Course Structure and Scheme of the Programme
B.Tech. (Department of Physics)

SEMESTER I & II

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PHX-101	Physics	3	1	-	3	4
2.	PHX-102	Physics Lab.	-	-	2	2	1

SEMESTER III

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PHX-201	Material Science & Technology	3	1	-	3	4

SEMESTER IV

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PHX-208	Electromagnetic Field Theory	3	1	-	3	4
2.	PHX-204	Material Science & Engineering	3	1	-	3	4
3.	PHX-224	Material Science & Engineering Lab.	-	-	2	2	1

SEMESTER V

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PHX-301	Material Science (Nano Science)	3	0	0	3	3

Open Elective

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PHX-301	Material Science (Nano Science)	3	0	0	3	3

PHX-101 Physics [3 1 0 4]

Theory of Relativity: Invariance of an equation and concept of ether; Michelson-Morley experiment; Einstein's postulates and Lorentz transformation equations, length, time and simultaneity in relativity; addition of velocity, variation of mass with velocity, mass-energy relation, energy-momentum relation.

(08 Lectures)

Quantum Theory: Need of Quantum theory, Photoelectric effect, The Compton effect; matter waves, group and phase velocities; Uncertainty principle and its application; time independent and time dependent Schrödinger wave equation; Eigen values and Eigen functions, Born's interpretation and normalization of wave function, orthogonal wave functions; applications of Schrödinger wave equation for particle in one dimensional infinite potential well

(08 Lectures)

Electrostatics: Gradient of a scalar, divergence and curl of a vector, Gauss's law and its applications; electric potential and electric field (in vector form); potential due to a monopole, dipole and multipoles (multipole expansion); work and energy in electrostatics; dielectrics; polarization, electric displacement, susceptibility & permittivity, Clausius Mossotti equation.

(08 Lectures)

Magnetostatics and Electrodynamics: Lorentz Force Law; magnetic field of a steady current (Biot –Savart law); ampere's law and its applications; magnetization, ampere's law in magnetized materials; electromotive force; Faraday's law; Maxwell's Equations, Wave Equation.

(06 Lectures)

Lasers: Spontaneous and stimulated emission; Einstein's coefficients, population inversion and optical pumping; three and four-level lasers; Ruby, He-Ne, Nd: Yag, CO_2, semiconductor lasers. Industrial and medical applications of lasers.

(08 Lectures)

Optics: Interference: Conditions for Interference of light, Fresnel biprism experiment; displacement of fringes, Interference in thin films-wedge shaped film; Newton's rings; Diffraction: Single Slit diffraction pattern; Diffraction grating, Grating spectra; Rayleigh's criterion and resolving power of grating, Polarization: Malus Law, Phenomena of double refraction, Nicol prism.

(08 Lectures)

Text Books:

1. D. J. Griffiths, “Introduction to Electrodynamics”, Prentice Hall of India, New Delhi, 2nd Ed. (1998).
2. Ajoy Ghatak, “Optics” , McGraw Hill Companies, 3rd Ed.
3. K. Thyagarajan and A. K. Ghatak, “Lasers, - Theory and Applications”, Macmilan India Ltd., New Delhi, (2000).
4. A. Beiser, “Concepts of Modem Physics”, McGraw Hill, New Delhi, 6th Ed. (2002).

Reference Books:

1. Eugene Hecht, “Optics” , Addison Wesley (2002).
2. A. P. Arya, “Elementary Modern Physics” Addison –Wesley, Singapore, (1974).
3. H. S. Mani and G. K. Mehta, “Introduction to Modem Physics”, Affiliated East West Press, New Delhi, (1991).
4. P. W. Milonni and J. H. Joseph Eberly, “Lasers” John Wiley and Sons, Singapore.

PHX – 102 PHYSICS LABORATORY (0 0 2 1)

LIST OF EXPERIMENTS

1. To verify the laws of vibrating strings by Melde's experiments that is to show that λ^2/T = constant.
2. To determine the impedance of A.C. Circuits.
3. To study the characteristic of PN diode and Zener diode.
4. To find out the intensity response of a solar cell/Photo diode.
5. To analyze the suitability of a given Zener diode as a power regulator.
6. To determine the band gap of a semiconductor.
7. To determine the Refractive index of the Prism material using spectrometer.
8. To determine the wavelength using Fresnel's Biprism/Diffraction grating.
9. To determine the wavelength of sodium light using Newton's ring method.
10. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.
11. To study the effect of voltmeter resistance on voltage measurement.
12. To study the variation of magnetic field with distance along the axis of a circular coil carrying current and its estimate the radius of the coil.
13. To verify Malus law..
14. To determine Planck's constant by LED method.
15. To determine the resolving power of a telescope.
16. To study the diffraction pattern by slits and gratings.
17. To determine the resistivity of a semiconductor by four probe method.
18. To confirm the de Broglie equation for electrons.

Recommended Books:

1. Dr. R.S. Sirohi, Practical Physics, Wiley Eastern, New Delhi.

PHX – 201 MATERIAL SCIENCE & TECNOLOGY (3 1 0 4)

Structure of Crystalline Solids: Crystal structure and crystal systems, Closed packing, some prominent crystal structure, Miller indices, Determination of crystal structure, Reciprocal lattice.

Imperfections in Solid: Points imperfections and their equilibrium concentration, Edge and screw dislocations, Burgers vector and the dislocation loop, Stress field and energy of dislocation, Dislocation multiplication.

Mechanical Properties: Basic concepts, Tensile stress-strain curve, Strength, Ductility, Elasticity, Toughness, Elastic deformation, Plastic deformation of metals, Critical resolved shear stress, Shear strength of ideal and real crystals, Mechanical failure – Fatigue, and Creep mechanism.

Electrical Properties: Classical and quantum theory of free electrons, Relaxation time and mean free path, Density of energy states, Fermi energy, Electron motion under periodic potential, Origin of energy bands in solids, Classification of materials on the basis of band theory, Effective mass, Intrinsic and Extrinsic semi-conductors. Hall effect and its applications.

Dielectric Properties: Mechanisms of dielectric polarization; Concept of polarizability, Dielectrics in alternating fields, Complex dielectric coefficient, Dielectric loss.

Magnetic Properties: Basic concepts, Soft and hard magnetic materials, Ferrites, Selection techniques for applications, Application of magnetic materials.

Phase and Equilibrium Diagrams: Solid solutions, Phase rule, Cooling curves, Phase diagrams – Solid solution system, Eutectic system, Combination type system, Lever rule, Iron – carbon system, Alloy steel.

Phase Transformation and Heat Treatment: Time – Temperature – Transformation (TTT) diagrams. Continuous – Cooling – Transformation (CCT) diagrams. Annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Maraging, Solid solution hardening, Precipitation hardening.

Books Recommended:

1. Callister W.D. “Material Science and Engineering”, John Wiley & Sons, Inc. New York, (1997).
2. Dekker A.J. “Solid State Physics”, MacMillan, India Limited, Madras, (1991).
3. V. Raghavan “Introduction to Material Science and Engineering”, Prentice Hall of India.
4. Van Vlack L.H. “Elements of Material Science and Engineering”, Addison Wasley Publishers.

PHX – 208 Electromagnetic Field Theory [3 1 0 4]

Electrostatic and Magnetic Fields: Poisson's and Laplace's equation in various co-ordinate systems, solution of single dimensional Laplace's equation, Conditions at a boundary between dielectrics, Electrostatic uniqueness theorem, Energy and Mechanical forces in electric fields, Method of Electrical images for a point charge in the neighborhood of infinite conducting plane, Application of image method for transmission line capacitance calculations. Magnetic vector Potential, Magnetic scaler Potential, Energy and Mechanical forces in magnetic fields.

Maxwell's Equations: Equation of continuity for time varying fields. Inconsistency of Amperes law, Maxwell's equations and their physical interpretation, Maxwell's Equations in Phasor Form. Conditions at a boundary surface.

Electromagnetic Waves: TEM, Derivation of the wave equation and their general solution. Plane waves in unbounded media. Wave propagation in lossless and conducting medium. Penetration depth. Reflection and refraction of plane waves, surface impedance.

Poynting Vector and Flow of Power: Poynting's theorem, Interpretation of (Ex H) - vector, Instantaneous, Average and complex Poynting Vector, Power Loss in a plane conductor.

Transmission Lines: Distributed parameters, Transmission Line Equations, Input impedance, Lossless propagation, Line distortion and attenuation, line termination, impedance matching, standing wave ratio, Transmission line charts (Smith Chart).

Guided Waves and Wave Guides: Waves between parallel planes, Characteristics of TE and TM waves, Velocities of wave propagation, wave impedances. Introduction to wave guides. TE and TM waves in rectangular wave guides, Circular waveguides, Impossibility of TEM waves in wave guides, Wave impedances and characteristics impedances, Transmission line analogy for wave guides, Attenuation and Q-factor of wave guides.

Books Recommended

1. Jordon E C and Balmain K G, "Electromagnetic waves and Radiating System", second edition, Prentice Hall New Delhi (1993).
2. Carter G W, "The Electromagnetic Fields in its Engineering aspects", Longmans, Green and Co. London, (1954).
3. Hayt W H and Buck J A, "Engineering Electromagnetics", McGraw-Hill Education (India) Pvt. Ltd. (2006).
4. Wazed Miah M A, "Fundamentals of Electromagnetics", Tata McGraw-Hill, New Delhi, (1982).
5. Raju G S N, "Electromagnetic Field Theory and Trnasmission Lines", Pearson (2006).

PHX – 204 MATERIAL SCIENCE AND ENGINEERING (3 1 0 4)

Structure of Crystalline Solids: Crystal structures and crystal system, reciprocal lattice, miller indices, closed packed structures, determination of crystal structures.

Imperfection in Solid: Point imperfections and their equilibrium concentration, Edge and screw dislocations; burgers vector and the dislocations; burgers vector and the dislocation leap, stress fields and energies of dislocations, dislocations forces, dislocation sources; Multiplication of dislocations.

Diffusion in Solids: Fick's laws of diffusion, solution to fick's second law, applications based on second law solution, the kirkendall effect, the atomic model of diffusion.

Mechanical Properties: The elastic properties, model of elastic behaviour, plastic deformation tensile stress-strain curve, shear strength of perfect and real crystals, mechanical failure, fatigue and fracture, creeps: mechanism of creep, characterization of creep curves.

Electrical Properties: Classical and quantum theory of free electronics; relaxation time, collision time and mean free path, density of energy states and Fermi energy, electron motion under periodic potential, origin of energy bands in solids, classification of material on the basis of band gap, effective mass, intrinsic and extrinsic semi-conductors, hall effect and its applications.

Dielectric Properties: Mechanism of polarization concept of polarizability and internal fields, dielectrics in alternating field; frequency dependence of polarizability.

Magnetic Properties: Magnetic moments and its origin, dia-and para-magnetism, ferro and ferri-magnetism, soft and hard magnetic materials, ferrites, application of magnetic materials.

Super Conductivity: Properties of superconductors. London equations, quantum explanation of super conductivity, flux quantization, application of super conductors.

Books Recommended:

1. William D. Calister, Jr. "Materials Science and Engineering" John Wiley and Sons, Inc. New York, (1997).
2. Dekker A.J., "Solid State Physics" Macmillan, India Limited, Madra, (1991).
3. Azaroff. L.V. "Introduction to Solid", Tata Mc Graw Hill, New Delhi, (1992).
4. Raghvan V. "Material Science and Engineering", Prentice Hall of India, New Delhi, (1998).
5. Kittal "Solid State Physics "Wiley Eastern Limited, New Delhi, (1987).

PHX – 224 MATERIAL SCIENCE & ENGINEERING LAB

LIST OF EXPERIMENTS

1. To determine the magnetic susceptibility of a paramagnetic salt by Guoy's balance method.
2. To calibrate an electromagnet.
3. To study temperature dependence of resistivity of semiconductor materials using four probe method and further deduce the band gap of this semiconductor.
4. To find Young's modulus, modulus of rigidity and Poisson's ratio for the material of a given wire by Searle's method.
5. To find the coefficient of thermal conductivity of bad conductor by using Lee's disc.
6. To determine the Hall coefficient of a semiconductor and hence to evaluate the charge carrier concentration, type and mobility of charge carrier in a given semiconductor material.
7. To investigate creep of a copper wire at room temperature.
8. To determine the Curie temperature of a ferroelectric material by measuring dielectric constant as a function of temperature.
9. To study the hysteresis loop of magnetic material (iron and steel) and determine its retentivity, coercivity and energy dissipated per unit volume per cycle of hysteresis.
10. To find the value of Planck's constant and evaluate the work function of cathode material by use of photoelectric cell.
11. To study the quantized energy of the first excited state in Argon using the Frank-Hertz Set-up.
12. To study various characteristics of photovoltaic cell: (a) Voltage-current characteristics (b) loading characteristics (c) power-resistance characteristics and (d) inverse square law behavior of photocurrent with distance of source of light from photovoltaic cell.

PHX-301 MATERIAL SCIENCE (Nano Science) [3 0 0 3]

Crystal Structure: Fundamental concepts, Crystal systems, Closed packed structures, Crystallographic planes and directions, Miller indices, Crystal defects.

Electrical Properties: Classical free electron theory of metals, Quantum theory – Particle in a box, Wave function and energy states, Finite potential barrier, tunneling, Fermi-Dirac distribution law, Density of energy states, Classification of solids into conductors, Semiconductors and insulators, Hall effect and its applications.

Semiconductor Materials: Intrinsic and extrinsic materials, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations, Conductivity and mobility.

Magnetic Properties: Basic concepts, Soft and hard magnetic materials, Ferrites, Selection techniques for applications, Magnetic recording, Magnetic memories.

Superconductivity: Properties of superconductors, London equations, Quantum explanation of superconductivity, Applications of superconductors.

Dielectric & Optical Properties: Dielectric materials, Polarization mechanisms, Dipole moment, Dielectric strength, Methods for producing polarization, Application of dielectric materials, Index of refraction, Damping constant, Characteristic penetration depth and absorbance, Reflectivity and transmissivity, Optical storage devices.

Nanomaterials: Introduction to nanotechnology, Nanowire and Nanotube, Carbon nanotubes, Single wall carbon nanotubes, Multiwall carbon nanotubes, Fabrications, Properties and applications.

Books Recommended:

1. Hummel R E, “Electronic Properties of Materials”, Narosa Publishing House, New Delhi (1997).
2. William D Callister, Jr, “Materials Science and Engineering”, John Wiley and Sons, Inc. New York (2002).
3. Dekker A J, “Solid State Physics”, MacMillan, India Limited, Madras (2000).
4. Pillai S O, “Solid State Physics”, New Age International Publishers, New Delhi (1999).
5. Van Vlack L H, “Elements of Material Science and Engineering”, Addison Wesley Publishers (1980).
6. Poole C P and Owens F J, “Introduction to Nanotechnology”, Wiley Edition (2003).