. Avadhanulu M.N. and Kshir Sagar P.G., "A Text Book of Engineering Physics", S. Chand & Company Ltd., New Delhi, 2003

Reference Books

1. Gour R.K. and Gupta S.L., “Engineering Physics”, Dhanpat Rai Publications, New Delhi, 2002
2. Arumugam M., “Engineering Physics”, Anuradha Agencies, Kumbakonam, 2002
3. Nelkon and Parker, “Advanced Level Physics”, Arnold Keinemann, 2002

PH104 APPLIED PHYSICS

Credit : 3:0:0 **Marks: 40 + 60**

Unit I : Optics

LASERS: Introduction – Interaction of radiation with matter (Quantum Mechanical View) – Metastable state – Active medium – Population and thermal equilibrium - Conditions for light amplification – Population inversion – Negative absorption – Pumping – The principle pumping schemes – Optical resonator – Laser beam characteristics - Kinds of lasers – He-Ne, CO_2, Nd-YAG & Semiconductor laser – Applications – Laser welding and cutting.
FIBRE OPTICS: Introduction – Optical fibres – Propagation of light through a cladded fibre – Modes of propagation – Types of optical fibres – Materials – V-number – Optical waves in communication – Advantages – Applications of Fibre in Sensors.

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

DIELECTRIC MATERIALS: Introduction – Definitions – Different types of Polarizations – Local Field – Types of Dielectric Materials – Clausius- Mosotti equation – Experimental determination of dielectric constant – Dielectric loss – Lossy dielectrics – Dielectric breakdown – Dielectric properties – Applications.
SUPER CONDUCTING MATERIALS: Introduction – Properties – Types of Superconductors – BCS theory – High temperature super conductor – Applications – Piezoelectric Materials and Shape Memory Alloys.

Unit IV : Acoustics

ARCHITECTURAL ACOUSTICS: Introduction – Sound – Reflection of sound waves – Defects due to reflected sound – Absorption of sound – Sabine's formula – Reverberation theory – Eyring's equation – Acoustic design of a Hall – Common acoustical defects – Acoustical materials.
ULTROSONICS: Introduction - Generation of ultrasonic waves – Properties of ultrasonic waves – Determination of wavelength and velocity – Applications.

Unit V : Atomic Physics

Introduction – Wave nature of matter – De Broglie's waves – Properties of matter waves – Experimental verifications: Davisson – Germer Experiment – G.P. Thomson's Experiment – Wave Packet – Heisenberg's uncertainty principle – Schroedinger's wave equation – Applications: Particle in a box, Electron in a cubic potential well.

Text Book:

1. Avadhanulu, M.N. and Kshir Sagar, P.G. - "***A Text Book of Engineering Physics***". S.Chand &Company Ltd, New Delhi, 2003.

Reference Books:

1. Gour R.K. and Gupta S.L. – "***Engineering Physics***". Dhanpat Rai Publications, New Delhi, 2002.
2. M. Arumugam – "***Engineering Physics***", Anuradha Agencies, Kumbakonam, 2002.
3. Nelkon and Parker – "***Advanced Level Physics***" - Arnold Keinemann, 2002.
4. S.O. Pillai – "***Solid State Physics***", McGraw Hill Publishers.
5. Feyman R.P., Leighton R.B. and Sands M. Feyman "Lectures on Physics", Vol. 1-5, Narosa
6. Haliday & Resinick, "Physics" Vol. I & II, Tata McGraw Hill
7. "Fundamentals of Acoustics", Kingsley

DEPARTMENT

OF

PHYSICS

ADDITIONAL SUBJECTS

Code	Title of the Paper	Credit
PH301	Classical Mechanics	4:0:0
PH302	Thermodynamics & Statistical Mechanics	4:0:0
PH303	Mathematical Physics: I	3:1:0
PH304	Electronics	4:0:0
PH305	Electromagnetic Theory	4:0:0
PH306	Mathematical Physics: II	3:1:0
PH307	Quantum Mechanics	4:0:0
PH308	Solid State Physics	4:0:0
PH309	Nuclear Physics	4:0:0
PH310	Spectroscopy	4:0:0
PH311	General Physics Lab	0:0:2
PH312	Electronics Lab 1	0:0:2
PH313	Electronics Lab 2	0:0:2
PH314	Microprocessor / Controller Lab	0:0:2

PH301 CLASSICAL MECHANICS

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

Unit I : Mechanics of a System of Particles

Constraints – Generalized co-ordinates – D'Alembert's principle and Lagrange's equations – Simple applications of the Lagrangian Formulations.
Hamilton's Principle – Deduction of Largrange's equations from Hamilton'g Principle.

Unit II : The Two Body Central Force Problem

Reduction to the equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force – The motion in time in the Kepler problem – Scattering in a central force field.

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 Lorent's transformation – Lorent'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

1. Classical Mechanics, H. Goldstein, Tata McGraw-Hill.
2. Classical Mechanics, B.D. Gupta, Vikas publishing house.

PH302 THERMODYNAMICS AND STATISTICAL MECHANICS

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

Unit I : Review of the Laws of Thermodynamics and their Consequences
Energy and the first law of thermodynamics – Heat content and Heat capacity – Specific heat – Entrophy and the second law of thermodynamics – Thermodynamic potentials and the reciprocity relations – Maxwell's relations – Deductions – Properties of thermodynamic relations – Gibb's – Helmholtz relation – Thermodynamic equilibrium – Nernst's Heat Theorem and third law – Consequences of third law – Nernst's - Gibb's phase rule – Chemical potential.

Unit II : Statistical Description of Systems of Particles
Statistical formulation of the state system – phase space – Ensemble – average value – density of distribution in phase space – Liouville Theorem – Equation of motion and Liouville theorem – Equal apriori probability – Statistical equilibrium – Ensemble representations of situations of physical interest – isolated system – Systems in contact.

Unit III : Simple Applications of Statistical Mechanics
General Method of approach – Partition functions and their properties – Ideal Monatomic Gas – Calculation of Thermodynamic quantities – Gibb's Paradox. The equipartition theorem and proof – application to harmonic oscillator.
Statistical Thermodynamic Properties of Solids:
Thermal characteristics of crystalline solids – Einestein modal – Debye modification – Limitations of Debye theory – Paramagnetism – General calculation of Magnetization.

Unit IV : Quantum Statistics of Ideal Gases
Maxwell – Boltzman statistics, Bose-Einstein statistics and Fermi Dirac statistics; Calculation of distribution functions from the partition function for M-B, B-E, and F-D statistics –Quantum statistics in the classical limit – ideal Bose Gas – Bose – Einstein condensation – Ideal Fermi Gas – Degnerate Electron Gas.

Unit V : 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.

Books for Study

1. Fundamentals of Statistical and Thermal Physics – Federick Reif.

Reference Books

1. Statistical Mechanics – Bipin K. Agarwal and Melvin Einsner
2. Statistical Thermodynamics – M.C. Gupta.

PH303 MATHEMATICAL PHYSICS: I

Credit: 3:1:0 **Marks : 40+60**

Unit I : Vector Analysis

Gradient – Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's divergence theorem, Green's theorem. Stoke's theorem and their applications to Hydrodynamics (Equation of continuity and Electric Potential) Orthogonal Curvilinear coordinates – Expressions for Laplacian in spherical polar and cylindrical polar coordinates and its solutions.

Unit II : Matrices

Special matrices and their properties, Rank and inverse of matrix. Characteristic equation. Cayley Hamilton's theorem, Eigen values and Eigen vectors of matrices and their properties. Diagonalisation of matrices. Use of similarity transformation.

Unit III : Tensor Analysis

Cartesian Tensors – Law of transformation of first and second order tensors. Addition, subtraction and multiplication (inner and outer) of tensors. Rank of a tensor. Covariant and mixed tensors. Symmetric and Anti-symmetric tensors. Quotient law of tensor. Tensor form of gradient, divergence and curl. Susceptibility tensors (electric and magnetic) piezoelectric tensors.

Unit IV : Second Order Linear Differential Equations and Special Functions

Sturm Liouvilile Theory – Orthohgonality of eigen functions – Legendre, Hermite, Laugere, Bessel and Hypergeometric functions – Series solutions of these differential equations – Generating functions – Orghohgonality 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, Poison 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

1. Vector Analysis – Harry Lass –McGraw Hill, Kogakusha Ltd.
2. Matrices and Tensors in Physics – A.W. Joshi – Wiley – Eastgern Ltd.
3. Special function for Scientists – Bell – Van Nostrand – 1968.
4. Introduction to Mathematical Physics – C. Harper – Prenticas Hall of India – 1987.
5. Mathematical Physics – B.D. Gupta – Vikas Publishing House, Bombay.

6. Mathematics for Physics and Engineers. Pipes – McGraw-Hill Publishing Company.

PH304 ELECTRONICS

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

Unit I : Semiconductor Devices
Uni-Junction Transistor – Characteristics – Relaxation Oscillator FET Volt – Ampere Characteristics – MOSFET, N Channel – P Channel – FET as a voltage variable resistor – Common source amplifier – SCR – TRIAC – DIAC – Tunnel Diode – Characteristics – Basic applications.

Unit II : Fabrication of Integrated Circuits
Integrated circuits fabrication and characteristics – Integrated circuit technology, basic monolithic integrated circuits – epitoxial growth, masking and etching – Diffusion of impurities – Monolithic diodes, integrated resisters, 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
Op. Amp characteristics – Parameters – Basic, application – summing – integrating - Differentiating – Logarithmic – Antilogarithmic amplifier – Sinusoidal, square – Triangular and ramp wave generation – Multivibrator – Bistable – Monostable – Schmit trigger – Solution of differential equation – Analog computation.

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

Electric field, Gauss Law – Scalar potential – Multipole expansion of electricfields – 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.

Unit II : Magneto Statics
Biot and Savart law – Differential equations of magnetostatics and Ampere's law – The magnetic vector potential – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – Macroscopic magnetization – Magnetic field.

Unit III : Time Varying Fields
Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem.

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
Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard – Wiechert Potentials – The field of a uniformly moving point charge.

Books for study

1. Classical electrodynamics – J.D. Jackson
2. Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy.

PH306 MATHEMATICAL PHYSICS – II

Credit: 3:1:0 **Marks : 40+60**

Unit I : Complex Variables
Functions of a complex variable – Single and many valued functions – Analytic functions – Cauchy – Riemaan equation – Conjugate functions – Complex line integrals – Cauchy's integral theorem, integral formula –Residues Cauchy's residue theorem and its application for evaluation of integrals.

Unit II : Fourier Series and Transforms
Fourier series – Dirichilet conditions – Sine and Cosine series – Half range series – Applications in heat conductions and spectroscopy.

Unit III : Vector Spaces
Definition – Linear dependence, Linear independence of vectors – Linear spaces – Basics – Change of basis – Inner product spaces – Schmit's orthogonalisation procedure – Schwar's inequality – Hilbert space.

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

Basic definitions – Subgroups – Classes – Isomorphism. Homomorphism – Normal subgroups – Factor group – Direct product groups – Point group and space groups – Representations – Unitary representations – Schur's Lemmas – Orghogonality theorem – Character tables – Constructions. Rotation groups – O (3), SU (2) and SU (3) groups.

Unit V : Numerical Analysis

Solution of equations – Iteration method – Newton – Raphson method – Interpolation – Newton's formula – Numerical integration – Trapezoidal rule – Simpson's rule – Solution of linear system of equation – Gaussian elimination method – Solution of differential equation – Tayler series – Range – Kutta method.

Books for Study

1. Complex Variables and Applications – Ruyel, V. Churchill – McGraw-Hill, Kogakuizha, 1974.
2. Methods of Mathematical Physics – Mathews and Walker – Addition Wesley.
3. Linear Algebra – Serge Larnd – Addison Wesley, 1968.
4. Elements of Group Theory of Physicists – A.W. Joshi – Wiley Eastern Ltd. 1973.
5. Methods of Mathematical Physics, B.D. Gupta.

PH307 QUANTUM MECHANICS

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

Unit I : Formulation of Quantum Mechanics

Schrodinger wave equation – Time independent and time dependent – Statistical Interpretation – Operator formalism – linear operators – Self adjoint operators – Parity operator – Symmetric and anti symmetric wave functions – Dirac's Bra and ket notations.

Expectation value – Eigen values and Eigen functions – Normalisation of wave function – Probability current density – The Dirac Delta Function – Completeness of set of eigen functions – Physical interpretation of eigen values and eigen functions – The uncertainty principle – Commutability.

Unit II : Simple Applications

Solutions to square well potential – Schrodinger equation for sphereically 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 second order – First order Stark effect in hydrogen atom – Zeeman effect – The variation method – Ground state of Helium – WKB approximation.

Unit IV: Angular Momentum and Time Dependent Perturbation
Commutation rules for angular momentum operators – Eigen value spectrum – Raising and lowering operators – Matrix representation of angular momenta – Clebch – Gordon Co-efficients symmetry properties (no derivation).
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
The Klein – Gordon equation – Charge and current densities – The Dirac equation – Dirac's relativistic Hamiltonian – The Dirac matrices – Free particle solutions – Significance of negative energy states – Spin angular momentum – Dirac's particle in electromagnetic field – Magnetic moment – The hydrogen atom.

Books for Study

1. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill (1976)
2. Advanced Quantum Theory and Fields – S.L. Gupta and I.D. Gupta, S. Chand & Co. Ltd. New Delhi.
3. Quantum Mechanics – Schiff – McGraw-Hill.

PH308 SOLID STATE PHYSICS

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

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.
Band Theory of Solids
Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II: Dielectric And Ferroelectric Properties
Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Classius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant.
Ferroelectricity – General properties – Dipole theory.

Unit III : Magnetic Properties
Quantum theory of Paramagnetism – Paramaganetism of ionic crystals – Rare earth ions – Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange

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 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)

Books for Study
1. Kittel, "Solid State Physics", Tata McGraw Hill
2. S.O. Pillai, "Solid State Physics", S. Chand & Co.

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 emperical 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:

1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 1971
2. Introduction to Nuclear Physics – H.A. Enge – Addision-Wesley, 1971.
3. Nuclear Physics – I. Kaplan – Addition – Wesley, 1971
4. An introduction to Nuclear Physics- M.R. Bhiday and V.A. Hoshi, Oriental Longmen, 1972.
5. The Atomic Nucleus – R.D. Evans – Tata Mcgraw-Hill, 1975.
6. Basic Nuclear Physics – D.N. Srivastava, Pragati Prakashan – Meerut – 1968.
7. Nuclear Physics – Roy and Nigam – Willey Eastern Ltd.

PH310 SPECTROSCOPY

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

Unit I : Atomic And Molecular Structure

Central field approximation – Thomas – Fermi Statistical model – Spin-orbit interaction – Alkali atoms – Doublet separation – Intensities - Complex atoms – Coupling Schemes – 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 - Maser principles – Applications of Masers.

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.

Books for study

Unit: I

1. Quantum Mechanics Schiff, McGraw-Hill
2. Introduction to Atomic Spectra, White. 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 Nostrand

Unit: IV

1. High Resolution NMR. Pople, Schneidu and Berstein. McGraw-Hill.
2. Principles of Magnetic Resonance C.P. Slitcher, Harper and Row.
3. Basic Principles of Spectroscopy R. Chang.

Unit: V

1. Nuclear Quadrupole Resonance T.P. Das and Hahn Supplement
2. Solid State Physics Academic Press
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

DEPARTMENT
OF
PHYSICS

ADDITIONAL SUBJECTS

Code	Subject Name	Credit
PH315	Thin Film Technology	3:0:0
PH316	Materials Characterization	3:0:0
PH317	Magnetic Properties of Materials	3:0:0
PH318	Solid State Physics	4:0:0

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
Chemical methods: – Qualitative study of preparation by electroplating – vapour phase growth.
Physical methods: – Vacuum evaporation – Vapour sources – Wire, sublimation, crucible, electron bombarded heat sources – Sputtering techniques - Glow discharge sputtering – Magnetron, RF sputtering– Nucleation and growth of thin films – Four stages of film growth

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:

1. Maissel L.I. and Gland R., "Hand book of thin film technology ", McGraw Hill, 1970.

References:

1. Chopra K.L., "Thin Film Phenomena", Mcgraw Hill, 1970.
2. Berry R.W., And Others, "Thin Film Technology", Mcgraw Hill, 1970.

PH316 MATERIALS CHARACTERIZATION

Credit :3:0:0 **Marks : 40 + 60**

Unit I: Structural Analysis
X-ray diffraction methods : Rotating crystal method – Powder method – Scherrer formula for estimation of particle size – Debye-Scherrer camera – structure factor – structure factor calculations – Instrumentation and result 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
Principles of differential thermal analysis – Differential scanning calorimetry and thermogravimetric analysis – Instrumentation – Determination of transition temperature, Heats of transition of plastics, metals and alloys and other materials

Unit V:
Electrochemical methods:- Electrical conductivity of liquids – Determination of pH – Principle of liquid and gas chromatography – Mechanical and Magnetic Analysis:- Vicker's Hardness test - Vibrating Sample Magnetometer – Working principle of VSM – Instrumentation

Text books:

1. Cullity Addision, "Elements of X-ray diffraction", Wesley publishing Co., 1967.
2. Prutton, M.,"surface Physics", Clarenden Press Oxford, 1975.
3. Treatise on materials and technology, Volume 27, "Analytical techniques for thin films", Academic Press Inc., Newyork, 1991.

PH317 MAGNETIC PROPERTIES OF MATERIALS

Credit :3:0:0 **Marks : 40 + 60**

Unit I: Magnetic Materials:
Origin of magnetic properties – Diamagnetism – Larmour precession – diamagnetic susceptibility – Langevin theory of Para magnetism – Magnetization in rare earth ions and transition metal ions.

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 – Ferromagnetic metals as spin injecting contacts – spin filtering in Ferromagnet – Magnet switching in High density MRAM – Nanomagnetic materials for medical applications.

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

References:

1. Kittel C.," Introduction to solid state physics", Wiley, 1987
2. Pillai S.O., "Solid state physics", Wiley, 1994.

PH318 SOLID STATE PHYSICS

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

Unit I : Introduction
Basic concepts of crystallography – Reciprocal lattice – Bruilloin zone – Experimental determination by X-Ray diffraction.
Lattice Vibration:
Elastic vibration – Mono atomic lattice – Linear diatomic lattice – optic and acoustic modes – infrared absorption – localized vibration – quantization of lattice vibration – Phonon momentum.
Band Theory of Solids
Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II: Dielectric and Ferroelectric Properties
Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Classius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant.
Ferroelectricity – General properties – Dipole theory.

Unit III : Magnetic Properties

Quantum theory of Paramagnetism – Paramaganetism of ionic crystals – Rare earth ions – Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange 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 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).

Books for Study

1. Kittel, "Solid State Physics", Tata McGraw Hill
2. S.O. Pillai, "Solid State Physics", S. Chand & Co.

ADDITIONAL SUBJECTS

Code	Title of the Paper	Credit
PH105	Applied Physics	3:0:0
PH106	Applied Physics	3:0:0
PH201	Acoustics and Optics	4:0:0
PH319	Classical Mechanics	4:0:0
PH320	Statistical Mechanics & Thermodynamics	4:0:0
PH321	Mathematical Physics I	3:1:0
PH322	Electronics	4:0:0
PH323	Mathematical Physics II	3:1:0
PH324	Quantum Mechanics	4:0:0
PH325	Solid State Physics	4:0:0
PH326	Nuclear Physics	4:0:0
PH327	Spectroscopy	4:0:0
PH328	Fibre Optics and Non-Linear Optics	4:0:0
PH329	Introduction to Nano Science	4:0:0
PH330	Physics of Nano Materials	4:0:0
PH331	Electronics Lab	0:0:4
PH332	Advanced Physics Lab	0:0:4
PH333	Microprocessor / Controller Lab	0:0:4
PH334	Computational Physics	4:0:0
PH335	Research Methodology	4:0:0
PH336	Material Characterization	4:0:0
PH337	Technology of Thin Films	4:0:0
PH338	Magnetic Materials and Properties	4:0:0
PH339	Nanofluids	4:0:0
PH340	Crystal Growth Techniques	4:0:0
PH341	Solid State Ionics	4:0:0
PH342	Battery and Its Characterizations	4:0:0
PH343	Renewable Energy Sources	2:0:0
PH344	Astrophysics	2:0:0

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

Properties of laser beam-Principle of laser-Einstein's theory of stimulated emission-Population inversion-Types of lasers-Nd :YAG, He:Ne, CO_2 and Semiconductor lasers-Application of lasers-Computer peripherals(CD-ROM)-Industrial applications –drilling and welding.

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

Ultrasonics-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:

V. Rajendran – Engineering Physics, Tata McGraw –Hill Publishing company Ltd, 2008 Publication.

Reference Books:

1. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics- S.Chand
2. R.K. Gaur, S.L. Gupta – Engineering Physics – Dhanpat Rai Publications, 7th edition, 2001
3. P.K. Mittal – Applied Physics – I.K. International Publishing House Pvt.Ltd, 2006
4. M. Arumugam- Materials Science – Anuradha Publications, 1998
5. M.R. Srinivasan- Physics for Engineers – New Age international (P) Limited Publishers, 1996

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

Newton's law of gravitation-gravitational field-gravitational potential-gravitational potential self energy-escape velocity-Kepler's law-satellites-gravity-Variation of acceleration due to gravity-Compound pendulum-Center of oscillations-Elasticity-Classification-stress-strain-Hook's law-Elastic behaviour of materials-factors affecting elasticity-Classification of elastic modulus-Poisson's ratio-relation between three moduli of elasticity-Torsion pendulum.

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 -impedence-resonance-powerfactor-impedence matching-Maxwell's equation-propagation of electromagnetic waves through conducting media penetration.

Unit V Waves and Particles

Wave and particle duality of radiation-De Broglie hypothesis- -Davission –Germer experiment-Thomson's experiment-Wave packet-Heisenberg uncertainity-Schrodinger wave equation-Significants –particle in one dimensional problem.-properties of photon-photoelectric effect-laws of photo electricity –photoelectric cells

Text book:

1. Gour R.K. and Gupta S.L. – "Engineering Physics". Dhanpat Rai Publications, New Delhi, 2002.

Reference Books:

1. Nelkon & Parker , Advanced Level Physics, Arnold Keinemann, 2002.
2. Feyman R.P, Leighton R.B. and Sands M. Feyman Lectures on Physics, Vol 1-5, Narosa, 2005.
3. Young & Freedman, University Physics, Pearson Education, 2004

PH201 ACOUSTICS AND OPTICS

Credit: 4:0:0

Unit. I: Light

Laws of reflection-Real and virtual images-Effect of rotation of plane mirrors-properties of image formed by plane mirror-spherical mirrors-mirror formula-Laws of refraction-refraction through number of media-propagation of light-Huygens's principle-interference-Michelson interferometer-coherence-Febray Parrot instrument-Diffraction-Fresnel and Franhofer diffraction-Scattering of light-polarization-linear, circular and elliptical polarization-polaroids.

Unit.II: Lens and Photometry

Lenses- lens formula-magnification-power of a lens-displacement of the lens with object and screen fixed-refraction through lens-Aplantic points and aplanatic surface-convergent meniscus lens-Aberrations of defects of a lens-Camera lens-photometry-laws of illumination-Illumination falls of cube- Lummer-Brodhun photometer-Guild's flicker photometer-determination of reflection and transmission coefficient of a surface.

Unit III Laser and Fibre-Optics

Principle of LASER-He-Ne laser-Semiconductor laser-application of laser CD ROM, 3D profiling and Holography-Holographic interferometer-acoustic Holography--Fibre optics-propagation of light in a cladded fibre- types of fibres-coupling of fibre-applications.

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:

1. Gour R.K. and Gupta S.L. – "Engineering Physics". Dhanpat Rai Publications, New Delhi, 2002.

References:

1. Brijlal& Subramaniam, Mcrawhill PublicationsNelkon & Parker –"Advanced Level Physics"- Arnold Keinemann
2. Feyman R.P, Leighton R.B. and Sands M. Feyman "Lectures on Physics", Vol 1-5, Narosa, 2005.
3. Young & Freedman, University Physics, Pearson Education, 2004

PH319 CLASSICAL MECHANICS

Credit: 4:0:0

Unit I : Mechanics of a System of Particles

Constraints – Generalized co-ordinates – D'Alembert's principle and Lagrange's equations – Simple applications of the Lagrangian Formulations.
Hamilton's Principle – Deduction of Largrange's equations from Hamilton'g Principle.

Unit II : The Two Body Central Force Problem

Reduction to the equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force – The motion in time in the Kepler problem – Scattering in a central force field.

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.

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:

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics- S.L.Gupta, V. Kumar & H.V.Sharma-Pragati Prakashan-Meerut.,2003

Reference Books:

1. Classical mechanics - T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
2. Classical Mechanics - John Robert Taylor, University Science Books, 2004
3. Classical Mechanics of Particles & Rigid Bodies-Kiran C.Gupta-Wiley Eastern Ltd.,1982
4. Classical Mechanics- Pragati – Gupta SI, Kumar V, Sharma HV- Pragati Prakashan - 2008

PH320 STATISTICAL MECHANICS AND THERMODYNAMICS

Credit: 4:0:0

Unit I : Review of the Laws of Thermodynamics and their Consequences
Energy and the first law of thermodynamics – Heat content and Heat capacity – Specific heat – Entrophy and the second law of thermodynamics – Thermodynamic potentials and the reciprocity relations – Maxwell's relations – Deductions – Properties of thermodynamic relations – Gibb's – Helmholtz relation – Thermodynamic equilibrium – Nernst's Heat Theorem and third law – Consequences of third law – Nernst's - Gibb's phase rule – Chemical potential.

Unit II : Statistical Description of Systems of Particles
Statistical formulation of the state system – phase space – Ensemble – average value – density of distribution in phase space – Liouville Theorem – Equation of motion and Liouville theorem – Equal apriori probability – Statistical equilibrium – Ensemble representations of situations of physical interest – isolated system – Systems in contact.

Unit III : Simple Applications of Statistical Mechanics
General Method of approach – Partition functions and their properties – Ideal Monatomic Gas – Calculation of Thermodynamic quantities – Gibb's Paradox. The equipartition theorem and proof – application to harmonic oscillator.
Statistical Thermodynamic Properties of Solids:
Thermal characteristics of crystalline solids – Einestein modal – Debye modification – Limitations of Debye theory – Paramagnetism – General calculation of Magnetization.

Unit IV : Quantum Statistics of Ideal Gases
Maxwell – Boltzman statistics, Bose-Einstein statistics and Fermi Dirac statistics; Calculation of distribution functions from the partition function for M-B, B-E, and F-D statistics –Quantum statistics in the classical limit – ideal Bose Gas – Bose – Einstein condensation – Ideal Fermi Gas – Degnerate Electron Gas.

Unit V : 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.

Text Book:
1. Fundamentals of Statistical and Thermal Physics , Federick Reif, McGraw-Hill, 1985.

Reference Books:
1. Statistical Mechanics – B. K. Agarwal and M. Einsner , John Wiley & Sons,1988
2. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
3. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale

Royal Society of Chemistry, 2001
4. Introduction to statistical mechanics – S.K.Sinha, Alpha Science International, 2005
5. Elements of Statistical Mechanics-Kamal Singh & S.P. Singh- S. Chand & Company, New Delhi,1999

PH321 MATHEMATICAL PHYSICS: I

Credit: 3:1:0

Unit I : Vector Analysis
Gradient – Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's divergence theorem, Green's theorem. Stoke's theorem and their applications to Hydrodynamics (Equation of continuity and Electric Potential) Orthogonal Curvilinear coordinates – Expressions for Laplacian in spherical polar and cylindrical polar coordinates and its solutions.

Unit II : Matrices
Special matrices and their properties, Rank and inverse of matrix. Characteristic equation. Cayley Hamilton's theorem, Eigen values and Eigen vectors of matrices and their properties. Diagonalisation of matrices. Use of similarity transformation.

Unit III : Tensor Analysis
Cartesian Tensors – Law of transformation of first and second order tensors. Addition, subtraction and multiplication (inner and outer) of tensors. Rank of a tensor. Covariant and mixed tensors. Symmetric and Anti-symmetric tensors. Derivative of tensors-Quotient law of tensor. Tensor form of gradient, divergence and curl. Susceptibility tensors (electric and magnetic) piezoelectric tensors.

Unit IV : Second Order Linear Differential Equations and Special Functions
Sturm Liouvilile Theory – Orthohgonality 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:
1. Mathematical Physics-B.D. Gupta-Vikas Publishing House, 3rd Edition, 2006
2. Mathematical Physics-B.S. Rajput- Pragati Prakashan- Meerut 17th Edition 2004

Reference Books:
1. Vector Analysis – Harry Lass –McGraw Hill, Kogakusha Ltd.
2. Matrices and Tensors in Physics – A.W. Joshi – Wiley – Eastern Ltd.
3. Special function for Scientists – Bell – Van Nostrand – 1968.
4. Introduction to Mathematical Physics – C. Harper – Prenticas Hall of India – 1987.

5. Mathematics for Physics and Engineers. Pipes – McGraw-Hill Publishing Company
6. Mathematical physics - Sadri Hassani, Springer, 2000

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PH322 ELECTRONICS

Credit: 4:0:0

Unit I : Semiconductor Devices
Uni-Junction Transistor – Characteristics – Relaxation Oscillator FET Volt – Ampere Characteristics – MOSFET, N Channel – P Channel – FET as a voltage variable resistor – Common source amplifier – SCR – TRIAC – DIAC – Tunnel Diode – Characteristics – Basic applications.

Unit II : Fabrication of Integrated Circuits
Integrated circuits fabrication and characteristics – Integrated circuit technology, basic monolithic integrated circuits – epitoxial growth, masking and etching – Diffusion of impurities – Monolithic diodes, integrated resisters, 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
Op. Amp characteristics – Parameters – Basic, application – summing – integrating - Differentiating – Logarithmic – Antilogarithmic amplifier – Sinusoidal, square – Triangular and ramp wave generation – Multivibrator – Bistable – Monostable – Schmit trigger – Solution of differential equation – Analog computation.

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:
1. Integrated Electronics – Millmaan. J. and Halkias C.C, McGraw Hill, 2004
2. Microprocessor Architecture, Programming and Applications –R.S. Gaonkar, 1999

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

Functions of a complex variable – Single and many valued functions – Analytic functions – Cauchy – Riemaan equation – Conjugate functions – Complex line integrals – Cauchy's integral theorem, integral formula –Residues Cauchy's residue theorem and its application for evaluation of integrals.

Unit II : Fourier Series and Transforms(Fourier and Laplace)

Fourier series – Dirichilet conditions – Sine and Cosine series – Half range series –Fourier Sine and Cosine transforms

Unit III : Vector Spaces

Definition – Linear dependence, Linear independence of vectors – Linear spaces – Basics – Change of basis – Inner product spaces – Schmit's orthogonalisation procedure – Schwar's inequality – Hilbert space.

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

Basic definitions – Subgroups – Classes – Isomorphism. Homomorphism – Normal subgroups – Factor group – Direct product groups – Point group and space groups – Representations – Unitary representations – Schur's Lemmas – Orghogonality theorem – Character tables (C_2V and C_3V) – Constructions.

Text Book:

1. Mathematical Physics-B.D. Gupta-Vikas Publishing House, 3rd Edition, 2006
2. Mathematical Physics-B.S. Rajput- Pragati Prakashan- Meerut 17th Edition 2004

Reference Books

1. Complex Variables and Applications – Ruyel, V. Churchill – McGraw-Hill, 7th Edition , 2003.
2. Methods of Mathematical Physics – Mathews and Walker – Addition Wesley, 2nd Edition, 1970.
3. Linear Algebra – Serge Larnd – Addison Wesley, 1968.
4. Elements of Group Theory of Physicists – A.W. Joshi – Wiley Eastern Ltd. 1997.

PH324 QUANTUM MECHANICS

Credit: 4:0:0

Unit I : Formulation of Quantum Mechanics

Schrodinger wave equation – The uncertainty principle - Time independent and time dependent equations – Physical Interpretation of Wave Function– Operator formalism – linear operators – Self adjoint operators – Parity operator – Symmetric and anti Asymmetric wave functions – Dirac's Bra and ket notations.

Expectation value – Eigenvalues and Eigenfunctions – Normalisation of wave function – Probability current density – The Dirac Delta Function – Completeness of set of eigenfunctions.

Unit II : Simple Applications

Solutions to square well potential – Schrodinger equation for sphereically symmetric potentials – Eigenvalues and eigenfunctions of the Hamiltonian for the isotropic Harmonic oscillator –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 second order – First order Stark effect in hydrogen atom – Zeeman effect – The variation method – Ground state of Helium – WKB approximation.

Unit IV: Angular Momentum and Time Dependent Perturbation

Commutation rules for angular momentum operators – Eigen value spectrum – Raising and lowering operators – Matrix representation of angular momenta – Clebch – Gordon Co-efficients symmetry properties (no derivation).

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

The Klein – Gordon equation – Charge and current densities – The Dirac equation – Dirac's relativistic Hamiltonian – The Dirac matrices – Free particle solutions – Significance of negative energy states – Spin angular momentum.

Text Book:

1. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, Ist edition (2005)

Reference Books:

1. Advanced Quantum Theory and Fields – S.L. Gupta and I.D. Gupta, S. Chand & Co. Ltd. New Delhi (1982).
2. Quantum Mechanics – L. Schiff , McGraw-Hill, New york 3rd edition (1968)
3. Quantum Mechanics – Aruldoss, Tata Mc Graw-Hill.
4. Basic Quantum Mechanics K. Ghatak and Lokanathan, Mc Millan,2006.

PH 325 SOLID STATE PHYSICS

Credit: 4:0:0

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.

Band Theory of Solids

Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II: Dielectric And Ferroelectric Properties

Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Classius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant.

Ferroelectricity – General properties – Dipole theory.

Unit III : Magnetic Properties

Quantum theory of Paramagnetism – Paramaganetism of ionic crystals – Rare earth ions – Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange 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 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, 8^{th} edition,2004

Reference Books:

1. Solid State Physics- S.O. Pillai New Age Publications, 2002
2. Elementary Solid State Physics- M. Ali Omar, Pearson Education, 2004

PH326 NUCLEAR PHYSICS

Credit: 4:0:0

Unit I : Nuclear Structure
Basic properties – magnetic moments – Experimental determination – Quadrupole moments – Experimental techniques – Systems of stable nuclei – Semi emperical 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.

Text Book:
1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 1971.
2. Nuclear Physics – I. Kaplan – Addison Wesley, 1971

Reference Books:
1. Introduction to Nuclear Physics – H.A. Enge – Addision-Wesley, 1971.
2. An introduction to Nuclear Physics- M.R. Bhiday and V.A. Hoshi, Oriental Longmen, 1972.
3. The Atomic Nucleus – R.D. Evans – Tata Mcgraw-Hill, 1975.
4. Basic Nuclear Physics – D.N. Srivastava, Pragati Prakashan – Meerut – 1968.
5. Nuclear Physics – Roy and Nigam – Willey Eastern Ltd, 1967

PH 327 SPECTROSCOPY

Credit: 4:0:0

Unit I : Atomic And Molecular Structure
Central field approximation – Thomas – Fermi Statistical model – Spin-orbit interaction – Alkali atoms – Doublet separation – Intensities - Complex atoms – Coupling Schemes –

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:

1. Molecular structure and **Spectroscopy**, G.**Aruldhas** Prentice-hall of India Pvt. Ltd. New Delhi, 2004

Reference Books:

1. Spectroscopy – Straughan Walker , McGraw-Hill, New york
2. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, 1934
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson
5. Molecular Spectroscopy- Banwell, , McGraw-Hill, New york 1994
6. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 2007
7. High Resolution NMR- Pople, Schneidu and Berstein. McGraw-Hill, 1959
8. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, 1963
9. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.1978
10. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, 1958

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-otpic 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 logitudinal 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:
1. Lasers and Electro-Optics: C.C. Davis ,Cambridge University Press, 1996
2. Optical Electronics - Gathak & Thyagarajan , Cambridge Univ. Press, 1989
3. The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University
4. Press), 1990

PH 329 INTRODUCTION TO NANOSCIENCE

Credit 4:0:0

Unit I : Introduction to Nano

What is nano-Why nano-Nanomaterials -Quantum Mechanics -Review of classical mechanics -de Broglie's hypothesis -Heisenberg uncertainty principle -Pauli exclusion principle -Schrödinger's equation -Properties of the wave function -Application: quantum well, wire, dot -Quantum cryptography

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:

top-down vs bottom-up -Thin film deposition -Epitaxial growth -CVD, MBE, plasma -Lithographic, photo, e-beam -Etching --FIB -Synthesis -Colloidal dispersions -Atomic and molecular -manipulations -Self assembly -Growth modes, Stransky-Krastinov etc --Ostwald ripening

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:

1. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
2. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004

PH 330 PHYSICS OF NANOMATERIALS

Credit 4:0:0

UnitI:I Introductory Aspects :

Free electron theory and its features, Idea of band structure— metals, insulators and semiconductors. Density of state in bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

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:

1. Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society).
2. Physics of Semiconductor Nanostructures: K.P. Jain, Narosa publishers, 1997.
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov, John Wiley & sons,1999.
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application J.H. Fendler John Wiley & sons,1998

Reference Books:

1. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski CambridgeUniv. 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).

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 Programing 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.
Methods of successive bisection. False position and mid point methods. Secant method. Newton-Raphson scheme.

Unit IV: Numerical differentiation and Integration
Divided difference method for differentiation. Newton-Cotes formula. Higher order derivatives. Comparison of errors. Midpoint, Trapezoidal , rectangular and Simpsons rules. Quadrature methods.

Unit V: Solutions of ordinary differential equations
Euler and predictor corrector methods. Runge Kutta method. Adaptive step size selection. Discrete and Fast FourierTransform. .

Text Books:

1. Numerical Methods for Engineers - S. C. Chopra and R. P. Canale. McGraw-Hill College (2001)
2. Applied Numerical Analysis - C. F. Gerald and P. O. Wheatley Addison Wesley, Boston, 2004. (2004)

Reference Books:

1. Computer Oriented Numerical Methods. V. Rajaraman . Prentice-Hall of India Pvt.Ltd (15 Aug 2004)
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
Solution of differential equations – simple iterative method- Newton Raphson method – Numerical by integration – Simpson rule – Gausian quadrature- solution of simultaneous equation – Gauss Jordon elimination method- Eigenvalue and eigenvectors by matrix diagnolization (Jacobian method)

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:

1. Computer applications in Physics- Suresh Chandra, Narosa publishing hours (2003)
2. Numerical methods for Mathematics, Science and Engineering – John H. Mathews, Prentice Hall, India (2000)
3. Gibaldi, Joseph, MLA Handbook for writers of Research paers, 6th edition, New Delhi, East-West Press Pvt, Ltd. (2003)
4. A guide to Matlab of beginners and experienced users- Brian R. hunt, R.L. Lipsman, J.M. Rosenberg, Cambridge University press (2003)
5. Computer programming FOTRAN IV- Prentice Hall

PH336 MATERIALS CHARACTERIZATION

Credit:4:0:0

Unit I: Structural Alalysis

X-ray diffraction methods : Rotating crystal method – Powder method – Scherrer formula for estimation of particle size – Debye-Scherrer camera – structure factor – structure factor calculations – Instrumentation and result 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
Principles of differential thermal analysis – Differential scanning calorimetry and thermogravimetric analysis – Instrumentation – Determination of transition temperature, Heats of transition of plastics, metals and alloys and other materials

Unit V: Electrochemical methods
Potentiostat- galvanostat- Cyclic voltammetry- Electrical conductivity of liquids – Determination of pH – Principle of liquid and gas chromatography – Mechanical and Magnetic Analysis:- Vicker's Hardness test - Vibrating Sample Magnetometer – Working principle of VSM – Instrumentation

Text books:
1.Cullity Addision, "Elements of X-ray diffraction", Wesley publishing Co., 1967.
2. Prutton, M.,"surface Physics", Clarenden Press Oxford, 1975.
3.ArulDas, Spectroscopy
4. Treatise on materials and technology, Volume 27, "Analytical techniques for thin films", Academic Press Inc., Newyork, 1991.

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, 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

Material selection, Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor – Transparent conducting oxide Thin films – Semiconducting Thin films – Thin film solar cells – CdS and Cu_2S based solar cells – CdS - Cu_2S and CdS or Cu In Se_2 solar cells – Thin film mask blanks for VLSI – Thin films sensors for gas detectors. Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

Text Book

1. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow, McGraw-Hill Professional, 1998
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,
3. Equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
4. Handbook of thin film technology,
   L.I.Maissel and R.Glang, McGraw Hill Book Company, New York (1983).
5. Thin-film deposition: principles and practice by Donald L. Smith, McGraw-Hill Professional, 1995

PH338 MAGNETIC MATERIALS AND PROPERTIES

Credit: 4:0:0

Unit I: Magnetic Materials

Origin of magnetic properties – Diamagnetism – Larmour precession – diamagnetic susceptibility – Langevin theory of Para magnetism – Magnetization in rare earth ions and transition metal ions

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:

1. Kittel C.,” Introduction to solid state physics”, Wiley, 1987
2. Pillai S.O., “Solid state physics”, Wiley,1994.
3. Magnetic Materials: Fundamentals and Device Applications
   By Nicola Ann Spaldin, Published by Cambridge University Press, 2003
4. Introduction to Magnetism and Magnetic materials, David Jiles, CRC press 1998
5. Hand book of Magnetic materials, K.H.J. Buschow, Elsevier, 2006
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**

Fundamentals of Cooling - Fundamentals of Nanofluids - Making anofluids - Experimental Discoveries Mechanisms and Models for enhanced thermal Transport.

Unit II : Synthesis of Nanofluids

Synthetic Methods: Common Issues of Concern - Microemulsion –Based Methods for Nanofluids - Solvothermal Synthesis - Synthesis using supports - Using Biology - Magnetic Nanofluids - Inert Gas Condensation

Unit III : Conduction Heat transfer in Nanofluids
Conduction Heat Transfer - Measurement of Thermal Conductivity of Liquids - Thermal Conductivity of Oxide Nanofluids - Temperature Dependence of Thermal Conductivity Enhancement - Metallic Nanofluids -
Nanofluids with Carbon Nanotubes

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 Nano fluids
Fundamentals of Convective Heat Transfer - Convection in Suspensions and Slurries - Convection in Nanofluids - Analysis of Convection in Nanofluids - Fundamentals of Boiling - Pool Boiling of Nanofluids - Critical Heat Flux in Pool Boiling of Nanofluids

Text Books:
1. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John wiley sons, 2007

References:

1. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 1972.
2. Heat and Mass Transfer, R.K. Rajput, S. Chand, 2008
3. Heat transfer Principles and applications, Binay K. Dutta, Prentice – Hall of India Pvt. Ltd, New Delhi, 2001

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:

1.Brice, J. C. Crystal Growth processes – Halstesd press, John Wiley & sons, New york (1986)
2. Elwell. D and Scheel. H. J, crystal growth from High Temperature solutions, Academic press, London (1975)

Reference books:-

1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge University press, (2005).
2. Mallin, J. N, ‘Crystallization’, Butternmths, London (2004)
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle North Holland – London (1993)
4. Buckley, H. E, ‘ Crystal Growth’ , Chapman and Hall, London(1952)
5. Heinz K. Henisch, Crystal Growth in Gels Dover publications (1996)

PH341 SOLID STATE IONICS

Credit 4:0:0

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

Distinguish between Normal and Superionic Conductor - Sublattice Disorder – Ionic motion in Fast ionic conductor- Co-operative motion of ions – Ionic Diffusion and conduction in disordered systems ; The Path Probability method – The State Variable – The Path Variables – The Path Probability – Stationary State Condition
Phenomenological Models : Hubermann's Theory – Rice-Strassler and Toomb's theory – Welch and Dienes Theory

Unit III : **Diffusion Process in Ionic Crystals**
Microscopic Aspects of Diffusion :- Markov Process – Mechanism of Diffusion – Microscopic Interpretation of Diffusion Coefficient – Self and Isotope Diffusion Coefficient – Defects Diffusion Coefficient – Chemical Diffusion Coefficient – Measurement of Diffusion Coefficient :- Tracer Method- NMR method:- Motional Narrowing of Resonance Band – Diffusion Coefficient from NMR Relaxation time

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 electgronic 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
Applications : Physico chemical measurements using solid state electrochemical cells – EMF of solid state cells – Measurement of Thermodynamic quantities – Measurement in Relation to kinetics of solid state reactions – Batteries – Sensing Devices – Electrochemical (electrochromic) displays – Photoelectrochemical devices

Text Books:

1. "Solid Electrolytes " ed by S.Geller , Springer Verlag Berlin Heidelberg New York (1977) ISBN 3-540-08338-3
2. "Solid State Ionics" by T.Kudo and K.Fueki, Kodansha Lts, Tokyo, (Japan), VCH Publisher, New York, USA (1990) ISBN: 3-527-28166-5

References :

1. "Superionic Solids – Principles and Applications" ed by Suresh Chandra, North Holland Publishing Company, Amsterdam, New York, Oxford (1981) ISBN: 0 444 86039 8

PH342 BATTERY AND ITS CHARACTERIZATIONS

Credit 4:0:0

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-MnO_2, 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

Solvents 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 emphasize 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)
2. Modern batteries 2nd Edition Eds, C.Vincentand B.Scrosati Butterworth Heinemann An imprint of Elsevier Science ISBN 0 340 66278 6 (2003)

References:

1. Analytical Electrochemistry 2nd edition by Joseph Wang Wiley (2000)
2. Electroanalytical Methods : Guide to experiments and applications by A.M. Bond, R.G. Compton, D.A. Fiedler, and G. Inzelt, Springer (Ist edition 2002; 2nd Edition 2005)
3. "Lithium Batteries. Bruno Scrosati, LA CHIMICA E L'INDUSTRIA, 79, 463 - 471 (1997) .
4. Rechargeable lithium batteries: a challenge for portable power source technology, B. Scrosati.. NATURE, 373, 557 - 558 (1995) .

PH343 RENEWABLE ENERGY SOURCES

Credits 2:0:0

Unit I : **Basic Concepts of Energy Sources**

Available Energy Sources — Classification of Energy Sources - Commercial and Non-commercial Energy Sources — Renewable Energy Resources — Advantages and Limitations of Renewable Energy sources.

Unit II: Solar Energy

Solar radiation at the Earth's Surface — Solar Radiation Measurements — Solar Energy Collectors - Flat-plate Collectors, Concentrating Collector: Focusing Type – Solar Energy Storage — Applications of Solar Energy – Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking.

Unit III: Wind-Energy

Wind Energy Conversion – Basic Components Of a WECS (Wind Energy Conversion System) – Classification of WECS – Wind Energy Collectors – Wind Energy Storage – Applications of Wind Energy.

UnitIV: Energy from Bio-Mass

Bio-mass Conversion Technologies – Wet processes and Dry Processes – Classification of Bio-gas plants – Bio-gas from plant Wastes – Materials Used For Bio-gas generation – Utilization if Bio-gas -- Methods for Obtaining energy from Bio-mass.

Unit-V: Energy from Other Sources

Energy From The Oceans – Energy And Power from the Waves – Wave Energy conversion – Advantages and Disadvantages Of Wave Energy – Chemical Energy Sources – Fuel Cells and Batteries – Applications of Chemical sources.

Text Book:

1. Non-Conventional Energy Sources: G.D. RAI (KHANNA PUBLISHERS).

References:

1. Renewable Energy - Power for a Sustainable Future: GARY ALEXANDER & GODFREY BOYLE (Second Edition).
2. Renewable Energy Sources: JOHN TWIDELL & TONY WEIR (Second Edition).

PH344 ASTROPHYSICS

Credits 2:0:0

Unit I: The Solar System (Fundamental Ideas)

The Historical Basis Of Solar System Models – The Solar System In Perspective: Planets, Moons, Rings And Debris – The Terrestrial Planets: Mercury, Venus, And Mars – The Jovian Planets And Pluto: Jupiter, Saturn, Uranus, Neptune, Pluto And Charon.

Unit II: The Stars

The Sun: The Structure of the Sun -- The Corona – The solar Wind – The Distances To Stars – The Stellar Magnitude Scale -- Hetzprung-Russel Diagrams

Unit III: Telescopes and Detectors

Optical Telescopes – Invisible Astronomy: The Hubble Space Telescope
Detectors And Image Processing: Photography, Phototubes, Charge Couple Devices,
Signal To Noise – The New Generation Of Optical Telescopes.

Unit IV: The Milky Way Galaxy

The Shape Of The Galaxy – The Distribution Of The Stars – Stellar Populations – Star Birth: The Birth Of Massive Stars, The Birth Of Solar Mass Stars And Deaths – Star Deaths: White Dwarfs And Brown Dwarfs, Black Holes.

Unit-V: The Universe

Hubble's Law – Cosmology: Einstein's Theory Of General Relativity – The World Models – The Standard Big Bang Model.

Text Book:

1. Introductory Astronomy And Astrophysics, Fourth Edition, ZEILIK, GREGORY

References:

1. Theoretical Astrophysics (Vol. I, II, II): T. Padmanabhan (Cambridge University)
2. An Introduction To Modern Astrophysics, Second Edition: Bradly W. Carroll & Dale A. Ostilie.

ADDITIONAL SUBJECTS

Code	Subject Name	Credit
09PH101	Applied Physics Lab	0:0:2
09PH201	Thin Films Technology For Engineers	3:0:0
09PH 202	Basic Science Of Sound, Light And Signals	3:0:0
09PH 203	Material Science For Engineers	3:0:0
09PH 301	Medical Radiation Dosimetry	4:0:0
09PH302	Radiation Treatment Planning	4:0:0
09PH303	Condensed Matter Physics	4:0:0
09PH 304	General Physics Lab	0:0:2

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
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 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
Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor — Thin film solar cells -Thin film mask blanks for VLSI – Thin films sensors for gas detectors- Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

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:

1. An Introduction to Physics and Technology of Thin Films, Alfred Wagendristel, Yuming, Yu-ming Wang, World Scientific, 1994
2. Handbook of Thin-film Deposition Processes and Techniques: Principles, MethodsEquipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
3. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book Company, New York,1983.
4. Thin Film Phenomena, Kasturi L. Chopra, R. E. Krieger Pub. Co., 1979

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
Velocity of transverse wave along a stretched string. Frequency of vibrating string – Harmonics and overtones. Sonometer – Experimental verification of laws of vibrating strings . Reflection sound at its end of pipes. Vibrations pf air column in open and closed organ pipe. Vibration in air cavity – Helmholtz resonater .

Unit IV : Acoustics
Classification of sound, Characteristics 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. Requisites of a good auditorium.

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:
1. A Text book of Optics, N.Subrahmanyam and Brij lal S.Chand & Co.ltd., New Delhi, 22^{nd} edition, 2000
2. Engineering Physics R.K. Gaur and S.L. Gupta Dhanpat Rai Publications, 2006
3. Acousics Waves and oscillations by SN Sen Wiley Eastern Limited, 1990
4. Fundamentals of digital signal processing Lonnie C Lumens, John Wiley and sons,1987

Reference Books:

1. A Text Book of Engineering Physics, Avadhanulu, M.N., Kshirsagar, P.G., **S.Chand & Co. Ltd., New Delhi, 6th edition, 2003.**
2. Li Tan, Jean Jiang Fundamentals of: Analog and Digital Signal Processing Author House, 2007
3. Understanding digital signal processing, R. G. Lyones, Addison Wesley 1997

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

Introduction – Electrical properties of Solids – Classical free electron theory or Drude-Lorentz theory – Quantum free electron theory of metals – Sommerfield theory – Fermi- Dirac statistics –Fermi-Dirac distribution – Kronig-Penny model – Example of conducting polymers – Metals and Alloys

Unit III: Semiconducting Materials

Introduction – Properties – Elemental and compound semiconductors – Metal oxide and organic semiconductors, Types of semiconductors – Carrier concentration in Intrinsic and Extrinsic— Variation of fermi energy level – Hall effect – Experimental determination of Hall effect – Semiconducting materials: solar cell – quantum efficiency and application.

Unit IV :Magnetic Materials

Introduction – Classification of Magnetic materials – Dia magnetic, Para magnetic, Ferro magnetic materials – Langevin's theory of Dia and Para magnetism – Weiss theory of Para and Ferro magnetism – Ferro magnetic domains – domain theory, Hysterisis loops – Soft and hard magnetic materials -- Antiferromagnetism – Ferrimagnetism- Examples: Compounds of Fe,Ni,Co

Unit V: New Materials

Ceramic materials – glass ceramics, ceramic semiconductors – Dielectric ceramics ($BaTiO_3$)– cermets – Shape memory alloys – martensite, Austenite – Two way shape memory – characteristics – applications of Nitinol - Polymers – polymerization – Thermoplastics and thermo settings – Elastomers – Polyester and polyamide – Bio-materials and its applications of Hydroxyapatatite

Text Books:

1. Raghavan, V., Material Science and Engineering, Prentice Hall of India Pvt., Ltd., New Delhi, 1999.
2. Wahab M.A., Solid State Physics, Narosa Publishing House, New Delhi, Second edition, 1999.

Reference Books:

1. Avadhanulu, M.N., Kshirsagar, P.G., A Text Book of Engineering Physics, S.Chand & Co. Ltd., New Delhi, 6th edition, 2003.
2. Kenneth G.Budinski and Micheal K.Budinski, Engineering Materials, Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
3. William D Callister Jr., Material Science and Engineering, John Wiley and Sons, 6th Edition, Singapore, 2005.

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
Atoms and nuclei – Fundamental particles - Atomic and nuclear structure - Mass defect and binding energy – Radiation - Classification of radiation - Electromagnetic spectrum – Radioactivity - Alpha, beta and gamma rays - Methods of decay – Isotopes - Radiation sources.

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 – Thermoluminiscent 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:

1. Review of Radiation Oncology - A Hand book for Teachers and Students by EB. Podgorsak, International Atomic Energy Agency, 2005
2. The Physics of Radiation Therapy by FM. Khan, Wolters Kluwer , 2003

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
3. Introduction to Radiological Physics and Radiation Dosimetry by FH. Attix , Wiley, 1986
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
Treatment planning - Volume definition - ICRU 50, ICRU 62 concepts - GTV – CTV – ITV – PTV – OAR - Dose specification - Patient data acquisition – Simulation - Conventional simulation - Isodose curves - Wedge filters – Bolus - Compensating filters - Field separation

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:

1. Review of Radiation Oncology Physics - A Hand book for Teachers and Students, EB. Podgorsak, International Atomic Energy Agency, 2005
2. The Physics of Radiation Therapy, FM. Khan, Wolters Kluwer, 2003

Reference Books:

1. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
2. Introduction to Radiological Physics and Radiation Dosimetry, FH. Attix, Wiley, 1986
3. Radiation therapy Physics, WR. Hendee and GS. Ibbott, J. Wiley, 2004

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 centrered cubic – Hexagonal – Hexagonal close packed – diamond
Classification of Lattices by symmetry – 14 bravais lattices and seven crystal systems – Symmetries of lattices with bases : -32cystallographic 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
Drude model of electrical conduction – Lorentz modification of Drude model – the density of states – Fermi Dirac statistics – effect of temperature of Fermi Dirac distribution - the electron heat capacity – the Sommerfield theory of electrical conduction – resistivity in metals – thermionic emission - Hall effect and its importance

Unit V: Defects in solids and diffusion theory
Point and line defects in solids – surface imperfections – Fick's law of diffusion – solution to Fick's second law – different diffusion mechanism – application of diffusion –diffusion in alkali Halides and their ionic conductivity.

Text Books:
1. Condensed matter physics by Michael P Marder John Wiley & Sons, 2000
2. Solid State Physics by Ashcroft & Mermin 1st edition, 2003
3. Introduction to Solid State Physics by Charles Kittel John Wiley,2005

Reference books:
1. Solid State Physics: Structure and Properties of Materials, A. M. Wahab ,Narosa Publishing House, India, 2nd Edition, 2005
2. Elements of Solid State Physics ,J. P. Srivatsava, Printice Hall of India, 2nd edition,2001
3. Introductory Solid State physics by H. P. Myers (Taylor & Francis Ltd, London) 2nd Edition,1998
4. Solid State Physics by C. M. Kachhava (Tata McGraw-Hill) 1st Edition,1996
5. Principles of the theory of Solids by J.M.Ziman Cambridge University Press,1999

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 – hysterics
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

Code	Subject Name	Credits
10PH202	Mechanics and Properties of Matter	4:0:0
10PH203	Thermodynamics and Statistical mechanics	4:0:0
10PH204	Optics and photonics	4:0:0
10PH205	Vacuum and Thin film technology	4:0:0
10PH206	Properties of matter lab	0:0:2
10PH207	Heat and Optics lab	0:0:2
10PH301	Electricity and magnetism	4:0:0
10PH302	Quantum Physics	4:0:0
10PH303	Condensed matter Physics	4:0:0
10PH304	Nano devices	4:0:0
10PH305	Nanophysics Lab	0:0:4
10PH306	Radiation Physics	4:0:0
10PH307	Spectroscopy	4:0:0
10PH308	Nanofluids	4:0:0
10PH309	Computational Physics	3:0:0

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

Projectile – range of a projectile on an inclined plane – collision between two bodies – impulse – laws of impact – coefficient of restitution – Elastic and inelastic collision – direct and oblique impact – velocities and kinetic energy in direct impact – loss of kinetic energy indirect impact – transfer of energy in collisions between two equal masses

Unit III : Elasticity

Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants –

Poisson's Ratio – Torsional pendulum – Cantilever – loaded at the free end – loaded uniformly.
Moment of Inertia : Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Claculation of the moment of inertia of a body and its units.

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
Rate of flow of liquid – Lines and Tubes of flow – Energy of the liquid – Bernoulli's theorem and its important applications – Viscosity – Co-efficient of viscosity – Critical velocity – Poiseuille's equation for flow of liquid – Stoke's method – Rotation viscometer
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

1. 1.Elements of Properties of Matter by Mathur D.S., Shyamlal Charitable Trust, New Delhi,2008.
2. Properties of Matter by Murugeshan. R., S. Chand & Co Pvt. Ltd., New Delhi. 2007.
3. Properties of Matter by Brij Lal & Subramaniam. N, Eurasia publishing Co., NewDeihi, 1994.

Reference Books

1. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
2. Waves & Oscillations by Subrahmanyam N. & Brij Lal, Vikas Publishing House Pvt. Ltd., New Delhi, 1994..
3. Mechanics and General Properties of Matter by P.K. Chakrabarthy - Books & Allied (P) Ltd., 2001.
4. Fundamentals of Physics, 6th Edition, by D. Halliday, R.Resnick and J.Walker, Wiley, NY, 2001.
5. Physics, 4th Edition, VoIs. I, II & II Extended by D. Halliday, R.Resnick and K.S. Krane, Wiley, NY, 1994.

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
Zeroth Law of thermodynamics – Heat – Internal Energy - first law of thermodynamics – Specific Heat of a gas –Second law of thermodynamics - Entropy – Change in entropy in adiabatic and reversible cycle– Third law of thermodynamics – Thermodynamic variables – Extensive and Intensive variables – Maxwell's relations – Applications: Specific heat equation, Joule – Thomson Cooling - Thermodynamic potentials – Significance – Relation of thermodynamics potentials with their variables

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
Introduction – Degrees of Freedom, Position Space, Momentum space, Phase Space, The mu-space and Gamma space – Applications to One Dimensional Harmonic Oscillator – Fundamental postulates of statistical mechanics – Statistical ensembles : Microcanonical ensembles – Canonical ensembles – Grand canonical ensembles – Comparison of ensembles – Partition function and its relation with Thermodynamic quantities

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:
Maxwell – Boltzmann energy Distribution law – Limitations of Maxwell – Boltzmann method - Bose – Einstein Distribution Law – Photon Gas – Planck's Radiation law – Fermi – Dirac Distribution law – Problems

Text Books

1. Heat thermodynamics and statistical physics- Brijlal, N.Subramanyam, P.S.Hemne, S.Chand & Co. Ltd, 2007
2. Fundamentals of Statistical and Thermal Physics – Federick Reif, McGraw-Hill,1985.

Reference Books

1. Statistical Mechanics – B. K. Agarwal and M. Einsner , John Wiley & Sons,1988
2. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
3. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale, 2001

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

Principle and production of laser, Einstein's coefficients (expression for energy density), requisites of laser system, Nd-YAG laser, He-Ne laser, CO_2laser, 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

1. Fundamentals of photonics, Chandrasekhar Roychoudhuri, 2008
2. Textbook of optics, N. Subrahmanyam and Brijlal, chand publications ,1985
3. Laser and nonlinear optics, B B Laud 2nd edition, 2003
4. An Introduction to Fiber optics, Ghatak and Thyagarajan, 1998

Reference books

1. A Text book of Engineering Physics, M N Avadhanulu & P G Kshirsagar, 8th ediion, 2006
2. Nonlinear Optics by Robert W Boyd, Elsevier publication, 3rd edition, 2008
3. The Elements of Fiber Optics, S L Wymer Meardon, Prentice Hall,1993
4. The elements of Nonlinear Optics, P N Bucher & D Cotter, Cambridge University Press, 1990

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.

Transport phenomena – viscosity - thermal conductivity – diffusion – thermal transpiration - mean free path – particle flux - interaction of gas molecules with surfaces - adsorption time - saturation pressure - surface coverage with gas molecules - gas dissolution in solids.

Unit II: Pumps and pumping systems

General characteristics of vacuum pumps – **R**ough-medium vacuum range pumps - rotary pump – **D**iffusion pumps –pumping mechanism– **T**urbomolecular pumps – pumping mechanism – turbomolecular pump designs – turbomolecular drag pumps – **C**ryogenic pumps - pumping mechanism – speed pressure and saturation.

Unit III: Measurement of Vacuum

Classification of measurement methods – Direct pressure measurement – Indirect pressure measurement – Pressure gauges – Direct reading gauges – Diaphragm & Bourdon gauge - capacitance manometer – Indirect reading gauges – thermal conductivity gauge – pirani gauge - thermocouple gauge – stability & calibration – spinning rotor gauge – Ionization gauges – hot cathode gauge – cold cathode gauge – gauge calibration.

Unit IV: Thin Film Growth Process

Evaporation – Thermodynamics of evaporation – evaporation rate – alloys – compounds – sources – transport – deposition monitoring – vapor flux monitoring.

Deposition – adsorption – surface diffusion – nucleation – structure development – interfaces – temperature control.

Chemical vapor deposition – gas supply – Convection – laminar flow in ducts – axisymmetric flow – free convection – Reaction – chemical equilibrium – gas phase rate – surface processes – Diffusion – diffusion limited deposition.

Unit V: Thin Film Deposition Techniques

Molecular Beam Epitaxy – basic MBE process – sputter deposition – physical sputtering theory – plasmas and sputtering systems – chemical vapor deposition – electro plating – potentiostat – galvanostat – pulsed plating – sol gel coating – laser ablation – spray pyrolsis.

Text Books

1. Vacuum Technique by L. N. Rozanov, Taylor and Francis, London, 2002, ISBN No: 0-415-27351-x.
2. Thin film deposition Principles & Practice, Donald L. Smith, McGraw Hill, 1995, ISBN No: 0-07-058502-4.

Reference Books

1. A user's guide to Vacuum Technology, John F. O' Hanlon, 3rd Ed., John Wiley & Sons Inc, 2003.
2. Modern Vacuum Physics, Austin Chambers, Chapman & Hall/CRC, Taylor and Francis, London, 2005, ISBN No: 0-8493-2438-6.
3. Hand book of thin film deposition processes & technologies Krishna Seshan, Noyes publications/William Andrew publishing, 2nd Ed., 2002.
4. The materials Science of thin films, Milton Ohring, Academic Press, 1992, ISBN No: 0-12-524990-x.
5. Thin film materials – stress, defect formation & surface evolution, L.B. Freund & S. Suresh, Cambridge University Press, 2003, ISBN No: 0-521-822815.
6. Thin film Device Applications, K.L Chopra, Plenum Press, NY, 1983

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

Coulomb's law – Electric Field – Gauss's law – Differential form of Gauss's Law – Scalar Potential – Surface Distribution of charges and dipoles and discontinuities in the electric field potential – Poisson and Laplace equations – Green's theorem – Dirichlet-Neumann Boundary Conditions – Electrostatic Potential energy and energy density – Relaxation method for two dimensional electrostatic problems

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 X 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

1. Electromagnetic waves and radiating systems, Edward C. Jordan, K.G.Balmain, Prentice-Hall of India, **ISBN** : 8120300548
2. Classical Electrodynamics, third ed., J. D. Jackson, John Wiley & Sons, Inc., New York, NY . , 1999, ISBN 0-471-30932-X

Reference Books

1. Electromagnetic wave theory, James R.Wait, Harper and Row, ISBN 0060468777
2. Electromagnetic waves and fields, V.V.Sarwate, Wiley Eastern Ltd, or New Age International (1993, Reprint 2006)
3. Electromagnetic Fields and Interactions , R. Becker, , Dover Publications, Inc., New York, NY, 1982, ISBN 0-486-64290-9.

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 1 Quantum Theory

Planck's Quantum hypothesis and radiation law- Quantum theory of radiation and photons- Matter waves- De Broglie wave theory–De Broglie wavelength of electrons. Experimental verification of matter waves- Davisson and Germer experiment, G.P. Thomson's experiment.

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 wavs in a periodic potential, Kronig –Penny periodic potential

Unit IV : Approximation Methods for Stationary States

Time independent perturbation theory – non degenerate – cases – first order perturbation — Removal of degeneracy in first order and second order – First order Stark effect in hydrogen atom – Zeeman effect – The variation method – Ground state of Helium – WKB approximation.

Unit V: Angular Momentum and Time Dependent Perturbation

Commutation rules for angular momentum operators – Eigen value spectrum – Raising and lowering operators – Matrix representation of angular momenta – Clebch – Gordon Co-efficients symmetry properties (no derivation).

Text Book:

1. Quantum mechanics-Gupta Kumar Sharma- Jai Prakash Nath & Co -2007
2. Quantum mechanics –G. Aruldhas –PH Learning Pvt. Lmt. – 2008

Reference Books:

1. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, Ist edition (2005)
2. Basic Quantum Mechanics K. Ghatak and Lokanathan, Mc Millan,2006
3. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, I edition 2005

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, Paramaganetism 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
2. Solid State Physics - S.O.Pillai – New Age International publishers.
3. Physics of semiconductor devices – S.M.Sze 2007

Reference Books
1. Basic Semiconductor Physics – Chihiro Hamaguchi 2nd Edition 2001
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.

Mesoscopic Devices, Metal Insulator Semiconductor devices, MOSFET characteristics - Nanoscale Transistors, NanoFET - Single Electron Transistors, and, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices. Connection with quantum dots, quantum wires, and quantum wells.

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:

1. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.
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)
2. Nano Engineering in Science & Technology : An introduction to the world of nano Design by Michael Rieth.
3. Enabling Technology for MEMS and nano devices -Balles, Brand, Fedder, Hierold.
4. Optimal Synthesis Methods for MEMS- G. K. Ananthasuresh
5. MEMS & MOEMS Technology and Applications- P. Rai Choudhury
6. Processing Technologies- Gandhi

7. From Atom to Transistor- Supriyo Datta

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

Mechanics – Units and dimensions – Work and energy – Relativity effects – Electricity – Electrical charge – Electric Potential- Electric Field – Energy Transfer – Elastic and inelastic collision – Electromagnetic waves – Quantum theory – Matter waves – Uncertainty Principle – Atomic and Nuclear structure – Various atom models – Excitation and ionization – Periodic table of the elements – The wave mechanics atomic model – The nucleus – The neutron and the nuclear force – Isotopes – The atomic mass unit – Binding energy – Nuclear models - Nuclear stability

Unit II :Radioactivity and interaction of radiation with matter

Radioactivity and decay mechanism – Alpha emission – Beta emission – Positron emission – Orbital electron capture – Gamma rays – Internal conversion – Kinetics of decay – Half life – Average life – Biological half life – The units of radioactivity – Curie – Becquerel – Roentgen – Gray – Sievert – Series decay – Alpha rays – Range-energy relationship – Energy transfer – Beta rays – Range energy relationship – Mechanism of energy loss – ionization and excitation – Gamma rays – Exponential absorption – Absorption mechanisms – Pair production – Compton scattering – Photoelectric effects – Neutrons – Production – Classification – Interaction

Unit III : Methods of measuring radiation
Gas filled detectors – General consideration – Ionization chamber – Proportional counters – Geiger Muller Counter – Considerations in the use of gas filled counters – Scintillation detection systems – Photomultipliers – Scintillators – Light guides – Detector systems – Cherenkov detectors – Semiconductor detectors – Principles of operation – Charged particle detectors – Lithium drifter detectors – Thermoluminescent detectors – High purity Germanium Detectors – Track devices – Photographic emulsion – Track etch dosimeters – Spark counters and spark chambers – Cloud chambers bubble chambers – Miscellaneous detectors

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

Unit V: Radiation in the environment and their applications
Types of radiation sources – Natural radiation sources – Cosmic Radiation – Terrestrial radiation – Indoor gamma radiation – Indoor Radon, thoron and their progeny – Artificial sources of radiation – Medical radiation sources – Radiation from nuclear industries – Industrial radiation sources – Applications of radiations – Medical applications – Industrial applications – Radiation in food processing industry – Agricultural applications – Isotope hydrology – Miscellaneous applications

Text Books

1. Measurement and detection of radiation, Nichola Tsoulfanidis, Taylor & Francis; 2 edition (1995), ISBN-10: 1560323175
2. Environmental Radioactivity From Natural, Industrial & Military Sources, Merril Eisenbud, Academic Press, (1997, Fourth Edition), ISBN: 0122351541

Reference Books

1. Principles of nuclear radiation detection, G.G.Eicholz and J.W.Poston, ANN Arbor Science, 1985
2. Introduction to Health Physics, Herman Cember, Pergamon Press, 1976
3. Nuclear Radiation Detection, W.J.Price, McGraw Hill Book Company, 1964

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

Hydrogen spectrum- Angular Momentum – Larmor Precession – Vector atom model - Spin-orbit interaction – spectra of Alkali atoms – angular momentum of many electron atoms –L-S Coupling – j-j coupling– Energy levels and spectral transitions of Helium – Normal and anamolous Zeeman effect – Paschen back effect – MO treatment of Hydrogen molecule ion –MO treatment of Hydrogen molecule – Heitler – London theory – Diatomic molecular orbitals.

Unit II : Infrared And Microwave Spectroscopy
Vibrational energy of diatomic molecule – Morse curve – Diatomic vibrating rotator – Vibrations of ployatomic molecules – IR spectrophotometer – sample handling techniques – Fourier transform spectrometer – Identification of molecular constituents – Classification of molecules - Rotational spectra of rigid diatomic molecules - Microwave spectrometer.

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
NMR – Magnetic properties of nuclei – Resonance condition - Bloch equation – Relaxation Processes: Spin – Spin and spin lattice relaxation process –NMR spectrometer - Fourier.
Transform NMR– ESR: Principle – Basic requirements of X-Band ESR - Balanced bridge ESR Spectrometer

Unit V : Resonance Spectroscopy - II
N Q R – Basic Principle – Transitions for axially symmetric systems nonaxially symmetric systems– N Q R instrumentation- NQRgroup frequencies – Hydrogen bonding - **Mossbauer spectroscopy**: Recoilless emission and absorption - Massbauer spectrometer – Chemical shift – Applications: Molecular structure – problems

Text Book:

1. Molecular structure and Spectroscopy, G.Aruldhas Prentice-hall of India Pvt. Ltd.New Delhi, 2004

Reference Books:

1. Spectroscopy – Straughan Walker , McGraw-Hill, New york
2. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, 1934
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson
5. Molecular Spectroscopy- Banwell, , McGraw-Hill, New york 1994
6. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 2007
7. High Resolution NMR- Pople, Schneidu and Berstein. McGraw-Hill, 1959
8. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, 1963
9. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.1978
10. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, 1958

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

Fundamentals of Cooling - Fundamentals of Nanofluids – Making Nanofluids – Materials for Nanoparticles and Nanofluids – Methods of Nanoparticle Manufacture – Dispersion – Milestones in Thermal conductivity measurements – Milestones in Convection Heat Transfer – Mechanism and Models for enhanced thermal support: Structure based Mechanism and Models – Dynamics based Mechanism and Models

Unit II: Synthesis of Nanofluids

Single step method – Two step method – Synthesis of colloidal Gold nanoparticles : Turkevich method – Brust method – Microwave Assisted Synthesis – Sonolysis – Electrochemical Reduction – Thermal Decomposition – Chalcogenides – Solvothermal Synthesis – Magnetic Nanofluids – Inert Gas Condensation

Unit III: Conduction Heat transfer in Nanofluids

Conduction Heat Transfer- Steady Conduction: Conduction in slab – Hollow cylinder – composite cylinder- Transient conduction: Lumped-parameter method – One Dimension Transient Conduction - Measurement of Thermal Conductivity of Liquids : Guarded Hot Plate method – Transient Hot wire – Temperature oscillation method (No derivation) – Thermal conductivity of Oxide nanofluids – Hamilton Crosser Theory (Al_2O_3 - Water and Al_2O_3 – Ethylene Glycol)

Unit IV: Convection in Nano fluids

Fundamentals of Convective Heat Transfer – Newton's law of cooling – equations of fluid flow and heat transfer: Navier-Stokes equations, Reynolds number - Prandtl number - Nusselt number - Natural convection : Grashof number, Rayleigh number – Experimental study of natural convection - Convection in Suspensions and Slurries: Eulerian-Eulerian approach – Eulerian-Lagrangian approach

Unit V: Pool Boiling and Application of Nanofluids

Fundamentals of Boiling : Nukiyama curve - Nucleate boiling –Experimental study of Pool Boiling of Water-Al_2O_3 Nanofluids – Applications of nanofluids: Vechile cooling , Transformer cooling, Biomedical applications

Text Book:

1. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John wiley sons, 2007

Reference Books:

1. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 1972.
2. Heat and Mass Transfer, R.K. Rajput, S. Chand, 2008

3. Heat transfer Principles and applications, Binay K. Dutta, Prentice – Hall of India Pvt. Ltd, New Delhi, 2001

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.
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Unit I: Solutions of nonlinear equations and minimization of functions.
Finding Roots of a Polynomial-Methods of successive bisection. False position and mid point methods. Secant method. Newton-Raphson scheme.

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

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

Unit IV: Solutions of ordinary differential equations
Euler Method – Adam's Bashforth predictor corrector methods. Runge Kutta method. Adaptive step size selection.

UNIT V : Matlab Programming
Matlab as {best} calculator - Standard Matlab windows - Operations with variables - Naming, Checking existence,Clearing,Operations – Arrays - Columns and rows: creation and indexing,Size & length, Multiplication, division, power,Operations - Writing script files - Logical variables and operators,Flow control,Loop operators - Writing functions - Input/output arguments - Examples - Simple Programs – FFT-Contour diagram- 2D plots,Figures and subplots.

Text Books:

1. Numerical Methods for Engineers - S. C. Chopra and R. P. Canale. McGraw-Hill (2001)
2. Applied Numerical Analysis - C. F. Gerald and P. O. Wheatley Addison Wesley, 2004.

Reference Books:

1. Computer Oriented Numerical Methods. V. Rajaraman . PHI Pvt.Ltd, Aug 2004
2. Elementary Numerical Analysis. S. D. Conte and C. de Boor McGraw-Hill College (1972)

3. Introduction to MATLAB and simulink A Project Approach Third Edition O. Beucher and M.Weeks Infinity Science Press LLC Hingham, Massachusetts, New Delhi.
4. Introduction to MATLAB 7 for Engineers – William J.Palm – McGrawHill .

PHYSICS

ADDITIONAL SUBJECT

Code	Subject Name	Credits
10PH201	Engineering Physics	2:0:0
10PH212	Applied Physics	3:0:0

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

Classical Mechanics, Newton's First Law, Force, Mass, Newton's Second Law, Newton's Third Law Of Motion, System Of Mechanical Units, The Force laws, Weight And Mass, Static Procedure For Measuring Forces, Applications Of Newton's' Laws Of Motion

Unit II Heat And Thermodynamics

Heat- A Form Of Energy, Quantity Of Heat And Specific Heat, Molar Heat Capacity Of Solids, Heat Conduction, The Mechanical Equivalent Of Heat

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

Unit III Magnetism

Coulomb's Law, Magnetic Potential, Tangent Law, Magnetic Induction, Permeability And Susceptibility, Magnetic Properties Of Materials I-H & B-H Curves, Properties Of Para, Dia and Ferro Magnetic Materials, Measurement Of Magnetic Moment—Stern & Gerlach Experiment

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

Faraday's Laws Of Electro-Magnetic Induction, Lenz's Law, Fleming's Right Hand Rule, Self Induction, Mutual Induction, Transformer, Practical Applications Of Electromagnetic Induction-Earth Inductor, Dynamo.

Text Books:

1. Fundamentals of Physics, Robert Resnick & David Halliday, Wiley Eastern Publishing Limited 2007
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
3. Fundamentals of Electrostatics, Joseph M. Crowley, 1986
4. Electricity and Magnetism, William C. Robertson, NSTA press, 2005
5. Heat and thermodynamics by M.S.Yadav, Anmol Publications Pvt. Ltd, 2002

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

Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Non Uniform bending - Cantilever – loaded at the free end – loaded uniformly.

Moment of Inertia : Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculations of the moment of inertia of a body and its units.(Torsional Pendulum)

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

Classification of sound, Characteristic of musical sound-Loudness- Weber and Fechner's law- Decibel- Absorption coefficient- Reverberation time- Factors affecting acoustics of buildings and their remedies.

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

Unit IV: Lasers

Properties of laser beam-Principle of laser-Einstein's theory of stimulated emission-Population inversion-Types of lasers-Nd :YAG, He:Ne, CO2 and Semiconductor lasers-Application of lasers-Computer peripherals(CD-ROM)-Industrial applications –drilling and welding.

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:

1. Concepts of Physics by H C Verma, Bharathi Bhavan, 2008 edition
2. Engineering Physics, . V. Rajendran , Tata McGraw –Hill Publishing company Ltd, 2008

Reference Books

1. A Text Book of Engineering Physics- M.N. Avadhanulu, P.G. Kshirshagar – S.Chand & Company, 2007
2. Engineering Physics – R.K. Gaur, S.L. Gupta – Dhanpat Rai Publications, 8th edition, 2008
3. Fundamentals of Physics by David Halliday, Robert Resnick, Jearl Walker , 9th Edition, 2010

DEPARTMENT OF PHYSICS

ADDITIONAL SUBJECTS

Subject Code	Title of the Paper	Credits
10PH208	Quantum Physics	4:0:0
10PH209	Introduction to Magnetism and Electromagnetism	4:0:0
10PH210	Condensed matter Physics	4:0:0
10PH211	Vacuum and Thin film Technology	4:0:0
10PH310	Particle Physics	4:0:0

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

Planck's Quantum hypothesis and radiation law- Matter waves- De Broglie wave theory–De Broglie wavelength of electrons. Experimental verification of matter waves- Davisson and Germer experiment, G.P. Thomson's experiment. Heisenberg Uncertainty Principle.

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:

1. Quantum mechanics-Gupta Kumar Sharma- Jai Prakash Nath & Co -2007
2. Quantum mechanics –G. Aruldhas –PH Learning Pvt. Lmt. – 2008
3. Introduction to Nano technology – Charles Poole Jr. & Frank J.Owens, Wiley,2003

Reference Books:

1. A text book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, Ist edition (2005)
2. Basic Quantum Mechanics K. Ghatak and Lokanathan, Mc Millan,2006
3. Quantum Mechanics – L.Schiff, McGraw-Hill, New York, 2004
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

Magnetic field of a moving charge – Magnetic field of a current element – The Biot-Savart Law– Magnetic field of a straight current carrying conductor – Force between parallel conductors – Definition of the Ampere and the Coulomb – Magnetic field of a circular current loop – Ampere's law – Applications of Ampere's law – Magnetic fields and displacement currents – Magnetic materials

Unit III : Electromagnetic Induction

Induction experiments – Faraday's law – Induced electric fields – Lenz's law – Motional electromotive force – Induced electric fields – Eddy currents – The Betatron – Inductance – LR circuits – Magnetic energy – Displacement currents – LC and LCR circuits – Superconductivity

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

1. Sears and Zemansky's University Physics with Modern Physics, Hugh D.Young and Roger A.Freedman, New Delhi: Pearson (2009)
2. Classical Electrodynamics, third ed., J. D. Jackson, New York: John Wiley & Sons, Inc., (1999)
3. Physics Vol.1 and Vol.2, Paul A.Tipler, New Delhi: CBS Publishers & Distributors, (2004)

Reference Books

1. University Physics, Francis W.Sears, Mark W.Zemansky and Hugh D .Young, New Delhi: Narosa, (1998)
2. Fundamentals of Physics, 7th Edition, Halliday, Resnick, Walker, Wiley Eastern (p) Ltd, (2004)
3. University Physics, Dexin Lu, New Delhi: CBS Publishers & Distributors, (2006)

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

1. Introduction to Solid State Physics – Charles Kittel.7th edition, 2000.
2. Solid State Physics - S.O.Pillai – New Age International publishers, 2005
3. Elementary Solid State Physics –M. Ali Omar, Addison-Wesley Pub. Co., 1993.

Reference Books

1. Basic Semiconductor Physics – Chihiro Hamaguchi 2nd Edition 2001
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

General characteristics of vacuum pumps – **R**ough-medium vacuum range pumps - rotary pump – **D**iffusion pumps –pumping mechanism– **C**ryogenic pumps - pumping mechanism – speed pressure and saturation. Classification of measurement methods – Direct pressure measurement – Indirect pressure measurement – Pressure gauges – Direct reading gauges – Diaphragm & Bourdon gauge - capacitance manometer – Indirect reading gauges – thermal conductivity gauge – pirani gauge.

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

Adsoption, 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

X- Ray Diffraction studies –Bragg's law – particle size – Scherrer's equation – crystal structure – Surface morphology - UV Vis NIR Spectroscopy – Absorption, transmission 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. Electrical properties: dc electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density.

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

1. Vacuum Technique by L. N. Rozanov, Taylor and Francis, London, 2002, ISBN No: 0-415-27351-x.
2. Thin film deposition Principles & Practice, Donald L. Smith, McGraw Hill, 1995, ISBN No: 0-07-058502-4.
3. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D.

Barlow, McGraw-Hill Professional, 1998
4. Thin Film Technology, Robert W. Berry, Peter M. Hall, Murray T. Harris, Van Nostrand company, London
5. Langmuir-Blodgett films an Introduction - Michael C. Petty, Cambridge University Press, 1996.
6. Langmuir-Blodgett films by Gareth Gwyn Roberts, Plenum Press, 1990.

Reference Books

1. A user's guide to Vacuum Technology, John F. O' Hanlon, 3rd Ed., John Wiley & Sons Inc, 2003.
2. Modern Vacuum Physics, Austin Chambers, Chapman & Hall/CRC, Taylor and
3. Francis, London, 2005, ISBN No: 0-8493-2438-6.
4. Hand book of thin film deposition processes & technologies Krishna Seshan, Noyes
5. Publications/William Andrew publishing, 2nd Ed., 2002.
6. The materials Science of thin films, Milton Ohring, Academic Press, 1992, ISBN No:
7. 0-12-524990-x.
8. Thin film materials – stress, defect formation & surface evolution, L.B. Freund & S.
9. Suresh, Cambridge University Press, 2003, ISBN No: 0-521-822815.
10. An Introduction to Physics and Technology of Thin Films
    a. By Alfred Wagendristel, Yuming, Yu-ming Wang, World Scientific, 1994
11. Handbook of Thin-film Deposition Processes and Techniques: by Krishna Seshan, Noyes Publications, New York, 2002.

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

The Classical Era – The Photons – Mesons – Antiparticles – Neutrinos – Strange particles – The Eightfold ways – The quark model – The November revolution and its aftermath – Intermediate vector bosons – The classification of Elementary particles - The Standard Model –Types of interactions

Unit II : Particle Accelerators

Classification of accelerators – Ion sources – Van de Graff electrostatic generator – The Cyclotron – Betatron – Synchrocyclotron – Proton and electron synchrotron – Linear accelerators – The modern particle accelerators – Large Electron Positron and Large Hadron Collider at Europe – Stanford Linear Accelerator, Tevatron, Relativistic Heavy Ion Collider at the U.S.A. – The next generation accelerators – International Linear Collider

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 ½ - Flavor symmetries – Discrete symmetries – Symmetry groups – 0(3), SU(2), SU(3), and SU(6)

Unit IV : Relativistic Kinematics
Introduction – Particle reactions – Lorentz invariant phase space – Four vectors - Two-body and three bodyphase space – Recursion relation – Effective mass – Classical collisions – Relativistic Collisions – Dalitz plots for dissimilar particles – Breit Wigner resonance formula – Mandelstem variables

Unit V : The Four Fundamental Interactions
Weak interactions – Introduction to four fermions Fermi theory – Development of V-A Theory – Weak neutral current and GIM model – Neutrino-nucleon scattering – Strong interactions – Introduction to gauge field theories – Unification schemes – Spontaneous symmetry breaking, Glashow-Weinberg-Salam model – GUTS – Supersymmetry – Recent developments – The Higgs Boson – Extra Dimensions – Dark Matter and Dark Energy

Text Books

1. Introduction to Elementary Particles, David Griffiths, Weinheim: Wiley VCH, (2009) 2nd edition ISBN:978-3-527-40601-2
2. Introduction to high energy physics, D. H. Perkins, Menlo Park: Addison-Wesley, (1987)
3. Elements of nuclear physics, M.L.Pandya and R.P.S.Yadav, Meerut: Kedar Nath Ram Nath (1997)

Reference Books

1. Introduction to particle physics, M.P.Khanna, New Delhi: Prentice-Hall of India
2. Elementary Particles : I.S. Hughes (Cambridge University Press, Cambridge).
3. Introduction to Unitary Symmetry :Litchtenberg (Addison Wesley, Reading)
4. Gauge Theories of Weak, Strong and Electromagnetic Interactions : C. Quigg (Gorden & Breach, New York).
5. An introduction to the standard model of particle physics, by W. N. Cottingham, and D. A. Greenwood (2007), Cambridge University Press
6. Particle physics: A very short introduction, F.E.Close, (2004), Oxford University Press, USA

ADDITIONAL SUBJECTS
for M.Sc Elective, M.Phil, Ph.D and B.Tech Programs

Code	Title of the Paper	Hours/Week			Credits
11PH201	Applied Physics	3	0	0	3
11PH202	Engineering Physics	2	0	0	2
11PH203	Astro Physics	2	0	0	2
11PH204	Introduction to Nano Structured Materials	3	0	0	3
11PH205	Nano Physics Lab	0	0	2	2
11PH301	Classical mechanics	4	0	0	4
11PH302	Statistical mechanics and thermodynamics	4	0	0	4
11PH303	Mathematical physics I	3	1	0	4
11PH304	Electronics	4	0	0	4
11PH305	Quantum mechanics I	3	0	0	3
11PH306	Physical optics	4	0	0	4
11PH307	Mathematical physics II	3	1	0	4
11PH308	Spectroscopy I	3	0	0	3
11PH309	Electro magnetic theory	4	0	0	4
11PH310	Quantum mechanics II	3	0	0	3
11PH311	Nuclear physics	4	0	0	4
11PH312	Spectroscopy II	3	0	0	3
11PH313	Solid state physics	4	0	0	4
11PH 314	Physics of Nanomaterials	4	0	0	4
11PH315	Photonics	4	0	0	4
11PH316	Thin film Technology	4	0	0	4
11PH317	Nano Devices	4	0	0	4
11PH318	Radiation Physics	4	0	0	4
11PH319	Crystal Growth Techniques	4	0	0	4
11PH320	Research Methodology	4	0	0	4
11PH321	Material Characterization	4	0	0	4
11PH322	Renewable Energy Sources	4	0	0	4
11PH323	Electronics lab	0	0	2	2
11PH324	General physics lab	0	0	2	2
11PH325	Microprocessor / controller lab	0	0	2	2
11PH326	Advanced physics lab I	0	0	2	2
11PH327	Computational physics lab	0	0	2	2
11PH328	Advanced physics lab II	0	0	2	2

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 variouslasers and its application in fibre optics
- Study the principles of acoustics and applications of ultrasonic waves

- Get more knowledge on engineering materials and its applilcations

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

Unit I: Quantum Physics
Planck's hypothesis, ,- Wave nature of matter- De Broglie wave –De Broglie wavelength of electrons-, phase velocity and group velocity, properties of matter waves, Experimental verification of matter waves- Davisson and Germer experiment, G.P. Thomson's experiment, Heisenberg's uncertainty principle.
Shrodinger's time independent wave equation , Applications: particle in a box, Zero point energy and overtones, SEM and its applications

Unit II : Lasers
Properties of laser beam-Principle of laser-Einstein's theory of stimulated emission-Population inversion-Types of lasers-Nd :YAG, He:Ne, CO2 and Semiconductor lasers-Application of lasers-Computer peripherals(CD-ROM)- Holography: Principle, recording and reconstruction. Medical applications

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
Magnetic materials: Dia, Para and Ferro magnetic materials, I-H and B-H curves, Magnetic recording and reading.

Text Book:
Hitendra K Malik, A K Singh – Engineering Physics, McGraw –Hill Publishing company Ltd, Publication,2008

Reference Books:
1. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics-S.Chand & Co Ltd, 2008
2. R.K. Gaur, S.L. Gupta – Engineering Physics – Dhanpat Rai Publications, 7th edition,2001
3. P.K. Mittal – Applied Physics – I.K. International Publishing House Pvt.Ltd, 2006
4. M. Arumugam- Materials Science – Anuradha Publications, 1998
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 harmnonic motion m 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, meldes' 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

Fundamentals of Physics, David Halliday, Robert Resnick, Jearl Warlker, John Wiley& sons.Inc.,2001

Reference Books:

1. University Physics, Sears and Zemansky –Pearson Addison Wesly,2007
2. Engineering Physics Hitendra k Malik , A K Singh Tata McGraw Hill Education Private Limited, 2010
3. Fundamental of Physics, Allan Giambattista, Betty McCarthy Richardson, Robert C Richardson, Tata McGraw Hill Education Private Limited, 2008
4. Engineering Physics, Dattu R Joshi Tata McGraw Hill Education Private Limited, 2010

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)

The Historical Basis of Solar System Models – The Solar System in Perspective: Planets, Moons, Rings and Debris – The Terrestrial Planets: Mercury, Venus, Earth and Mars – The Gas Giant Planets: Jupiter, Saturn, Uranus, Neptune and Minor Planets – Other Constituents of Solar System – Asteroids, Comets, Meteors, Meteoroids and Meteorites.

Unit II: The Stars

The Sun – Internal Structure of the Sun – Properties - Solar Mysteries - The Distance, Motion and Brightness of Stars – Stellar Spectra - Hetzprung-Russel Diagrams – Stellar Masses – The Formation of Stars and Planets – The Evolution of Stars –Types of Stars - White dwarfs, Neutron Stars and Black Holes – Star Clusters.

Unit III: Telescopes and Detectors

Optical Telescopes – Invisible Astronomy: The Hubble Space Telescope Detectors and Image Processing: Photography, Phototubes, Charge Couple Devices, Signal to Noise – The New Generation of Optical Telescopes. – A Brief Introduction to Other Windows to Heaven

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

Clusters of Galaxies – Super Clusters of Galaxies - Hubble's Law – Cosmological Models – The Standard Big Bang Model – The Big Bounce Theory– Inflation – The Fate of the Universe – The Big Crunch Theory – The Big Rip Theory – Life in the Universe

Text Books:

1. Introductory Astronomy and Astrophysics, Fourth Edition, Michael Zeilik, Stephen A. Gregory, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. Astronomy and Astrophysics, A. B. Bhattacharya, S. Joardar, R. Bhattacharya, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6

Reference Books:

1. Handbook of astronomy and Astrophysics, Martin V. Zombeck, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
2. Theoretical Astrophysics (Vol. I, II, II): Thanu Padmanabhan, Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2

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

What is nano-Why nano-Nanomaterials -Quantum Mechanics -Review of classical mechanics -de Broglie's hypothesis -Heisenberg uncertainty principle -Pauli exclusion principle -Schrödinger's equation -Properties of the wave function -Application: quantum well, wire, dot -Quantum cryptography

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:

top-down vs bottom-up -Thin film deposition -Epitaxial growth -CVD, MBE, plasma -Lithographic, photo, e-beam -Etching --FIB -Synthesis -Colloidal dispersions -Atomic and molecular -manipulations -Self assembly -Growth modes, Stransky-Krastinov etc --Ostwald ripening

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:

1. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
2. Introduction to Solid State Physics, C.Kittel, a chapter about Nanotechnology, Wiley, 2004

11PH205 NANO PHYSICS LAB

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 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 nanopartrticles 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. Spetra of atoms and molecules
12. LASER particle analyzer
13. XRD analysis
14. UV- visible spectrophotometer

11PH301 CLASSICAL MECHANICS

Credits: 4:0:0

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'g Principle, applications of Lagrange's equation of motion

Unit II : The Two Body Central Force Problem
Reduction to the equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force – The motion in time in the Kepler problem – Scattering in a central force field.

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:

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics- S.L.Gupta, V. Kumar & H.V.Sharma-Pragati Prakashan-Meerut.,2003

Reference Books:

1. Classical mechanics - T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
2. Classical Mechanics - John Robert Taylor, University Science Books, 2004
3. Classical Mechanics Gupta SI, Kumar V, Sharma HV- Pragati Prakashan 2008

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
Energy and the first law of thermodynamics – Heat content and Heat capacity – Specific heat – Entrophy and the second law of thermodynamics – Thermodynamic potentials and the reciprocity relations – Maxwell's relations – Deductions – Properties of thermodynamic relations – Gibb's – Helmholtz relation – Thermodynamic equilibrium – Nernst's Heat Theorem and third law – Consequences of third law – Nernst's - Gibb's phase rule – Chemical potential

Unit II: Statistical Description of Systems of Particles
Statistical formulation of the state system – phase space – Ensemble – average value – density of distribution in phase space – Liouville Theorem – Equation of motion and Liouville theorem – Equal apriori probability – Statistical equilibrium – Ensemble representations of situations of physical interest – isolated system – Systems in contact.

Unit III: Simple Applications of Statistical Mechanics
General Method of approach – Partition functions and their properties – Ideal Monatomic Gas – Calculation of Thermodynamic quantities – Gibb's Paradox The equipartition theorem and proof – application to harmonic oscillator.
Statistical Thermodynamic Properties of Solids: Thermal characteristics of crystalline solids – Einstein model – Debye modification – Limitations of Debye theory – Paramagnetism – General calculation of Magnetization

Unit IV: Quantum Statistics of Ideal Gases
Maxwell – Boltzman statistics, Bose-Einstein statistics and Fermi Dirac statistics; Calculation of distribution functions from the partition function for M-B, B-E, and F-D statistics – Quantum statistics in the classical limit – ideal Bose Gas – Bose – Einstein condensation – Ideal Fermi Gas – Degnerate Electron Gas.

Unit V: 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.

Text Book:
1. Fundamentals of Statistical and Thermal Physics , Federick Reif, McGraw-Hill, 1985.

Reference Books:
1. Statistical Mechanics – B. K. Agarwal and M. Einsner , John Wiley & Sons,1988
2. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
3. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale Royal Society of Chemistry, 2001
4. Introduction to statistical mechanics – S.K.Sinha, Alpha Science International, 2005
5. Elements of Statistical Mechanics-Kamal Singh & S.P. Singh- S. Chand & Company, New Delhi, 1999

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
Review of basic concepts – Differentiation of vectors – Scalar and vector fields - Gradient, Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's Divergence theorem – Green's theorem – Stoke's theorem and their applications to Hydrodynamics (Equation of continuity and Electric Potential) – Orthogonal Curvilinear Coordinates – expressions for Laplacian in spherical polar and cylindrical polar coordinates and its solutions.

Unit II: Matrices
Special matrices and their properties – Rank and inverse of matrix – Solutions of linear equations – Cramer's rule – Characteristic matrix and characteristic Equation – Cayley Hamilton Theorem – Eigen Values and Eigen vectors of matrices and their properties – Quadratic forms and their reduction - Diagonalisation of matrices – Differentiation and integration of matrices

Unit III: Tensor Analysis
Definition of Cartesian tensors – The summation convention and Kronecker Delta symbol – Rank of a tensor – Covariant and mixed tensors – Symmetric and anti-symmetric tensors – Invariant Tensors - Algebraic operations of tensors - Addition, subtraction and multiplication (inner and outer product) of tensors Derivative of tensors – Quotient law of tensor – The Christoffel's symbols – Tensor form of gradient, divergence and curl – Simple applications of tensors – Dynamics of a particle – Theory of Elasticity - Susceptibility (electric and magnetic) – Piezoelectricity

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
Definition of probability – Compound Probability – Total Probability – The multinomial law – The Laplace De Moivre Limit Theorem – Distribution functions - Binomial, Poisson and Gaussian distribution and their properties – Mean, Median, Mode, Dispersion, and Range, Mean Deviation, and Standard Deviation – Different types of errors – Errors and residuals — The principle of Least square and curve fitting

Text Books:

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – Pragati Prakashan – Meerut, 17th edition, 2004

Reference Books:

1. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN-10 3-540-30273-5 (2007)
2. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence - Cambridge University Press – ISBN 0 521 81372 7 (2004)
3. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arfken – Academic Press, U.S.A. – ISBN 0-12-059877-9 (2003)
4. Mathematical Physics Including Classical Mechanics - Satya Prakash - Sultan Chand & Sons, New Delhi - ISBN-13: 9788180544668 (2007)

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

Uni-Junction Transistor – Characteristics **–Application:** Relaxation Oscillator - FET Volt – Ampere Characteristics – MOSFET, N Channel – P Channel – FET as a voltage variable resistor –Common source amplifier – SCR – TRIAC – DIAC – Tunnel Diode – Characteristics –Basic applications.

Unit II: Fabrication of Integrated Circuits

Integrated circuit technology- Basic monolithic integrated circuits- epitaxial growth - masking and etching – Diffusion of impurities – Monolithic diodes, integrated resisters, 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

Op. Amp characteristics – Parameters – Basic, application – summing – integrating - Differentiating – Logarithmic – Antilogarithmic amplifier – Sinusoidal, square – Triangular and ramp wave generation – Multivibrator – Bistable – Monostable – Schmit trigger – Solution of differential equation – Analog computation

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

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

Text Books:

1. Millman's Electronics Devices & Circuits by Jacob Millman, Christos C Halkias, Satyabrata , Tata McGraw-HillPublishing Company Pvt. Ltd. 2008
2. Integrated Electronics – Millmaan. J. and Halkias C.C, McGraw Hill, 2004

Reference Books:

1. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India, 2009
2. Digital Principles and Applications – Malvino and Leach, Tata McGraw Hill,Co. 2008.
3. Principles of Electronics by V.K.Metha, Rohit Metha. 2006

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

Orbital Angular Momentum-Spin Angular Momentum-Total Angular Momentum Operators-Commutation Relations of Total Angular Momentum with Components-Ladder operators-Commutation Relation of Jz with J+ and J- - Eigen values of J2, Jz- Matrix representation of J2, Jz, J+ and J- - Addition of angular momenta- Clebsch Gordon Coefficients – 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 Many Electron Atoms

Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two-electrons- The Helium Atom – Central Field Approximation - Thomas-Fermi model of the Atom - Hartree Equation- Hartree -Fock equation.

Text Books:

1. A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan - Tata McGraw Hill 2007.
2. Quantum Mechanics – G. Aruldhas - Prentice Hall of India 2006

Reference Books:

1. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
2. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
3. Quantum mechanics, Satya Prakah & Swati Saluja, kedar Nath Ram Nath &Co,Meerut, 2007
4. Principles of Quantum Mechanics-R.Shankar, Springer 2005

11PH306 PHYSICAL OPTICS

Credits: 4:0:0

Course Objectives:

• To learn the working of various optical elements like lenses and mirrors.
• To understand the nature of light

Course Outcome:

• Students can understand the usage of various optical elements like lenses and mirrors.

Unit I: Geometrical Optics

Lenses- Thin Lens Equations- Mirrors- Mirror Formula-Prisms-Dispersing and Reflecting-Thick Lenses and Lens Systems-Analytical Ray Tracing- Matrix Methods for Lenses and Mirrors- Optical Cavity

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- Waveplates- Full-Wave, Half-Wave and Quarter-Wave Plates- Optical Activity

Unit IV: Interference and Diffraction

Interference-General Considerations- Conditions for Interference- Temporal and Spatial Coherence- Amplitude-Splitting Interferometers- Michelson and Mach-Zehnder Interferometer- Multiple Beam Interference- Fabri-Perot Interferometer.Diffraction- Huygens-Fresnel Principle- Fraunhofer and Fresnel Diffraction- Fraunhofer Diffraction- Single, Double and Many Slits- Diffraction Grating- Fresnel Diffraction-Kirchhoff's Scalar Diffraction Theory.

Unit V: Fourier Optics

Fourier Transforms- One- and Two-Dimensional Transforms- Dirac Delta Function- Optical Applications- Spectra and Correlation

Text Books:

1. Optics: Eugene Hecht and A. R. Ganesan, Dorling Kindersely (India) (2008)
2. Optics: A. K. Ghatak, Tata McGraw Hill, (2008)

Reference Book:

1. Principles of Physical Optics, Charles A. Bennett, Wiley, (2008)

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

Functions of a complex variable – Single and many valued functions – Analytic functions – Cauchy – Riemaan conditions and equation – Conjugate functions – Complex Integration – Cauchy's integral theorem, integral formula – Taylor's series and Laurent Series – Poles, Residues and contour integration - Cauchy's residue theorem – Computation of residues – Evaluation of integrals.

Unit II : Fourier Series and Fourier Transforms

Fourier series – Dirichilet conditions – Complex representations – Sine and Cosine series – Half range series – Properties of Fourier Series – Physics applications of Fourier series – The Fourier Transforms – Applications to boundary value problems

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

Basic definition of a group – Subgroups – Classes – Isomorphism Homomorphism – Cayley's theorem – Endomorphism and automorphism – Important Theorems of Group representations – Unitary theorem – Schur's Lemma – Equivalent Theorem – Orthogonality Theorem – Some special groups – Unitary Group – Point Group – Translation Group – Homogenous and Inhomogenous Lorentz groups – Direct product group

Unit V : Numerical Methods

Finite Differences – Shifting Operator – Numerical Interpolations – Newton's forward and backward formula – Central Difference interpolation – Lagrange's Interpolation – Numerical Differentiation – Newton's and Stirling's Formula – Numerical Integration – Trapezoidal Rule – Simpson's 1/3 and 3/8 rule – Numerical Solution of ordinary differential equations – Taylor's Euler's, Adam's Methods – Runge-Kutta methods – Piccard's Methods

Text Books:

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – Pragati Prakashan – Meerut, 17th edition, 2004

Reference Books:

1. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN-10 3-540-30273-5 (2007)
2. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence - Cambridge University Press – ISBN 0 521 81372 7 (2004)
3. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arfken – Academic Press, U.S.A. – ISBN 0-12-059877-9 (2003)
4. Mathematical Physics Including Classical Mechanics - Satya Prakash - Sultan Chand & Sons, New Delhi - ISBN-13: 9788180544668 (2007)

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

Central field approximation – Thomas – Fermi Statistical model – Spin-orbit interaction – Alkali atoms – Doublet separation – Intensities - Complex atoms – Coupling Schemes – Energy levels – Selection rules and intensities in dipole transition – Paschen back effect

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-Opprenheimer Approxiamation-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
Electronic Spectra of Diatomic Molecules- Born-Oppenheimer Approximation- Franc-Condon Principle- Dissociation Energy- Rotational Fine Structure- Fortrat Diagram- Predissociation-Polyatomic Molecules- Re-emission from Excited Molecules.

Text Books:
1. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw-Hill Publ. Comp. Ltd. (2010)
2. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 1950

Reference Books:
1. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)
2. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, 1934

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 electricfields – 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
Biot and Savart law – Differential equations of magnetostatics and Ampere's law – The magnetic vector potential – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – Macroscopic magnetization – Magnetic field.

Unit III : Time Varying Fields

Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem.

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
Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard – Wiechert Potentials – The field of a uniformly moving point charge.

Text Books:

1. Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy, Addison Wesley, 2008
2. Electromagnetic theory: B. B. Laud,Wiley,1983

Reference Books:

1. Classical Electrodynamics, J. D. Jackson, John Wiley and sons,1998
2. Electromagnetism I S Grant, W R Pillips, A S Grant John Wiley & Sons,1991

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
Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation-Transition Probabilities-Selection Rules for Dipole Radiation-Collision-Adiabatic Approximation.

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 as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates-Density Matrix and its Applications.

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:

1. A Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGr aw Hill 2007
2. Quantum Mechanics – G Aruldhas - Prentice Hall of India 2006

Reference Books:

1. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
2. Quantum mechanics, Satya Prakas & Swati Saluja, kedar Nath Ram Nath &Co,Meerut, 2007
3. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
4. Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillan India,2004

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

Basic properties – magnetic moments – Experimental determination – Quadrupole moments – Experimental techniques – Systems of stable nuclei – Semi emperical 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
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, Swimming pool type reactor –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.

Text Books:
1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 1971.
2. Nuclear Physics – I. Kaplan – Addison Wesley, 1971

Reference Books:
1. Introduction to Nuclear Physics – H.A. Enge – Addision-Wesley, 1971.
2. An introduction to Nuclear Physics- M.R. Bhiday and V.A. Hoshi, Oriental Longmen, 1972.
3. The Atomic Nucleus – R.D. Evans – Tata Mcgraw-Hill, 1975.
4. Basic Nuclear Physics – D.N. Srivastava, Pragati Prakashan – Meerut – 1968.
5. Nuclear Physics – Roy and Nigam – Willey Eastern Ltd, 1967

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
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.

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 spliting, 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:

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw-Hill Publ. Comp. Ltd. (2010)
2. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)

Reference Books:

1 High Resolution NMR- Pople, Schneidu and Berstein. McGraw-Hill, (1959)
2. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, (1963)
3. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.(1978)
4. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, (1958)

11PH313 SOLID STATE PHYSICS

Credit: 4:0:0

Course objectives:
Students will be able to

- Get knowledge on band theory of solids
- Understand theoretical aspects of dielectric magnetic and optical properties of solids
- Gain knowledge on the principle of super conductivity

Course Outcome:
Students will be able 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)
Band Theory of Solids: Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II : Dielectric And Ferroelectric Properties
Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Classius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant. Ferroelectricity – General properties – Dipole theory.

Unit III : Magnetic Properties
Quantum theory of Paramagnetism – Paramaganetism of ionic crystals – Rare earth ions –

Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange 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 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:

1. Solid State Physics- S.O. Pillai New Age Publications, 2002
2. Elementary Solid State Physics- M. Ali Omar, Pearson Education, 2004

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

Free electron theory and its features, Idea of band structure— metals, insulators and semiconductors. Density of state in bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

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:

1. Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society).
2. Physics of Semiconductor Nanostructures: K.P. Jain, Narosa publishers, 1997.
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov, John Wiley & sons,1999.
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application J.H. Fendler John Wiley & sons,1998

Reference Books:

1. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski 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

Overview of Optical Fibers: Structure of optical fibers. Step-index and graded index fibers; Single mode, multimode and W-profile fibers. Ray Optics representation. Meridional and skew rays. Numerical aperture and acceptance angle. Multipath dispersion materials - Material dispersion -Combined effect of material and multipath dispersion - RMS pulse widths and frequencyresponse - Model Birefringence - Attenuation in optical fibers - Absorption - Scattering losses -Radiative losses

Text Books:

1. Lasers and nonlinear Optics: B. B. Laud, New Age International (P) Ltd. (2007)
2. Laser Electronics: J. T. Verdeyen, Prentice-Hall Inc. (1995).
3. Laser Fundamentals: W. T. Silfvast, Cambridge University Press, (2003)

Reference Books :

1. Laser Spectroscopy- Basic Concepts: W. Demtroder, Springer-Verlag, (2003)
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

Material selection, Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor – Transparent conducting oxide Thin films – Semiconducting Thin films – Thin film solar cells – CdS and Cu2S based solar cells – CdS - Cu2S and CdS or Cu In Se2 solar cells – Thin film mask blanks for VLSI – Thin films sensors - for gas detectors. Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

Text Books:

1. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow, McGraw-Hill Professional, 1998
2. Thin film Technology, Chopra, Tata McGraw-Hill, 1985

Reference Books:

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, Method, equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
3. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book Company, New York (1983).
4. Thin-film deposition: principles and practice by Donald L. Smith, McGraw-Hill Professional, 1995

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.
Mesoscopic Devices, Metal Insulator Semiconductor devices, MOSFET characteristics - Nanoscale Transistors, NanoFET - Single Electron Transistors, and, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices. Connection with quantum dots, quantum wires, and quantum wells.

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:

1. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.2008
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
2. Nano Engineering in Science & Technology : An introduction to the world of nano Design by Michael Rieth,2003
3. Enabling Technology for MEMS and nano devices -Balles, Brand, Fedder, Hierold,John Wiley and sons, 2004
4. Optimal Synthesis Methods for MEMS- G. K. Ananthasuresh,Klower Academic publisher,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
Mechanics – Units and dimensions – Work and energy – Relativity effects – Electricity – Electrical charge: the statcoulomb – Electric Potential: the statvolt – Electric Field – Energy Transfer – Elastic and inelastic collision – Electromagnetic waves – Excitation and ionization – Periodic table of the elements – The wave mechanics atomic model – The nucleus – The neutron and the nuclear force – Isotopes – The atomic mass unit – Binding energy – Nuclear models - Nuclear stability

Unit II : Radioactivity and interaction of radiation with matter
Radioactivity and decay mechanism – Kinetics of decay – The units of radioactivity – Series decay – Alpha rays – Range-energy relationship – Energy transfer – Beta rays – Range energy relationship – Mechanism of energy loss – ionization and excitation – Gamma rays – Exponential absorption – Absorption mechanisms – Pair production – Compton scattering – Photoelectric effects – Neutrons – Production – Classification – Interaction

Unit III : Methods of measuring radiation
Gas filled detectors – Ionization chamber – Proportional counters – Geiger Muller Counter – Scintillation detection systems – Photomultipliers – Scintillators – Semiconductor detectors – Principles of operation – Charged particle detectors – Thermoluminescent detectors – High purity Germanium Detectors – Track devices – Photographic emulsion – Track etch dosimeters – Spark counters and spark chambers – Miscellaneous detectors

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:

1. Nichola Tsoulfanidis, Measurement and detection of radiation, Taylor & Francis; 2 edition (1995), ISBN-10: 1560323175
2. Environmental Radioactivity From Natural, Industrial & Military Sources, Merril Eisenbud, Academic Press, (1997, Fourth Edition), ISBN: 0122351541

Reference Books:

1. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010, ISBN0470131489, 9780470131480
2. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed, Academic Press, Elsevier (2007)
3. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, New York (2010)

4. G.G.Eicholz and J.W.Poston, Principles of nuclear radiation detection, ANN Arbor Science, 1985

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

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 (CZ) – 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 (PVD) – Evaporation and Sublimation processes – sputtering – chemical vapour Deposition (CVD) – Advantages and disadvantages –chemical vapour transport – Fundamentals – Growth by chemical vapour transport (CVT) Reaction .

Text Books:

1.Brice, J. C. Crystal Growth processes – Halstesd press, John Wiley & sons, (1986)
2. Elwell. D and Scheel. H. J, crystal growth from High Temperature solutions, Academic press, London (1975)

Reference books:-

1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge University press, (2005).
2. Mallin, J. N, 'Crystallization', Butternmths, London (2004)
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle North Holland – London (1993)

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

Ultraviolet and visible Spectroscopy:UV visible Spectrophotometers-Measurement of Absorption-Infrared Spectroscopy- Fluorescence and Phosphorescence : Measurement of Fluorescence-Spectrofluorometers – Photoluminiscence:light-matter interaction, instrumentation- Electroluminescence:instrumentation,Applications

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 curvemethod of moments

Unit IV Numerical methods

Solution of differential equations – simple iterative method- Newton Raphson method – Numerical by integration – Simpson rule – Gausian quadrature- solution of simultaneous equation – Gauss Jordon elimination method- Eigenvalue and eigenvectors by matrix diagnolization (Jacobian method)

Unit V Application of Numerical and statistical methods using C++ 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

Text Books:

1. Computer applications in Physics- Suresh Chandra, Narosa publishing hours (2003)
2. Numerical methods for Mathematics, Science and Engineering – John H. Mathews, Prentice Hall, India (2000)

Reference Books :

1. B.K.Sharma,Spectroscopy Goel publishing house,2007
2. Elements of X-ray Diffraction by B.D. Cullity (II edition), Addison-Wesley Publishing Co. Inc., Reading, USA, 1978.
3. Electron Microscopy and Analysis by P.J. Goodhew and F.J. Humphreys, Taylor and Francis, London, 1988
4. Electron Microscopy: Principles And Fundamentals, S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), VCH, Weinheim, 1997.
5. Atomic Force Microscopy / Scanning Tunneling Microscopy, S.H. Cohen and Marcia L. Lightbody (Editors), Plenum Press, New York, 1994.

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

Optical Microscopy: Optical Microscopy Techniques – Bright & dark field optical microscopy- phase contrast microscopy- Differential interference contrast microscopy – Fluorescence Microscopy- Scanning probe microscopy (STM, AFM) – Scanning new field optical microscopy – X-Ray Diffraction methods - Rotating crystal- Powder method – Debye-Scherrer camera- Structure factor calculations- EBSD & ED.

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 : Thermal Analysis

Introduction- Thermogravimetric analysis (TDA)- instrumentation- determination of weight loss and decomposition products- differential thermal analysis (DTA) – cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters- Chromatography- Liquid & Gas Chromatography.

Unit V : Electrical, Mechanical & Magnetic Analysis
Two probe and four probe methods- van der Pauw method- Hall probe and measurement-scattering mechanism- C-V characteristics- Schottky barrier capacitance- impurity concentration- Mechanical and Magnetic Analysis: Vickers Hardness test - Vibrating Sample Magnetometer- Working principle of VSM- Instrumentation.

Text books:

1. B.D.Cullity, "Elements of X-Ray diffraction" (II Edition) Addision Wesley publishing Co., 1978.
2. Lawrence E.Murr, Electron and Ion Microscopy and Microanalysis principles and Applications, Mariel Dekker Inc., Newyork, 1991.

Reference Books:

1. Atomic Force Microscopy/ Scanning Tunneling Microscopy, S.H.Cohen & Marcia L.Lightbody (Editors), plenum press, Newyork, 1994.
2. Principles of Thermal analysis and calorimetry by P.J.Haines (Editor), Royal Society of chemistry (RSC), Cambridge, 2002.

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**
Available Energy Sources – Classification of Energy Sources – Commercial and Noncommercial Energy Sources – Fossil Fuels and Climate Change issues – Renewable Energy Resources – Advantages and Limitations of Renewable Energy sources.

Unit II: Solar Energy
Solar radiation at the Earth's Surface – Solar Radiation Measurements – Solar Cell – Solar Energy Collectors – Flat-plate Collectors, Concentrating Collector: Focusing Type – Solar Energy Storage – Applications of Solar Energy – Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking.

Unit III: Wind-Energy
Wind Energy Technology – Aerodynamics – Wind Energy Conversion – Basic Components Of a WECS (Wind Energy Conversion System) – Classification of WECS – Wind Energy Collectors – Wind Energy Storage – Applications of Wind Energy.

Unit IV: Energy from Bio-Mass

Photosynthesis Process – Bio Fuels – Bio mass Resources – Bio-mass Conversion Technologies – Wet processes and Dry Processes – Classification of Bio-gas plants – Bio-gas from plant Wastes – Materials Used For Bio-gas generation – Utilization if Bio-gas -- Methods for Obtaining energy from Bio-mass.

Unit-V: Energy from Other Sources

Energy From The Oceans – Energy And Power from the Waves – Tide and Wave Energy conversion – Advantages and Disadvantages Of Wave Energy – Ocean Thermal Energy Conversion - Geothermal Energy - Chemical Energy Sources – Fuel Cells and Batteries – Hydrogen Energy – Thermionic and Thermoelectric Generators – Micro Hydel Powers

Text Books:

1. Non-Conventional Energy Sources, G.D. Rai, Standard Publishers Distributors, ISBN 9788186308295 (2004)
2. Non-Conventional Energy Sources, B.H.Khan, Tata McGraw Hill (2006) ISBN 0-07-060654-4
3. Renewable Energy, Godfrey Boyle, Oxford University Press in association with the Open University, (2004), ISBN 9780199261789

Reference Books:

1. Renewable energy: sources for fuels and electricity, Thomas B. Johansson, Laurie Burnham, Island Press, (1993), ISBN 9781559631389
2. Renewable energy: sustainable energy concepts for the future, Roland Wengenmayr, Thomas Bührke, Wiley-VCH, (2008), ISBN 9783527408047
3. Renewable Energy: Sources and Methods, Anne Maczulak, Infobase Publishing, (2009), ISBN 9780816072033

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.
5. Construction of an Astable multivibrator circuit using op-amp and transistors.
6. Construction of a bitable multivibrator circuit using op-amp and study its performance.
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.
9. Construction of a circuit using logic gates.
10. Construction of a Wein's bridge oscillator circuit using op-amp and study its performance.

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
9. Viscosity of a liquid - Oscillating disc method.
10. Stefan's constant - To determine Stefan's constant
11. Dielectric constant by Lecher Wire .
12. Frauhnhofer lines-identification of elements
13. Anderason bridge(AC)-determination of inductance.
14. Determination of 'h'-photoelectric effect.
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

Sub. Code	Name of the Subject	Credits
12PH201	Applied Physics	4:0:0
12PH202	Applied Physics Lab	0:0:2
12PH203	Engineering Physics	3:0:0
12PH204	Mechanics & Properties of Matter	4:0:0
12PH205	Properties of Matter and Waves Lab	0:0:2
12PH206	Thermodynamics and Statistical Mechanics	4:0:0
12PH207	Optics and Photonics	4:0:0
12PH208	Heat and Optics Lab	0:0:2
12PH209	Thin Films Technology for Engineers	3:0:0
12PH210	Astrophysics	3:0:0
12PH211	Introduction to Nanostructured Materials	3:0:0
12PH212	Material Science for Engineers	3:0:0
12PH213	Vacuum and Thin Film Technology	4:0:0
12PH214	Basic Science of Sound, Light and Signals	3:0:0
12PH215	Nano Physics Lab	0:0:2
12PH216	Nuclear Physics for Engineers	3:0:0
12PH301	Classical Mechanics	4:0:0
12PH302	Statistical Mechanics and Thermodynamics	4:0:0
12PH303	Mathematical Physics I	3:1:0
12PH304	Electronics	4:0:0
12PH305	Quantum Mechanics I	4:0:0
12PH306	Physical Optics	4:0:0
12PH307	Mathematical Physics II	3:1:0
12PH308	Spectroscopy I	4:0:0
12PH309	Electromagnetic Theory	4:0:0
12PH310	Quantum Mechanics II	4:0:0
12PH311	Nuclear and Particle Physics	4:0:0
12PH312	Spectroscopy II	4:0:0
12PH313	Solid State Physics	4:0:0
12PH314	Physics of Nanomaterials	4:0:0
12PH315	Photonics	4:0:0
12PH316	Thin Film Technology	4:0:0
12PH317	Nanodevices	4:0:0
12PH318	Quantum Physics	4:0:0
12PH319	Electromagnetism	4:0:0
12PH320	Renewable Energy Sources	4:0:0
12PH321	Spectroscopy	4:0:0
12PH322	Condensed Matter Physics	4:0:0
12PH323	Radiation Treatment Planning	4:0:0
12PH 324	Medical Radiation Dosimetry	4:0:0
12PH325	Research Methodology	4:0:0
12PH326	Material Characterization	4:0:0
12PH327	Crystal Growth Techniques	4:0:0
12PH328	Radiation Physics	4:0:0
12PH329	Nanofluids	4:0:0

12PH330	Electronics Lab	0:0:2
12PH331	General Physics Lab	0:0:2
12PH332	Microprocessor / Controller Lab	0:0:2
12PH333	Advanced Physics Lab –I	0:0:2
12PH334	Computational Physics Lab	0:0:2
12PH335	Advanced Physics Lab –II	0:0:2
12PH336	Nano Physics Lab	0:0:4

12PH201 APPLIED PHYSICS

Credits 4:0:0

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

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, Schrodinger's time dependent and independent wave equations, particle in a box. Application- Principle and working of Scanning Electron Microscope (SEM).

Unit II

LASERS: Principle of laser - Properties of laser beam- Einstein's quantum theory of radiation- Population inversion- components of Laser - Types of lasers- Nd :YAG, He:Ne, CO_2 and Semiconductor lasers- Applications of lasers: Computer peripherals (CD-ROM) - Holography: Principle, recording and reconstruction - Medical applications - Material Processing.

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

ACOUSTICS AND ULTRASONICS: Classification of sound, Characteristic of musical sound-Loudness- Weber and Fechner's law-Decibel- Absorption coefficient- Reverberation time- Sabine's formula, Factors affecting acoustics of buildings and their remedies. Classification of ultrasonic waves-properties of ultrasonic waves- ultrasonic production-Magnetostriction and Piezoelectric methods - Acoustic grating, SONAR, NDT.

Unit V

MATERIALS: Magnetic materials: Dia, Para, Ferro, Ferri and Antiferro magnetic materials, Hysteresis curve, Hard and soft magnetic materials, Magnetic recording and reading. Superconductors- Properties of superconducting materials, Type I and Type II superconductors, Applications: Maglev, Superconducting magnets.

Text Book

1. V. Rajendran – Engineering Physics, McGraw –Hill Publishing company Ltd, Publication, 2011.

Reference Books

1. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics- S.Chand & Co Ltd, 2008

2. R.K. Gaur, S.L. Gupta – Engineering Physics – Dhanpat Rai Publications, 7th edition,2001
3. Hitendra K Malik, A K Singh – Engineering Physics, McGraw –Hill Publishing company Ltd,Publication,2008
4. P.K. Mittal – Applied Physics – I.K. International Publishing House Pvt.Ltd, 2006
5. M. Arumugam- Materials Science – Anuradha Publications, 1998
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

1. Fundamentals of Physics, David Halliday, Robert Resnick, Jearl Warlker, John Wiley& sons.Inc.,2001

Reference Books

1. University Physics, Sears and Zemansky –Pearson Addison Wesly, 2007
2. Engineering Physics Hitendra k Malik , A K Singh Tata McGraw Hill Education Private Limited, 2010
3. Fundamental of Physics, Allan Giambattista, Betty McCarthy Richardson, Robert C Richardson, Tata McGraw Hill Education Private Limited, 2008
4. Engineering Physics, Dattu R Joshi Tata McGraw Hill Education Private Limited, 2010

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
PROJECTILE AND COLLISION: Projectile – range of a projectile on an inclined plane – collision between two bodies – impulse – laws of impact – coefficient of restitution – Elastic and inelastic collision – direct and oblique impact – velocities and kinetic energy on impact – loss of kinetic energy- relative masses of colliding bodies

Unit III
ELASTICITY: Introduction – Stress and strain – Hooke's law – Three types of Elasticity – Rigidity modulus – Young's modulus – Bulk modulus – Relation connecting elastic constants – Poisson's Ratio – Torsional pendulum – Cantilever – loaded at the free end – loaded uniformly.

MOMENT OF INERTIA : Moment of Inertia and its physical significance – Expression for moment of inertia – Radius of Gyration – Torque – General theorems on moment of inertia – Calculation of the moment of inertia of a body and its units.

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
FLOW OF LIQUIDS: Rate of flow of liquid – Lines and Tubes of flow – Energy of the liquid – Bernoulli's Theorem, Applications: Venturimeter – Viscosity – Co-efficient of viscosity – Critical velocity – Poiseuille's equation for flow of liquid – Stoke's method – Rotation viscometer
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 by Jaeger's method.

Text Books

1. Elements of Properties of Matter by Mathur D.S., Shyamlal Charitable Trust, New Delhi, 2008.
2. Properties of Matter by Brij Lal & Subramaniam. N, S.Chand & Co., New Delhi, 2005.

Reference Books

1. Properties of Matter by Murugeshan. R., S. Chand & Co Pvt. Ltd., New Delhi. 2007.
2. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
3. Waves & Oscillations by Subrahmanyam N. & Brij Lal, Vikas Publishing House Pvt. Ltd., New Delhi, 1994..
4. Mechanics and General Properties of Matter by P.K. Chakrabarthy - Books & Allied (P) Ltd., 2001.
5. Fundamentals of Physics, 6th Edition, by D. Halliday, R.Resnick and J.Walker, Wiley, NY, 2001.

6. Physics, 4th Edition, VoIs. I, II & II Extended by D. Halliday, R.Resnick and K.S. Krane, Wiley, NY, 1994.

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
14. Determination of A.C frequency of a stretched string.
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

LAWS OF THERMODYNAMICS: Zeroth Law of thermodynamics – Heat – Internal Energy - first law of thermodynamics – Specific Heat of a gas –Second law of thermodynamics - Entropy – Change in entropy in adiabatic and reversible cycle– Third law of thermodynamics – Thermodynamic variables – Extensive and Intensive variables – Maxwell's relations – Specific heat equation - Thermodynamic potentials – Significance – Relation of thermodynamics potentials with their variables

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: Introduction – Degrees of Freedom, Position Space, Momentum space, Phase Space, The mu-space and Gamma space – Applications to One Dimensional Harmonic Oscillator – Fundamental postulates of statistical mechanics – Statistical ensembles : Microcanonical ensembles – Canonical ensembles – Grand canonical ensembles – Comparison of ensembles – Partition function and its relation with Thermodynamic quantities

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: Maxwell – Boltzmann energy Distribution law – Limitations of Maxwell – Boltzmann method - Bose – Einstein Distribution Law – Photon Gas – Planck's Radiation law – Fermi – Dirac Distribution law.

Text Books

1. Heat thermodynamics and statistical physics- Brijlal, N.Subramanyam, P.S.Hemne, S.Chand & Co. Ltd, 2007
2. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990

Reference Books

1. Statistical Mechanics – B. K. Agarwal and M. Einsner , John Wiley & Sons,1988
2. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale,

2001
3. Fundamentals of Statistical and Thermal Physics – Federick Reif, McGraw- Hill,1985

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, Babinets 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, CO_2 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

1. Fundamentals of photonics, Chandrasekhar Roychoudhuri, 2008

2. Textbook of optics, N. Subrahmanyam and Brijlal, chand publications ,1985
3. Laser and nonlinear optics, B B Laud 2nd edition, 2003
4. An Introduction to Fiber optics, Ghatak and Thyagarajan, 1998

Reference Books

1. A Text book of Engineering Physics, M N Avadhanulu & P G Kshirsagar, 8^{th} edition, 2006
2. Nonlinear Optics by Robert W Boyd, Elsevier publication, 3rd edition, 2008
3. The Elements of Fiber Optics, S L Wymer Meardon, Prentice Hall,1993
4. The elements of Nonlinear Optics, P N Bucher & D Cotter, Cambridge University Press, 1990

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: 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 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: Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor — Thin film solar cells -Thin film mask blanks for VLSI – Thin films sensors for gas detectors- Magnetic sensors- storage device-magnetic thin films for MEMS and NEMS application

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

1. An Introduction to Physics and Technology of Thin Films, Alfred Wagendristel, Yuming, Yu-ming Wang, World Scientific, 1994
2. Handbook of Thin-film Deposition Processes and Techniques: Principles, Methods Equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
3. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book Company, New York,1983.
4. Thin Film Phenomena, Kasturi L. Chopra, R. E. Krieger Pub. Co., 1979

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

THE SOLAR SYSTEM : Various Solar System Models – The Solar System in Perspective: Planets, Moons, Rings and Debris – Other Constituents of Solar System – Kepler's laws of planetary motion.

Unit II

THE STARS : The Sun – Important Properties of stars – Measuring the distances of a star – The Parallax Method – The Formation of Stars and Planets – Types of Stars – White dwarfs, Neutron Stars and Black Holes – Star Clusters – Supernovae and their types

Unit III

TELESCOPES AND DETECTORS : Optical Telescopes – The Hubble Space Telescope – Detectors and Image Processing: Photography, Phototubes, Charge Couple Devices, Signal to Noise – The New Generation of Optical Telescopes. – Other Windows to Heaven

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 – The Local Group

Unit-V

THE UNIVERSE : Clusters of Galaxies – Super Clusters of Galaxies - Hubble's Law – Cosmological Models – The Standard Big Bang Model – The Big Bounce Theory – The Fate of the Universe – The Big Crunch Theory – The Big Rip Theory – Life in the Universe

Text Books

1. Introductory Astronomy and Astrophysics, Fourth Edition, Michael Zeilik, Stephen A.Gregory, Saunders College Pub., Michigan, U.S.A, 1998 ISBN 9780030062285
2. Astronomy and Astrophysics, A. B. Bhattacharya, S. Joardar, R. Bhattacharya, Jones and Barlett Publishers, U.S.A., (2010) ISBN 978-1-934015-05-6

Reference Books

1. Handbook of astronomy and Astrophysics, Martin V. Zombeck, Cambridge University Press, U.K. (2007) ISBN 978-0-521-78242-5
2. Theoretical Astrophysics (Vol. I, II, II): Thanu Padmanabhan, Cambridge University Press, U.S.A., (2002) ISBN 0 521 56242 2

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

INTRODUCTION TO NANO: What is nano-Why nano-Nanomaterials -Quantum Mechanics -Review of classical mechanics -de Broglie's hypothesis -Heisenberg uncertainty principle -Pauli exclusion principle - Schrödinger's equation -Properties of the wave function -Application: quantum well, wire, dot -Quantum cryptography

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

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

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

1. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
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

CONDUCTING MATERIALS: Introduction – Electrical properties of Solids – Classical free electron theory or Drude-Lorentz theory – Quantum free electron theory of metals – Sommerfield theory – Fermi- Dirac statistics –Fermi-Dirac distribution – Kronig-Penny model – Example of conducting polymers – Metals and Alloys

Unit II

SEMICONDUCTING MATERIALS: Introduction – Properties – Elemental and compound semiconductors – Metal oxide and organicsemiconductors, Types of semiconductors – Carrier concentration in Intrinsic and Extrinsic— Variation of fermi energy level – Hall effect – Experimental determination of Hall effect – Semiconducting materials: solar cell – quantum efficiency and application.

Unit IV

MAGNETIC MATERIALS: Introduction – Classification of Magnetic materials – Dia magnetic, Para magnetic, Ferro magnetic materials – Langevin's theory of Dia and Para magnetism – Weiss theory of Para and Ferro magnetism – Ferro magnetic domains – domain theory, Hysterisis loops – Soft and hard magnetic materials -- Antiferromagnetism – Ferrimagnetism- Examples: Compounds of Fe,Ni,Co

Unit V

NEW MATERIALS: Ceramic materials – glass ceramics, ceramic semiconductors – Dielectric ceramics ($BaTiO_3$)– cermets – Shape memory alloys – martensite, Austenite – Two way shape memory –characteristics – applications of Nitinol - Polymers – polymerization – Thermoplastics and thermo settings – Elastomers – Polyester and polyamide – Bio-materials and its applications of Hydroxyapatatite

Text Books

1. Raghavan, V., Material Science and Engineering, Prentice Hall of India Pvt., Ltd., New Delhi, 1999.
2. Wahab M.A., Solid State Physics, Narosa Publishing House, New Delhi, Second edition, 1999.

Reference Books:

1. Avadhanulu, M.N., Kshirsagar, P.G., A Text Book of Engineering Physics, S.Chand & Co. Ltd., New Delhi, 6th edition, 2003.
2. Kenneth G.Budinski and Micheal K.Budinski, Engineering Materials, Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.
3. William D Callister Jr., Material Science and Engineering, John Wiley and Sons, 6th Edition, Singapore, 2005.

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

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. Transport phenomena – viscosity - thermal conductivity – diffusion – thermal transpiration - mean free path – particle flux - interaction of gas molecules with surfaces - adsorption time - saturation pressure - surface coverage with gas molecules – gas dissolution in solids.

Unit II

PUMPS AND PUMPING SYSTEMS: General characteristics of vacuum pumps – **R**ough-medium vacuum range pumps – rotary pump – **D**iffusion pumps –pumping mechanism– **T**urbomolecular pumps – pumping mechanism – turbomolecular pump designs – turbomolecular drag pumps – **C**ryogenic pumps - pumping mechanism – speed pressure and saturation.

Unit III

MEASUREMENT OF VACUUM: Classification of measurement methods – Direct pressure measurement – Indirect pressure measurement – Pressure gauges – Direct reading gauges – Diaphragm & Bourdon gauge - capacitance manometer – Indirect reading gauges – thermal conductivity gauge – pirani gauge - thermocouple gauge – stability & calibration – spinning rotor gauge – Ionization gauges – hot cathode gauge – cold cathode gauge – gauge calibration.

Unit IV

THIN FILM GROWTH PROCESS: Evaporation – Thermodynamics of evaporation – evaporation rate – alloys – compounds– sources – transport – deposition monitoring – vapor flux monitoring. Deposition – adsorption – surface diffusion – nucleation – structure development – interfaces – temperature control. Chemical vapor deposition – gas supply – Convection – laminar flow in ducts – axisymmetric flow – free convection – Reaction – chemical equilibrium – gas phase rate – surface processes – Diffusion – diffusion limited deposition.

Unit V

THIN FILM DEPOSITION TECHNIQUES: Molecular Beam Epitaxy – basic MBE process – sputter deposition – physical sputtering theory – plasmas and sputtering systems – chemical vapor deposition – electro plating – potentiostat – galvanostat – pulsed plating – sol gel coating – laser ablation – spray pyrolsis.

Text Books

1. Vacuum Technique by L. N. Rozanov, Taylor and Francis, London, 2002, ISBN No: 0-415-27351-x.
2. Thin film deposition Principles & Practice, Donald L. Smith, McGraw Hill, 1995, ISBN No: 0-07-058502-4.

Reference Books

1. A user's guide to Vacuum Technology, John F. O' Hanlon, 3rd Ed., John Wiley & Sons Inc, 2003.
2. Modern Vacuum Physics, Austin Chambers, Chapman & Hall/CRC, Taylor and Francis, London, 2005, ISBN No: 0-8493-2438-6.
3. Hand book of thin film deposition processes & technologies Krishna Seshan, Noyes publications/William Andrew publishing, 2nd Ed., 2002.
4. The materials Science of thin films, Milton Ohring, Academic Press, 1992, ISBN No: 0-12-524990-x.
5. Thin film materials – stress, defect formation & surface evolution, L.B. Freund & S. Suresh, Cambridge University Press, 2003, ISBN No: 0-521-822815.
6. Thin film Device Applications, K.L Chopra, Plenum Press, NY, 1983

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 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: Velocity of transverse wave along a stretched string. Frequency of vibrating string – Harmonics and overtones. Sonometer – Experimental verification of laws of vibrating strings. Reflection sound at its end of pipes. Vibrations pf air column in open and closed organ pipe. Vibration in air cavity – Helmholtz resonater .

Unit IV

ACOUSTICS: Classification of sound, Characteristics of musical sound – loudness –Weber and fechner's lawdecibel- Absorption coefficient- Reverberation time- Sabine's formula (growth and decay). Factors affecting acoustics of buildings and their remedies. Requisites of a good auditorium.

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:

1. A Text book of Optics, N.Subrahmanyam and Brij lal S.Chand & Co.ltd., New Delhi, 22nd edition, 2000
2. Engineering Physics R.K. Gaur and S.L. Gupta Dhanpat Rai Publications, 2006
3. Acoustics Waves and oscillations by SN Sen Wiley Eastern Limited, 1990
4. Fundamentals of digital signal processing Lonnie C Lumens, John Wiley and sons,1987

Reference Books:

1. A Text Book of Engineering Physics, Avadhanulu, M.N., Kshirsagar, P.G.,S.Chand & Co. Ltd., New Delhi, 6th edition, 2003.
2. Li Tan, Jean Jiang Fundamentals of: Analog and Digital Signal Processing Author House, 2007
3. Understanding digital signal processing, R. G. Lyones, Addison Wesley 1997

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 and The Large Hadron Collider

Unit IV

NUCLEAR REACTIONS : Conservation laws for nuclear reactions – Reaction Energetics – The Q-value equation – Threshold energy – Fission and Fusion reactions: Elementary ideas of fission reaction – Theory of fission – Elementary ideas of fusion – Controlled Thermonuclear reactions –Fusion power – The International Thermonuclear Experimental Reactor

Unit V

NUCLEAR REACTORS : Classification of nuclear reactors - First and Second generation nuclear reactors –Boiling Water Reactors – Pressurzied Water Reactors – Gas Cooled Reactors – Liquid Metal Cooled Fast Breeder Reactor – The advanced third generation nuclear reactors – Advanced Heavy Water Reactor – Light Water Reactors – Indian Three Stage Nuclear Power Programs.

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

1. Introduction to Nuclear Physics – H.A. Enge – Addision-Wesley, 1971.
2. An introduction to Nuclear Physics- M.R. Bhiday and V.A. Hoshi, Oriental Longmen, 1972.
3. The Atomic Nucleus – R.D. Evans – Tata Mcgraw-Hill, 1975.
4. Basic Nuclear Physics – D.N. Srivastava, Pragati Prakashan – Meerut – 1968.
5. Nuclear Physics – Roy and Nigam – Willey Eastern Ltd, 1967
6. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 1971.
7. Nuclear Physics – I. Kaplan – Addison Wesley, 1971.

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

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: Reduction to the equivalent one body problem – The equation of motion and first integral – Kepler Problem: Inverse square law of force – The motion in time in the Kepler problem – Scattering in a central force field.

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

1. Classical Mechanics, H. Goldstein, Narosa publishing house, Second Edition 2001
2. Classical Mechanics- S.L.Gupta, V. Kumar & H.V.Sharma-Pragati Prakashan-Meerut.,2003

Reference Books

1. Classical mechanics - T. W. B. Kibble, Frank H. Berkshire, Imperial College Press, 2004
2. Classical Mechanics - John Robert Taylor, University Science Books, 2004
3. Classical Mechanics Gupta SI, Kumar V, Sharma HV- Pragati Prakashan 2008

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

REVIEW OF THE LAWS OF THERMODYNAMICS AND THEIR CONSEQUENCES: Energy and the first law of thermodynamics – Heat content and Heat capacity – Specific heat – Entrophy and the second law of thermodynamics – Thermodynamic potentials and the reciprocity relations – Maxwell's relations – Deductions – Properties of thermodynamic relations – Gibb's – Helmholtz relation – Thermodynamic equilibrium –

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

Unit II

STATISTICAL DESCRIPTION OF SYSTEMS OF PARTICLES: Statistical formulation of the state system – phase space – Ensemble – average value – density of distribution in phase space – Liouville Theorem – Equation of motion and Liouville theorem – Equal apriori probability – Statistical equilibrium – Ensemble representations of situations of physical interest – isolated system – Systems in contact.

Unit III

SIMPLE APPLICATIONS OF STATISTICAL MECHANICS: General Method of approach – Partition functions and their properties – Ideal Monatomic Gas – Calculation of Thermodynamic quantities – Gibb's Paradox The equipartition theorem and proof – application to harmonic oscillator.

STATISTICAL THERMODYNAMIC PROPERTIES OF SOLIDS: Thermal characteristics of crystalline solids – Einstein model – Debye modification – Limitations of Debye theory – Paramagnetism – General calculation of Magnetization

Unit IV

QUANTUM STATISTICS OF IDEAL GASES: Maxwell – Boltzman statistics, Bose-Einstein statistics and Fermi Dirac statistics; Calculation of distribution functions from the partition function for M-B, B-E, and F-D statistics – Quantum statistics in the classical limit – ideal Bose Gas – Bose – Einstein condensation – Ideal Fermi Gas – Degnerate Electron Gas.

Unit V

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.

Text Book

1. Fundamentals of Statistical and Thermal Physics , Federick Reif, McGraw-Hill, 1985.

Reference Books

1. Statistical Mechanics – B. K. Agarwal and M. Einsner , John Wiley & Sons,1988
2. Statistical Thermodynamics – M.C. Gupta, Wiley Eastern Ltd, 1990
3. Thermodynamics and statistical mechanics - By John M. Seddon , Julian D. Gale Royal Society of Chemistry, 2001
4. Introduction to statistical mechanics – S.K.Sinha, Alpha Science International, 2005
5. Elements of Statistical Mechanics-Kamal Singh & S.P. Singh- S. Chand & Company, New Delhi, 1999

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 havea 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: Addition, Subtraction, multiplication of vectors –Simple Problems – Magnitude of Vectors – Linear Combination of vectors –Simple problems – Product of two vectors – Triple product of vectors - Simple applications of vectors to Mechanics - Work done by force - Torque of a force-Force on a particle in magnetic field-Force on a charged particle- Angular velocity - Differentiation of vectors – Scalar and vector fields - Gradient, Divergence and Curl operators – Integration of vectors – Line, surface and volume integrals – Gauss's Divergence theorem – Green's theorem – Stoke's theorem

Unit II

MATRICES: Equality of matrices – Matrix Addition, multiplication and their properties – Special matrices –Definitions: Square matrix, Row matrix, Null matrix, Unit matrix, Transpose of a matrix, Symmetric and skew symmetric matrices, Conjugate of matrix- Adjoint of matrix (Simple problems)- Unitary matrix, Orthogonal matrix (simple problems) – Inverse of matrix – Problems- Rank of matrix –Problems - Solutions of linear equations – Cramer's rule – Cayley-Hamilton Theorem – Eigen Values and Eigen vectors of matrices and their properties –Quadratic forms and their reduction - Diagonalisation of matrices

Unit III

TENSOR ANALYSIS: Definition of tensors – Transformation of coordinates - The summation convention and Kronecker Delta symbol –Covariant Tensors – Contravariant tensors – Mixed Tensors - Rank of a tensor – Symmetric and anti-symmetric tensors – Quotient law of tensor - Invariant Tensors - Algebraic operations of tensors - Addition, subtraction and multiplication(inner and outer product) of tensors Derivative of tensors

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

PROBABILITY AND THEORY OF ERRORS: Definition of probability – Compound Probability – Total Probability – The multinomial law – Distribution functions - Binomial, Poisson and Gaussian distribution– Mean (Arithmetic - Individual observations ,Discrete series, Continuous series) – Median (Individual observations ,Discrete series, Continuous series) – Mode (Individual observations ,Discrete series, Continuous series) -Mean Deviation and Standard Deviation(Individual observations ,Discrete series, Continuous series) – Different types of errors – Errors and residuals —The principle of Least squares fitting a straight line.

Text Books

1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – PragatiPrakashan – Meerut, 17th edition, 2004

Reference Books

1. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN-10 3-540-30273-5 (2007)
2. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence - Cambridge University Press – ISBN 0 521 81372 7 (2004)
3. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arfken – Academic Press, U.S.A. – ISBN 0-12-059877-9 (2003)
4. Mathematical Physics Including Classical Mechanics - SatyaPrakash - Sultan Chand & Sons, New Delhi - ISBN-13: 9788180544668 (2007)

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:** Relaxation Oscillator - FET Volt – Ampere Characteristics – MOSFET, N Channel – P Channel – FET as a voltage variable resistor –Common source amplifier – SCR – TRIAC – DIAC – Tunnel Diode – Characteristics –Basic applications.

Unit II

FABRICATION OF INTEGRATED CIRCUITS: Integrated circuit technology- Basic monolithic integrated circuits- epitaxial growth – masking and etching – Diffusion of impurities – Monolithic diodes, integrated resisters, 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: Op. Amp characteristics – Parameters – Basic, application – summing – integrating - Differentiating – Logarithmic – Antilogarithmic amplifier – Sinusoidal, square – Triangular and ramp wave generation – Multivibrator – Bistable – Monostable – Schmit trigger – Solution of differential equation – Analog computation

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

1. Millman's Electronics Devices & Circuits by Jacob Millman, Christos C Halkias, Satyabrata , Tata McGraw-HillPublishing Company Pvt. Ltd. 2008
2. Integrated Electronics – Millmaan. J. and Halkias C.C, McGraw Hill, 2004

Reference Books

1. Electronic Devices and Circuits – Allen Mottershead, Prentice Hall of India, 2009
2. Digital Principles and Applications – Malvino and Leach, Tata McGraw Hill,Co. 2008.
3. Principles of Electronics by V.K.Metha, Rohit Metha. 2006

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_+ and J_- - Eigen values of J^2, J_z - Matrix representation of J^2, J_z, J_+ and J_- - 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

MANY ELECTRON ATOMS: Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two electrons - The Helium Atom – Central Field Approximation - Thomas-Fermi model of the Atom - Hartree Equation- Hartree-Fock equation.

Text Books

1. Quantum Mechanics – G. Aruldhas - Prentice Hall of India, 2006
2. Quantum mechanics, Satya Prakah & Swati Saluja, kedar Nath Ram Nath & Co,Meerut, 2007

Reference Books

1. A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan – Tata McGraw Hill 2007
2. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
3. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
4. Principles of Quantum Mechanics-R.Shankar, Springer 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

GEOMETRICAL OPTICS: Lenses- Thin Lens Equations- Mirrors- Mirror Formula-Prisms-Dispersing and Reflecting- Thick Lenses and Lens Systems-Analytical Ray Tracing-Matrix Methods for Lenses and Mirrors- Optical Cavity

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

INTERFERENCE AND DIFFRACTION: Interference-General Considerations- Conditions for Interference- Temporal and Spatial Coherence- Amplitude-Splitting Interferometers-Michelson and Mach-Zehnder Interferometer- Multiple Beam Interference- Fabri-Perot Interferometer- Holography.Diffraction- Huygens- Fresnel Principle- Fraunhofer and Fresnel Diffraction- Fraunhofer Diffraction- Single, Double and Many Slits- Diffraction Grating-Fresnel Diffraction-Kirchhoff's Scalar Diffraction Theory.

Unit V

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

Text Books

1. Optics: Eugene Hecht and A. R. Ganesan, Dorling Kindersely (India) (2008)
2. Optics: A. K. Ghatak, Tata McGraw Hill, (2008)

Reference Book

1. Principles of Physical Optics, Charles A. Bennett, Wiley, (2008)

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

COMPLEX VARIABLES: Functions of a complex variable– Analytic functions – Cauchy – Riemann conditions and equation – Conjugate functions – Complex Integration – Cauchy's integral theorem, integral formula – Taylor's series and Laurent Series – Poles, Residues and contour integration - Cauchy's residue theorem – Computation of residues - Evaluation of integrals.

Unit II

FOURIER SERIES AND FOURIER TRANSFORMS:

Fourier series – Dirichilet conditions – Complex representations – Sine and Cosine series – Half range series – Properties of Fourier Series – Physics applications of Fourier series – The Fourier Transforms – Applications to boundary value problems

Unit III

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS & GREENS FUNCTION: Solutions of one dimensional wave equation- one dimensional equation of heat conduction-Two dimensional heat equations – Steady state heat flow in two dimensions – Green's Function – Symmetry properties - Solutions of Inhomogeneous differential equation - Green's functions for simple second order differential operators.

Unit IV
GROUP THEORY: Basic definition of a group – Subgroups – Classes – Isomorphism Homomorphism – Cayley's theorem – Endomorphism and automorphism – Important Theorems of Group representations – Unitary theorem – Schur's Lemma – Equivalent Theorem – Orthogonality Theorem – Some special groups – Unitary Group – Point Group – Translation Group – Homogenous and Inhomogenous Lorentz groups – Direct product group

Unit V
NUMERICAL METHODS: Finite Differences – Shifting Operator – Numerical Interpolations – Newton's forward and backward formula – Central Difference interpolation – Lagrange's Interpolation – Numerical Differentiation – Newton's and Stirling's Formula – Numerical Integration – Trapezoidal Rule – Simpson's 1/3 and 3/8 rule – Numerical Solution of ordinary differential equations – – Runge-Kutta methods – Piccard's Methods

Text Books
1. Mathematical Physics – B.D.Gupta – Vikas Publishing House, 3rd edition, 2006
2. Mathematical Physics – B.S.Rajput – Pragati Prakashan – Meerut, 17th edition, 2004

Reference Books
1. Mathematical Methods for Engineers and Scientists – K.T.Tang – Springer Berlin Heidelberg New York ISBN-10 3-540-30273-5 (2007)
2. Mathematical Methods for Physics and Engineering – K.F.Riley, M.P.Hobson and S.J.Bence - Cambridge University Press – ISBN 0 521 81372 7 (2004)
3. Essential Mathematical Methods for Physicists – Hans J.Weber and George B.Arfken – Academic Press, U.S.A. – ISBN 0-12-059877-9 (2003)
4. Mathematical Physics Including Classical Mechanics - Satya Prakash - Sultan Chand & Sons, New Delhi - ISBN-13: 9788180544668 (2007)

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

principle- LS & JJ coupling- Zeeman, Paschen Bach and Stark effect- Hyperfine structure - Photoelectron spectroscopy- Characteristic of X-ray spectra and Moseley's law.

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

INFRA-RED SPECTROSCOPY: Simple Harmonic oscillator- The Anharmonic Oscillator- Vibrating Rotator- Vibration-Rotation Spectrum of Carbon Monoxide-Breakdown of Born-Oppenheimer Approxiamation-Vibration of Polyatomic Molecules- Vibration-Rotation Spectra of Polyatomic Molecules- Techniques and Instrumentation

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

ELECTRONIC SPECTROSCOPY: Electronic Spectra of Diatomic Molecules- Born-Oppenheimer Approximation- Vibrational Coarse structure- Franck-Condon Principle- Dissociation Energy- Rotational Fine Structure- Fortrat Diagram- Predissociation- Polyatomic Molecules- Re-emission from Excited Molecules - Techniques and Instrumentation.

Text Books

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell and E.M. McCash, 4th Edn. Tata McGraw-Hill Publ. Company Ltd. (2010)
2. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)

Reference Books

1. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)
2. G. Aruldhas, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt.Ltd., New Delhi, (2008)Spectroscopy Vol I, II, III B. P Straughan and S.D Walker, Chapman and Hall, 1976
3. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 1950
4. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, (1934)

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
MAGNETO STATICS: Biot and Savart law – Differential equations of magnetostatics and Ampere's law – The magnetic vector potential – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – Macroscopic magnetization – Magnetic field.

Unit III
TIME VARYING FIELDS: Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Columb's gauge – Gauge invariance – Poynting's theorem.

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: Radiation from an oscillating dipole – Radiation from a half wave antenna – Radiation damping – Thomson cross section – Lienard – Wiechert Potentials – The field of a uniformly moving point charge.

Text Books

1. Electromagnetic Waves and Radiating Systems, E. C. Jordan, K. G Balmain, PHI Learning Pvt. Ltd., 2008
2. Engineering Electromagnetics, W. H. Hayt, J. A., Buck, Tata McGraw-Hill, 2011

Reference Books

1. Classical Electrodynamics, J. D. Jackson, John Wiley & Sons, 1998
2. Foundations of Electro Magnetic Theory – John R. Reits, Fredrick J. Milford & Robert W. Christy. Narosa Publishing House (1998)
3. Electromagnetics: B. B. Laud, New Age International 2nd Edition (2005)

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

TIME DEPENDENT PERTURBATION THEORY: Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation-Transition Probabilities-Selection Rules for Dipole Radiation-Collision-Adiabatic Approximation.

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 as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates-Density Matrix and its Applications.

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

1. A Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata Mc Graw Hill 2007
2. Quantum Mechanics – G Aruldhas - Prentice Hall of India 2006

Reference Books

1. Introduction to Quantum Mechanics – David J.Griffiths Pearson Prentice Hall 2005
3. Quantum mechanics, Satya Prakash & Swati Saluja, kedar Nath Ram Nath & Co,Meerut, 2007
3. Quantum Mechanics – L.I Schiff - McGraw Hill 1968
4. Quantum Mechanics - A.K. Ghatak and S. Loganathan-McMillan India,2004

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

NUCLEAR STRUCTURE: Basic properties – magnetic moments – Experimental determination – Quadrupole moments – Experimental techniques – Systems of stable nuclei – Semi emperical 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: 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, Swimming pool type reactor –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.

Text Books

1. Concepts of Nuclear Physics – B.L. Cohen – McGraw-Hill – 1974.
2. Nuclear Physics – I. Kaplan – Addison Wesley, 1971

Reference Books

1. Introduction to Nuclear Physics – H.A. Enge – Addision-Wesley, 1971.
2. An introduction to Nuclear Physics- M.R. Bhiday and V.A. Hoshi, Oriental Longmen, 1972.
3. The Atomic Nucleus – R.D. Evans – Tata Mcgraw-Hill, 1975.
4. Basic Nuclear Physics – D.N. Srivastava, Pragati Prakashan – Meerut – 1968.
5. Nuclear Physics – Roy and Nigam – Willey Eastern Ltd, 1967
6. Physics of Nuclei and Particles : P. Marmier and E. Sheldon Academic press (1970)
7. Introduction to Particle Physics : M. P. Khanna Prentice Hall of India (1990)
8. Nuclear and particle Physics : W. Burcham and M. Jobes, Addision-wesley (1998)

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

NUCLEAR QUADRUPLE RESONANCE SPECTROSCOPY: 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.

Unit IV

MOSSBAUER SPECTROSCOPY: Basic principles, spectral parameters and spectrum display, applications to the study of bonding and structure of Fe^{2+} compounds. Isomer shieft, quadruple spliting, 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

1. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Tata McGraw-Hill Publ. Comp. Ltd. (2010)
2. Modern Spectroscopy; J.M.Hollas, John Wiley, (2004)

Reference Books

1. High Resolution NMR- Pople, Schneidu and Berstein. McGraw-Hill, (1959)
2. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, (1963)
3. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.(1978)
4. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, (1958)
5. Understanding Mass spectra-A basic approach Smith, R.M and Busch,K.L Newyork, John Wiely& sons inc. (1999),
6. Introduction to Mass Specroscopy , Watson,J.T, New york, Raven Press.(1985)

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)

BAND THEORY OF SOLIDS: Energy bands in solids – Nearly free electron model – Bloch's theorem – Kronig and Penny model – Tight bound approximation – Brillouin zone – Fermi surface – density of states – de Hass – Van Alphen effect.

Unit II

DIELECTRIC AND FERROELECTRIC PROPERTIES: Dielectric constant and polarisability – Local field – different types of polarization – Langevin function – Classius – Mosotti relation – Dipolar dispersion – Dipolar polarization in solids – Ionic Polarisability, Electronic Polarisability – Measurement of dielectric constant. Ferroelectricity – General properties – Dipole theory.

Unit III

MAGNETIC PROPERTIES: Quantum theory of Paramagnetism – Paramaganetism of ionic crystals – Rare earth ions – Ferromagnetism – Weiss theory – Temperature dependence of magnetism – Exchange 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 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

1. Solid State Physics- S.O. Pillai New Age Publications, 2002
2. Elementary Solid State Physics- M. Ali Omar, Pearson Education, 2004

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 – Nano indentation -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 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

1. Silicon VLSI Technologies, J.D.Plummer, M.D.Deal and P.B. Griffin, Prentice Hall, 2000
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
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 Q-switching and mode locking process, devices for Q-switching and mode locking, high power Co_2 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: Overview of Optical Fibers: Structure of optical fibers. Step-index and graded index fibers; Single mode, multimode and W-profile fibers. Ray Optics representation. Meridional and skew rays. Numerical aperture and acceptance angle. Multipath dispersion materials – Material dispersion -Combined effect of material and multipath dispersion - RMS pulse widths and frequencyresponse - Model Birefringence - Attenuation in optical fibers - Absorption - Scattering losses -Radiative losses

Text Books
1. Laser Electronics: J. T. Verdeyen, Prentice-Hall Inc. (1995).
2. Laser Fundamentals: W. T. Silfvast, Cambridge University Press, (2003)

Reference Books
1. Laser Spectroscopy- Basic Concepts: W. Demtroder, Springer-Verlag, (2003)
2. The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), (1993)
3. Lasers and nonlinear Optics: B. B. Laud, New Age International (P) Ltd. (2007)

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: 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 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

THIN FILM APPLICATIONS: Material selection, Design and Fabrication of Thin film resistor – Thin film capacitor – Thin film diode – Thin film transistor – Transparent conducting oxide Thin films – Semiconducting Thin films – Thin film solar cells – CdS and Cu_2S based solar cells – CdS - Cu_2S and CdS or Cu In Se_2 solar cells – Thin film mask blanks for VLSI – Thin films sensors - for gas detectors. Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

Text Books

1. Thin Film Technology Handbook by Aicha Elshabini, Aicha Elshabini-Riad, Fred D. Barlow, McGraw-Hill Professional, 1998
2. Thin film Technology, Chopra, Tata McGraw-Hill, 1985

Reference Books

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, Method, equipment and Applications By Krishna SeshanWilliam Andrew Inc., 2002
3. Handbook of thin film technology, L.I.Maissel and R.Glang, McGraw Hill Book

Company, New York (1983).
4. Thin-film deposition: principles and practice by Donald L. Smith, McGraw-Hill Professional, 1995

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

QUANTUM STRUCTURES AND DEVICES: Mesoscopic Devices, Metal Insulator Semiconductor devices, MOSFET characteristics - Nanoscale Transistors, NanoFET - Single Electron Transistors, and, Resonant Tunneling Devices, Carbon Nanotube based logic gates, optical devices. Connection with quantum dots, quantum wires, and quantum wells.

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

1. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.2008
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
2. Nano Engineering in Science & Technology : An introduction to the world of nano Design by Michael Rieth,2003
3. Enabling Technology for MEMS and nano devices -Balles, Brand, Fedder, Hierold,John Wiley and sons, 2004
4. Optimal Synthesis Methods for MEMS- G. K. Ananthasuresh,Klower Academic publisher,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

QUANTUM THEORY: Planck's Quantum hypothesis and radiation law- Quantum theory of radiation and photons- Matter waves- De Broglie wave theory–De Broglie wavelength of electrons. Experimental verification of matter waves- Davisson and Germer experiment, G.P.Thomson's experiment.

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: Time independent perturbation theory – non degenerate – cases – first order perturbation — Removal of degeneracy in first order and second order – First order Stark effect in hydrogen atom – Zeeman effect – The variation method – Ground state of Helium –
WKB approximation.

Unit V

ANGULAR MOMENTUM AND TIME DEPENDENT PERTURBATION: Commutation rules for angular momentum operators – Eigen value spectrum – Raising and lowering operators – Matrix representation of angular momenta – Clebch – Gordon Co-efficients symmetry properties (no derivation).

Text Book

1. Quantum mechanics-Gupta Kumar Sharma- Jai Prakash Nath & Co -2007
2. Quantum mechanics –G. Aruldhas –PH Learning Pvt. Lmt. – 2008

Reference Books

1. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, Ist edition (2005)
2. Basic Quantum Mechanics K. Ghatak and Lokanathan, Mc Millan,2006
3. A test book of Quantum Mechanics – P.M. Mathews and Venkatesan. Tata McGraw-hill, I edition 2005

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

FUNDAMENTALS OF ELECTROMAGNETISM: Coulomb's law – Electric Field – Gauss's law – Differential form of Gauss's Law – Scalar Potential – Surface Distribution of charges and dipoles and discontinuities in the electric field potential – Poisson and Laplace equations – Green's theorem – Dirichlet- Neumann Boundary Conditions – Electrostatic Potential energy and energy density – Relaxation method for two dimensional electrostatic problems

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

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 X 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

1. Electromagnetic waves and radiating systems, Edward C. Jordan, K.G.Balmain, Prentice-Hall of India, **ISBN** : 8120300548
2. Classical Electrodynamics, third ed., J. D. Jackson, John Wiley & Sons, Inc., New York, NY . , 1999, ISBN 0-471-30932-X

Reference Books

1. Electromagnetic wave theory, James R.Wait, Harper and Row, ISBN 0060468777
2. Electromagnetic waves and fields, V.V.Sarwate, Wiley Eastern Ltd, or New Age International (1993, Reprint 2006)
3. Electromagnetic Fields and Interactions , R. Becker, , Dover Publications, Inc.,New York, NY, 1982, ISBN 0-486-64290-9.

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

BASIC CONCEPTS OF ENERGY SOURCES: Available Energy Sources – Classification of Energy Sources – Commercial and Noncommercial Energy Sources – Fossil Fuels and Climate Change issues – Renewable Energy Resources – Advantages and Limitations of Renewable Energy sources.

Unit II

SOLAR ENERGY: Solar radiation at the Earth's Surface – Solar Radiation Measurements – Solar Cell – Solar Energy Collectors – Flat-plate Collectors, Concentrating Collector: Focusing Type – Solar Energy Storage – Applications of Solar Energy – Solar Water Heating, Solar Pumping, Solar Furnace, Solar Cooking.

Unit III

WIND-ENERGY: Wind Energy Technology – Aerodynamics – Wind Energy Conversion – Basic Components Of a WECS (Wind Energy Conversion System) – Classification of WECS – Wind Energy Collectors – Wind Energy Storage – Applications of Wind Energy.

Unit IV

ENERGY FROM BIO-MASS: Photosynthesis Process – Bio Fuels – Bio mass Resources – Bio-mass Conversion Technologies – Wet processes and Dry Processes – Classification of Bio-gas plants – Bio-gas from plant Wastes – Materials Used For Bio-gas generation – Utilization if Bio-gas -- Methods for Obtaining energy from Bio-mass.

Unit-V

ENERGY FROM OTHER SOURCES: Energy From The Oceans – Energy And Power from the Waves – Tide and Wave Energy conversion – Advantages and Disadvantages Of Wave Energy – Ocean Thermal Energy Conversion - Geothermal Energy - Chemical Energy Sources – Fuel Cells and Batteries – Hydrogen Energy – Thermionic and Thermoelectric Generators – Micro Hydel Powers

Text Books

1. Non-Conventional Energy Sources, G.D. Rai, Standard Publishers Distributors, ISBN 9788186308295 (2004)
2. Non-Conventional Energy Sources, B.H.Khan, Tata McGraw Hill (2006) ISBN 0- 07- 060654-4
3. Renewable Energy, Godfrey Boyle, Oxford University Press in association with the Open University, (2004), ISBN 9780199261789

Reference Books

1. Renewable energy: sources for fuels and electricity, Thomas B. Johansson, Laurie Burnham, Island Press, (1993), ISBN 9781559631389
2. Renewable energy: sustainable energy concepts for the future, Roland Wengenmayr, Thomas Bührke, Wiley-VCH, (2008), ISBN 9783527408047
3. Renewable Energy: Sources and Methods, Anne Maczulak, Infobase Publishing, (2009), ISBN 9780816072033

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

ATOMIC AND MOLECULAR STRUCTURE: Hydrogen spectrum- Angular Momentum – Larmor Precession – Vector atom model - Spin-orbit interaction – spectra of Alkali atoms – angular momentum of many electron atoms –L-S Coupling – j-j coupling– Energy levels and spectral transitions of Helium – Normal and anamolous Zeeman effect – Paschen back effect – MO treatment of Hydrogen molecule ion –MO treatment of Hydrogen molecule – Heitler – London theory – Diatomic molecular orbitals.

Unit II
INFRARED AND MICROWAVE SPECTROSCOPY: Vibrational energy of diatomic molecule – Morse curve – Diatomic vibrating rotator – Vibrations of ployatomic molecules – IR spectrophotometer – sample handling techniques – Fourier transform spectrometer – Identification of molecular constituents – Classification of molecules - Rotational spectra of rigid diatomic molecules – Microwave spectrometer.

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: NMR – Magnetic properties of nuclei – Resonance condition - Bloch equation –Relaxation Processes: Spin – Spin and spin lattice relaxation process –NMR spectrometer - Fourier. Transform NMR– ESR: Principle – Basic requirements of X-Band ESR - Balanced bridge ESR Spectrometer

Unit V
RESONANCE SPECTROSCOPY – II: N Q R – Basic Principle – Transitions for axially symmetric systems nonaxially symmetric systems– N Q R instrumentation- NQRgroup frequencies – Hydrogen bonding - **Mossbauer spectroscopy**: Recoilless emission and absorption – Massbauer spectrometer – Chemical shift – Applications: Molecular structure – problems

Text Book

1. Molecular structure and Spectroscopy, G.Aruldhas Prentice-hall of India Pvt. Ltd.New Delhi, 2004

Reference Books

1. Spectroscopy – Straughan Walker , McGraw-Hill, New york
2. Introduction to Atomic Spectra, Harvey Elliot White. McGraw-Hill, 1934
3. Atomic Spectra and Chemical Bond - Manas Chandra, TMH
4. Quantum Mechanics - Pawling and Wilson
5. Molecular Spectroscopy- Banwell, , McGraw-Hill, New york 1994
6. Molecular Spectra and Molecular Structure: G. Herzberg Van Nostrand, 2007
7. High Resolution NMR- Pople, Schneidu and Berstein. McGraw-Hill, 1959
8. Principles of Magnetic Resonance - C.P. Slitcher, Harper and Row, 1963
9. Basic Principles of Spectroscopy R. Chang, R.E. Krieger Pub. Co.1978
10. Nuclear Quadrupole Resonance Spectroscopy - T.P. Das and Hahn , Supplement, 1958

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

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, Paramaganetism 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
2. Solid State Physics - S.O.Pillai – New Age International publishers.
3. Physics of semiconductor devices – S.M.Sze 2007

Reference Books

1. Basic Semiconductor Physics – Chihiro Hamaguchi 2nd Edition 2001

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

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

CLINICAL TREATMENT PLANNING IN PHOTON BEAMS AND RECENT ADVANCES: Treatment planning - Volume definition - ICRU 50, ICRU 62 concepts - GTV – CTV – ITV – PTV – OAR - Dose specification - Patient data acquisition – Simulation – Conventional simulation - Isodose curves - Wedge filters – Bolus - Compensating filters - Field separation

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

1. Review of Radiation Oncology Physics - A Hand book for Teachers and Students, EB. Podgorsak, International Atomic Energy Agency, 2005
2. The Physics of Radiation Therapy, FM. Khan, Wolters Kluwer, 2003

Reference Books

1. Treatment Planning in Radiation Oncology, FM. Khan and RA. Potish, Williams & Wilkins, 1998
2. Introduction to Radiological Physics and Radiation Dosimetry, FH. Attix, Wiley, 1986
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

BASIC RADIATION PHYSICS: Atoms and nuclei – Fundamental particles - Atomic and nuclear structure - Mass defect and binding energy – Radiation - Classification of radiation - Electromagnetic spectrum – Radioactivity - Alpha, beta and gamma rays - Methods of decay – Isotopes - Radiation sources.

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 – Thermoluminiscent dosimetry - Calorimetry - Chemicaldosimetry

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

1. Review of Radiation Oncology - A Hand book for Teachers and Students by EB. Podgorsak, International Atomic Energy Agency, 2005
2. The Physics of Radiation Therapy by FM. Khan, Wolters Kluwer , 2003

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
3. Introduction to Radiological Physics and Radiation Dosimetry by FH. Attix , Wiley, 1986
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 tpply 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: Ultraviolet and visible Spectroscopy:UV visible Spectrophotometers - Measurement of Absorption - Infrared Spectroscopy - Fluorescence and Phosphorescence : Measurement of Fluorescence - Spectrofluorometers – Photoluminiscence: light-matter interaction, instrumentation- Electroluminescence: instrumentation, Applications

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 curvemethod of moments

Unit IV

NUMERICAL METHODS: Solution of differential equations – simple iterative method- Newton Raphson method – Numerical by integration – Simpson rule – Gausian quadrature- solution of simultaneous equation – Gauss Jordon elimination method- Eigenvalue and eigenvectors by matrix diagnolization (Jacobian method)

Unit V

APPLICATION OF NUMERICAL AND STATISTICAL METHODS USING C++ 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

Text Books

1. Computer applications in Physics- Suresh Chandra, Narosa publishing hours (2003)
2. Numerical methods for Mathematics, Science and Engineering – John H. Mathews, Prentice Hall, India (2000)

Reference Books

1. B.K.Sharma,Spectroscopy Goel publishing house,2007
2. Elements of X-ray Diffraction by B.D. Cullity (II edition), Addison-Wesley Publishing Co. Inc., Reading, USA, 1978.
3. Electron Microscopy and Analysis by P.J. Goodhew and F.J. Humphreys, Taylor and Francis, London, 1988
4. Electron Microscopy: Principles And Fundamentals, S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), VCH, Weinheim, 1997.
5. Atomic Force Microscopy / Scanning Tunneling Microscopy, S.H. Cohen and Marcia L. Lightbody (Editors), Plenum Press, New York, 1994.

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

MICROSCOPIC METHODS: Optical Microscopy: Optical Microscopy Techniques – Bright & dark field optical microscopy- phase contrast microscopy- Differential interference contrast microscopy – Fluorescence Microscopy- Scanning probe microscopy (STM, AFM) – Scanning new field optical microscopy – X-Ray Diffraction methods - Rotating crystal- Powder method – Debye- Scherrer camera- Structure factor calculations- EBSD & ED.

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
THERMAL ANALYSIS: Introduction- Thermogravimetric analysis (TDA)-instrumentation- determination of weight loss and decomposition products- differential thermal analysis (DTA) – cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters- Chromatography- Liquid & Gas Chromatography.

Unit V
ELECTRICAL, MECHANICAL & MAGNETIC ANALYSIS: Two probe and four probe methods- van der Pauw method- Hall probe and measurementscattering mechanism- C-V characteristics- Schottky barrier capacitance- impurity concentration- Mechanical and Magnetic Analysis: Vickers Hardness test - Vibrating Sample Magnetometer- Working principle of VSM- Instrumentation.

Text books

1. B.D.Cullity, "Elements of X-Ray diffraction" (II Edition) Addision Wesley publishing Co., 1978.
2. Lawrence E.Murr, Electron and Ion Microscopy and Microanalysis principles and Applications, Mariel Dekker Inc., Newyork, 1991.

Reference Books

1. Atomic Force Microscopy/ Scanning Tunneling Microscopy, S.H.Cohen & Marcia L.Lightbody (Editors), plenum press, Newyork, 1994.
2. Principles of Thermal analysis and calorimetry by P.J.Haines (Editor), Royal Society of chemistry (RSC), Cambridge, 2002.

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
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 andHeterogeneous 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 (CZ) – 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 (PVD) – Evaporation and Sublimation processes – sputtering – chemical vapour Deposition (CVD) – Advantages and disadvantages –chemical vapour transport – Fundamentals – Growth by chemical vapour transport (CVT) Reaction .

Text Books

1. Brice, J. C. Crystal Growth processes – Halstesd press, John Wiley & sons, (1986)
2. Elwell. D and Scheel. H. J, crystal growth from High Temperature solutions, Academic press, London (1975)

Reference books

1. Ichiro Sunagawa, Crystal Growth, Morphology and performance, Cambridge University press, (2005).
2. Mullin, J. N, 'Crystallization', Butternmths, London (2004)
3. Hand book of crystal growth, Volume 1, 2 & 3. Edited by D. T. J. Hurle North Holland – London (1993)

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

REVIEW OF PHYSICAL PRINCIPLES : Mechanics – Units and dimensions – Work and energy – Relativity effects – Electricity – Electrical charge: the statcoulomb – Electric Potential: the statvolt – Electric Field – Energy Transfer – Elastic and inelastic collision – Electromagnetic waves – Excitation and ionization – Periodic table of the elements – The wave mechanics atomic model – The nucleus – The neutron and the nuclear force – Isotopes – The atomic mass unit – Binding energy – Nuclear models - Nuclear stability

Unit II

RADIOACTIVITY AND INTERACTION OF RADIATION WITH MATTER: Radioactivity and decay mechanism – Kinetics of decay – The units of radioactivity – Series decay – Alpha rays – Range-energy relationship – Energy transfer – Beta rays – Range energy relationship – Mechanism of energy loss – ionization and excitation – Gamma rays – Exponential absorption – Absorption mechanisms – Pair production – Compton scattering – Photoelectric effects – Neutrons – Production – Classification – Interaction

Unit III

METHODS OF MEASURING RADIATION: Gas filled detectors – Ionization chamber – Proportional counters – Geiger Muller Counter – Scintillation detection systems – Photomultipliers – Scintillators – Semiconductor detectors – Principles of operation – Charged particle detectors – Thermoluminescent detectors – High purity Germanium Detectors – Track devices – Photographic emulsion – Track etch dosimeters – Spark counters and spark chambers – Miscellaneous detectors

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

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

1. Nichola Tsoulfanidis, Measurement and detection of radiation, Taylor & Francis; 2 edition (1995), ISBN-10: 1560323175
2. Environmental Radioactivity From Natural, Industrial & Military Sources, Merril Eisenbud, Academic Press, (1997, Fourth Edition), ISBN: 0122351541

Reference Books

1. Radiation Detection and Measurement, Glenn F. Knoll, John Wiley & Sons, 2010, ISBN0470131489, 9780470131480
2. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed, Academic Press, Elsevier (2007)
3. Radiation Physics for Medical Physicists, Ervin B. Podgorsak, Springer, New York (2010)
4. G.G.Eicholz and J.W.Poston, Principles of nuclear radiation detection, ANN Arbor Science, 1985

12PH329 NANOFLUIDS

Credit: 4:0:0

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

INTRODUCTION TO NANOFLUIDS: Fundamentals of Cooling - Fundamentals of Nanofluids – Making Nanofluids – Materials for Nanoparticles and Nanofluids – Methods of Nanoparticle Manufacture – Dispersion – Milestones in Thermal conductivity measurements – Milestones in Convection Heat Transfer – Mechanism and Models for enhanced thermal support: Structure based Mechanism and Models – Dynamics based Mechanism and Models

Unit II

SYNTHESIS OF NANOFLUIDS: Single step method – Two step method – Synthesis of colloidal Gold nanoparticles : Turkevich method – Brust method – Microwave Assisted Synthesis – Sonolysis – Electrochemical Reduction – Thermal Decomposition – Chalcogenides – Solvothermal Synthesis – Magnetic Nanofluids – Inert Gas Condensation

Unit III

CONDUCTION HEAT TRANSFER IN NANOFLUIDS: Conduction Heat Transfer-Steady Conduction: Conduction in slab – Hollow cylinder – composite cylinder- Transient conduction: Lumped-parameter method – One Dimension Transient Conduction - Measurement of Thermal Conductivity of Liquids : Guarded Hot Plate method – Transient Hot wire – Temperature oscillation method (No derivation) – Thermal conductivity of Oxide nanofluids – Hamilton Crosser Theory (Al_2O_3 – Water and Al_2O_3 – Ethylene Glycol)

Unit IV

CONVECTION IN NANO FLUIDS: Fundamentals of Convective Heat Transfer – Newton's law of cooling – equations of fluid flow and heat transfer: Navier-Stokes equations, Reynolds number - Prandtl number - Nusselt number - Natural convection : Grashof number, Rayleigh number – Experimental study of natural convection - Convection in Suspensions and Slurries: Eulerian-Eulerian approach – Eulerian-Lagrangian approach

Unit V

POOL BOILING AND APPLICATION OF NANOFLUIDS: Fundamentals of Boiling : Nukiyama curve - Nucleate boiling –Experimental study of Pool Boiling of Water-Al_2O_3 Nanofluids – Applications of nanofluids: Vechile cooling , Transformer cooling, Biomedical applications

Text Book

1. Nanofluids: Science and Technology, Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, John wiley sons, 2007

Reference Books

1. Holman J.P., 'Heat Transfer', SI Metric Ed., Mc Graw Hill, ISE, 1972.
2. Heat and Mass Transfer, R.K. Rajput, S. Chand, 2008
3. Heat transfer Principles and applications, Binay K. Dutta, Prentice – Hall of India

Pvt. Ltd, New Delhi, 2001

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.

5. Construction of an Astable multivibrator circuit using op-amp and transistors.

6. Construction of a bitable multivibrator circuit using op-amp and study its performance.

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.

9. Construction of a circuit using logic gates.

10. Construction of a Wein's bridge oscillator circuit using op-amp and study its performance.

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 short 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
9. Viscosity of a liquid - Oscillating disc method.
10. Stefan's constant - To determine Stefan's constant
11. Dielectric constant by Lecher Wire .
12. Frauhnhofer lines-identification of elements
13. Anderson bridge(AC)-determination of inductance.
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

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

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 andvariance

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 rain water, 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

Code	Subject Name	Credits
13PH201	Applied Physics	3:0:0
13PH202	Applied Physics Lab	0:0:2

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

QUANTUM PHYSICS: Wave nature of matter- De Broglie wave - Wave packets-De Broglie wavelength of Electrons - properties of matter waves - Experimental verification of matter waves: Davisson and Germer experiment - Heisenberg's uncertainty principle - Schrodinger's time dependent and independent wave equations - particle in a box - Application : Principle and working of Scanning Electron Microscope (SEM).

Unit II

LASERS: Principle of laser - Properties of laser beam- Einstein's quantum theory of radiation- Population inversion - Optical Resonator - Types of lasers: Nd :YAG, He:Ne, CO_2 and Semiconductor lasers - Application: Holography: Principle, recording and reconstruction.

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

ACOUSTICS AND ULTRASONICS: Classification of sound, Characteristic of musical sounds - Absorption coefficient- Reverberation time- Sabine's formula-derivation, Factors affecting acoustics of buildings and their remedies - Production of Ultrasonic waves: Magnetostriction and Piezoelectric methods- Applications: Acoustic grating - Pulse Echo Testing (NDT).

Unit V

MAGNETIC AND SUPERCONDUCTING MATERIALS: Dia, Para, Ferro magnetic materials- properties, Hysteresis curve, Hard and soft magnetic materials - Application: Magnetic recording and reading. Superconductors: Properties of superconducting materials - Type I and Type II superconductors- Application: Maglev.

Text Book

1. V. Rajendran – Engineering Physics, McGraw –Hill Publishing company Ltd, Publication, 2011.

Reference Books

1. John W.Jewett, Jr., Raymond A.Serway - Physics for Scientists and Engineers with Modern Physics, Cenage Learning India Private Ltd, 2008
2. M.N. Avadhanulu, P.G. Kshirshagar – A Text Book of Engineering Physics- S.Chand & Co. Ltd, 2008
3. Hitendra K Malik, A K Singh – Engineering Physics, McGraw –Hill Publishing company Ltd,2008
4. G.Aruldhas - Engineering Physics, PH1 Learning Pvt. Ltd , 2010

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.