DEPARTMENT OF PHYSICS AND MATERIAL SCIENCE

BPM-01 ENGINEERING PHYSICS-I

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this Course

1. Basics of relativity and its application in Engineering.
2. Quantum Mechanics and its applications to understand material properties.
3. Use of the principle of optics in the engineering and instrumentation.
4. Applications of Laser and holography in Engineering.
5. Basic Principles of optical Fibre and its application in Engineering.

Topics Covered

UNIT-I 9

Relativistic Mechanics: Inertial and Non-inertial Frames of reference, Galilean transformation, Michelson-Morley Experiment, Postulates of special theory of relativity, Lorentz Transformation, Length contraction, Evidences of length contraction, Time dilation, Evidences for time dilation, Relativistic velocity transformation, Relativistic variation of mass with velocity, Evidence of mass variation with velocity, Relativistic kinetic energy, Mass energy equivalence, Examples from nuclear physics, Relativistic energy-momentum relation.

UNIT-II 9

Quantum Mechanics: De Broglie waves and Group velocity concept, Uncertainty principle and its application, Davisson-Germer experiment, Derivation of Schrodinger equation for time independent and time dependent cases. Postulates of quantum mechanics, Significance of wave function, Application of Schrodinger wave equation for a free particle (one dimensional and three dimensional case), Particle in a box (one dimensional), Simple harmonic oscillator (one dimensional).

UNIT-III 9

Physical Optics:

Interference: Interference of light, Interference in thin films (parallel and wedge-shaped film), Newton's rings, refractive index and wavelength determination

Diffraction: Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power, Rayleigh's criterion and resolving power of grating.

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter

UNIT-IV

Modern Optics 9

Laser: Spontaneous and stimulated emission of radiation, population inversion, concept of 3 and 4 level Laser, construction and working of Ruby, He-Ne lasers and laser applications.

Fiber Optics: Fundamental ideas about optical fiber, Propagation mechanism, Acceptance angle and cone, Numerical aperture, Propagation Mechanism and communication in fiber Single and Multi Mode Fibers, step index and graded index fiber.

Holography: Basic Principle of Holography, Construction and reconstruction of Image on hologram and applications of holography.

EXPERIMENTS

1. To determine the wavelength of monochromatic light by Newton's Ring
2. To determine the specific rotation of cane sugar solution using polarimeter
3. To determine the wavelength of spectral lines using plane transmission grating.
4. To verify Brewster's law using rotating Nicol prism
5. To verify Stefan's law by electrical method
6. To Study resonance in LCR circuit with a c source.
7. To determine the height of a tower with a Sextant.
8. To determine the refractive index of a liquid by Newton's ring.

Textooks

1. Introduction to Special theory Relativity-Robert Resnick, Wiley Eastern Ltd.
2. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, Tata McGraw-Hill
3. Optics- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
4. Fiber optics and laser Principles and Applications-Anuradha De, New Age International
5. Engineering Physics : B.K. Pandey and S. Chaturvedi, Cengage Learning

References

1. Optics- Ajoy Ghatak, Tata McGraw-Hill
2. Concepts of Modern Physics-Arthur Beiser, Tata McGraw-Hill

BPM-02 ENGINEERING PHYSICS-II

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this Course

1. Basics of crystallography and its application in Engineering
2. Use of the principles of sound wave and acoustics in civil engineering
3. Basic principles of electricity and magnetism applied in Engineering.
4. Maxwell's equation of electromagnetic theory and its application in engineering.

5. Basic principles of semiconducting and advanced materials and its applications in engineering.

Topics Covered

UNIT-I 9

Crystal Structures and X-ray Diffraction: Space lattice, basis, Unit cell, Lattice parameter, Seven crystal systems and Fourteen Bravais lattices, Crystal-System Structure, Packing factor (cubic, body and face), Crystal structure of NaCl, Lattice planes and Miller Indices, Diffraction of X-rays by crystal, Laue's experiment, Bragg's Law, Bragg's spectrometer.

UNIT-II 9

Sound Waves and Acoustics: Sound waves, intensity, loudness, reflection of sound, echo; Reverberation, reverberation time, Sabine's formula, remedies over reverberation; Absorption of sound, absorbent materials; Conditions for good acoustics of a building; Noise, its effects and remedies; Ultrasonics –Production of ultrasonics by Piezo-electric and magnetostriction; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing).

UNIT-III 9

Electrodynamics –I: Basic concepts of Gauss's law, Ampere's law and faradays law of electromagnetic induction. Correction of Ampere's law by Maxwell (concept of displacement current), Maxwell's equation, transformation from integral form to differential form, physical significance of each equation

Electrodynamics –II: Maxwell's equation in free space, velocity of electromagnetic wave, transverse character of the wave and orthogonality of E, H and k vectors, Maxwell's equations in dielectric medium and velocity of e. m. wave, comparison with free space, Maxwell's equations in conducting media, solution of differential equation in this case and derivation of penetration depth

UNIT-IV 9

Physics of Advanced Materials

Semiconducting Materials: Concept of energy bands in solids, Carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence, carrier concentration and conductivity in extrinsic semiconductors and their temperature dependence. Hall effect in semiconductors, Compound semiconductors, Optoelectronic Materials.

Superconducting Materials: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Temperature dependence of critical field, Type I and Type II superconductors, Electrodynamics of superconductors, BCS theory (Qualitative), High temperature superconductors and Applications of Superconductors.

Nano-Materials: Basic principle of nanoscience and technology, structure, properties and uses of Fullerene and Carbon nanotubes, Applications of nanotechnology.

EXPERIMENTS

1. To determine the specific resistance of a given wire using Carrey Foster's Bridge.
2. To study the variation of magnetic field along the axis of current carrying circular coil.
3. To study the Hall's effect and to determine Hall coefficient in n type Germanium.
4. To study the energy band gap of n- type Germanium using four probe method
5. To determine e/m of electron using Magnetron valve
6. To draw hysteresis curve of a given sample of ferromagnetic material
7. To determine the velocity of Ultrasonic waves
8. To determine the Elastic constants (Y, η, σ) by Searl's method

Text books

1. Solid State Physics - S. O. Pillai, 5th edition, New Age International.
2. Semiconductor Devices and Application - S.M. Sze, Wiley
3. Introduction to Nano Technology - Poole Owens, Wiley India
4. Master Hand book of Acoustics - F. Alton Everest and Ken Pohlmann, 5th edition, McGraw Hill
5. Engineering Physics : B.K. Pandey and S. Chaturvedi, Cengage Learning

References

1. Introduction to Solid State Physics- Kittel , 7th edition, Wiley Eastern Ltd.
2. Introduction to Electrodynamics- David J. Griffiths Pearson, New International Edition

BPM-03 SPACE SCIENCE

Course category	: Basic Sciences & Maths (BSM)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	: 3
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this Course

1. Breadth and depth of knowledge in Space Science subject.
2. Students will find a useful place for applying their engineering knowledge and skills in the domain of Space Science and broadly saying astrophysics.
3. Group learning and problem solving.
4. The tools and techniques which can help them to peep into the Universe and fiddle the riddles there in.

Topics Covered

UNIT-I 6

Observational Astronomy: Introduction ancient age astronomy and the scientific revolution of Copernicus and Galileo, Astronomical techniques: Telescope, its construction, functioning, resolving and its light gathering power, Use of balloon for observations on earth, Requirement of rocket and satellite technology, Charge Couple Device (CCD) as an optical detection system, An overview of Radio, infrared, microwave, ultra-violet, X-rays & γ –rays telescope with specific examples and their pioneering breakthroughs, An overview of near earth and space explorations using satellite, robotic and manned missions, Gravitational redshift by sun, clock rates in satellites, Gravitational lensing, Perihelion motion of mercury, Importance of observational astronomy and telecommunication.

UNIT-II 6

Our Solar System: Origin of our solar system, Sun and its theoretical model, Energy production inside stars: proton-proton chain & CNO cycle, Sun's chromosphere, Solar storm and the solar wind, Neutrinos from Sun, The description of eight planets and their moons with their atmospheric and geographical conditions & vital statistics, Removal of Pluto from the list of nine planets, Classification of planets, The green house effect, Existence in favor water in remote past of mars,

Other planetary bodies: Asteroids, comets and meteorites, The cosmic dust, Oort cloud and the Kuiper's belt, The great comet crash: Shoemaker-Levy, Types of asteroids and their properties, The direct and indirect spectroscopy.

Titus-Bode law, Keplar's laws of planetary motion, Newton's law of gravitation from Keplar's law of planetary motion

UNIT-III 6

(a) **Stars and their classification:** Harvard classification of stars, Morgan-Keenan system, spectral classification of stars, The Hertzsprung-Russel diagram: main sequence stars, red and super-red giants, dwarf stars and black holes, Sun's evolution in H-R diagram, The Schwarzchild solution: massive stars, singularity and the black holes, Loss of information from a black hole, Accretion of mass and emission of jets in a binary star system: neutron star, black hole, Theory of compact stars: White dwarf stars and neutron stars; their evolution and equilibrium.

(b) **Large celestial bodies:** Our galaxy, Types of galaxies: Elliptical, Spiral and SO type of galaxies, Irregular galaxies, their morphology, evolution and contents, Hubble's tuning fork diagram, Cluster of galaxies and their evolution, Collision and merger of galaxies, Active galaxies: Exploding galaxies, Seyfert galaxies, Quasars and pulsars etc.

(c)

UNIT-IV 6

The Big-Bang Theory: The expanding universe: Hubble's law and constant, The flaw in Hubble's measurement, The hot big-bang model: arguments in its favor and against, The evolution of the universe after big-bang: description of different phases, matter, energy and forces, Models of the Universe: the closed, open and flat models and their relevance with observations, Origin of various bands of electromagnetic bands of spectrum in Universe, COBE: black body spectrum of the Universe, The existence of dark matter and dark energy: composition, Role of dark matter and dark energy in evolution of Universe, Cosmic rays, Creation of mass and the God particle.

Books & References

1. Introduction to Cosmology- J. V. Narlikar, Cambridge University Press
2. Introduction to Special Relativity and Space Science - Satya Pal Singh, Wiley India Pvt. Ltd., New Delhi
3. Observational Astronomy - D. Scott Birney, Guillermo Gonzalez and David Oesper, Cambridge University Press.
4. Observational Astronomy: Technique and Instrumentation - Edmund C Sutton, Cambridge University Press
5. 100 Billion Suns: The Birth, Life and Death of Stars - Kippenhahn R, Weidenfeld and Nicolson

BPM-04 NANOTECHNOLOGY

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits : 3
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor test and One Major Theory Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Will be able to demonstrate breadth and depth of knowledge in nanoscience and nanotechnology.
2. The effect of dimensionality and size on material properties.
3. The tools and techniques which can help them to experimentally observe nanomaterials.

4. They can explore the material world with their advance possible applications in making devices and sophisticated instruments.
5. They can find the vital role of this emerging area across various engineering disciplines

Topics Covered

UNIT-I

Introduction **6**

Definition of Nanoscience and Nanotechnology, Applications of Nanotechnology

Introduction to Physics of Solid State

Structure: Size dependence of properties; crystal structures, Face Centered Cubic FCC) and Hexagonal Closed Packing (HCP) nanoparticles; Tetrahedrally bounded semiconductor structures lattice vibrations.

Energy Bands: Insulators, semiconductor and conductors; Reciprocal space; Energy bands and gaps of semiconductors.

UNIT-II **6**

Quantum Theory For Nanoscience: Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step, Overview of Reflection and tunneling, Penetration of Barrier, Electron trapped in 2D plane sheet, Quantum confinement effect in nanomaterials.

Quantum Wells, Wires and Dots: Preparation of Quantum Nanostructure; Size and Dimensionality effect.

UNIT-III **6**

Growth Techniques of Nanomaterials: Lithographic and Non-lithographic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique. Thermal evaporation technique, E-beam evaporation, Chemical Vapour Deposition (CVD), Pulsed Laser Deposition, Molecular beam Epitaxy, Sol-Gel Technique (No chemistry required), Electro-deposition, Chemical bath deposition, Ion beam deposition system.

Some Important Nanostructures: Bucky Ball, Carbon nanotubes, synthesis, properties and their applications

UNIT-IV **6**

Tools for Characterization of Nanomaterials Structure: Crystallography, particle size determination, surface structure.

Microscopy: Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Field Ion Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy (TEM).

Books & References

1. Introduction to Nanotechnology - C.P. Poole Jr and F.J. Owens, Wiley India, New Delhi
2. Nano Materials - A.K. Bandyopadhyay, New Age International
3. Microcluster Physics - S. Sugano & H. Koizuoni, Springor 1998
4. Handbook of Nanostructured Materials & Nanotechnology‖ vol.-5, Academic Press, 2000

BPM-05 SOLID STATE PHYSICS

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical

Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this Course

1. The fundamental concepts of crystal structure and various kinds of bonds in solid.
2. The knowledge of crystal imperfections and different theories related to molar heat capacity.
3. The knowledge of energy bands in insulators and semiconductors. Concept of Fermi level.
4. The knowledge of electrical and optical properties of semiconductors and brief knowledge of superconductivity.

Topics Covered

UNIT-I 9

Crystal Structure and Binding

Classification of Solids, Space lattice and Bravias lattice, Primitive and unit cell, Co-ordination number , Atomic packing factor, Atomic radii, Miller indices, Inter planner spacing, Important crystal structures (NaCl, CsCl, ZnS, graphite and diamonds), Primary and Secondary bonds, Ionic, covalent, metallic and hydrogen bonds, Vander wall bonds, Forces between bonds, Dislocation energy, Cohesive energy.

Determination of Crystal Structure

Bragg's law, Laue pattern, X-ray diffractometer, Determination of lattice parameters using XRD, Absorption of X-rays, Absorption edge.

UNIT-II 9

Defects in Solids

Various kinds of crystal imperfections, Point defect, Schottky and Frenkel defect, Dislocations, Edge and screw dislocation, Grain boundary, Effect of defects on electrical properties of materials.

Lattice Dynamics and Thermal Properties

Concept of lattice vibrations and thermal heat capacity, classical, Einstein and Debye theories of molar heat capacity and their limitations, concept of phonons.

UNIT-III **9**

Band Theory of Solids

Allowed and forbidden energy bands, Classification of materials on the basis of energy bands, Energy bands in insulators and semiconductors Fermi energy, effect of impurity addition on the position of Fermi level

UNIT-IV 9

Semiconducting Properties of Solids

Semiconductors, Carrier generation and recombination, Carrier drift and carrier diffusion, effect of temperature and impurity addition on the conductivity of semiconductors, Mobility of charge carriers, effect of temperature on mobility, Hall effect in semiconductors, Junction properties.

Superconductivity

Basic properties and types of superconductors; Thermodynamics of superconducting transition, London equation, Coherence length, Basic idea of BCS Theory, Elementary discussion of high T_c superconductors.

Optical Properties of Solids

Optical reflectance, Kramers-Kronig relations; Conductivity and dielectric function of collision electron gas; Basic Theories and models of luminescence, phosphorescence, thermoluminescence, electroluminescence and photo-conductivity; colour centres.

EXPERIMENTS

Minimum Six experiments are to be conducted from the following:

1. Measurement of dielectric constant at high temperature.
2. Determination of reverse saturation current of p-n junction.
3. Study of Energy Band Gap of p-n Junction.
4. Study of Junction Capacitance of p-n junction.
5. To study the current vs voltage characteristics of CdS photo-resistor at constant irradiance.
6. To measure the photo-current as a function of the irradiance at constant voltage.
7. Measurement of resistivity of semiconductor by four probe method.
8. Determination of Energy Band Gap of semiconductor.

Books & References

1. J.P. Srivastava: Elements of Solid State Physics, (PHI New Delhi)
2. Solid State Physics by S.O. Pillai (New Age Science Ltd., New Delhi)
3. Solid state Physics by A-J. Dekkar (McMillan and Co., London)
4. Introduction to Solid State Physics by C. Kittel (Wiley Eastern, New Delhi)