M.Sc. Semester- II

2PHY-1 : ELECTRODYNAMICS – I

UNIT-I : Review of vector differential calculus Gauss' law; Electrostatic potential, Poisson and Laplace equations; Eelectrostatic energy density, electric energy of a charge distribution

UNIT-II : Laplace equation and boundary value problems – Potentials under Cartesian, cylindrical and spherical
symmetries, two-dimensional problems – separations of variables, method of images, simple illustrative problems – point charge, linear conducting plane, cylinder ,sphere. Introduction to Green's function method.

UNIT-III : Magnetostatics, Biot-Savart Law, Ampere's law; Magnetic fields of arbitrary current distributions, straight wire, loop, solenoid, toroid, current sheet; Magnetic moment, magnetic force and torque on a circuit.

UNIT-IV : Charge distribution in finite region, multipole expansion of potential and field; Material media, boundary conditions; Dielectric sphere in uniform field; Susceptibility and polarizability, molecular model.

UNIT-V : Time varying fields, displacement current, Faraday induction; Maxwell's equations for time varying fields, scalar and vector potentials, gauge invariance, wave equation, Poynting theorem.

Books

1. Classical Electrodynamics, J.D. Jackson (John-Wiley, 3rd Ed. 1998)
2. Introduction to Electrodynamics, D. J. Griffiths (Prentice-Hall, 3rd Ed. 1999).
3. Electricity and Magnetism, A Mahajan and A Rangwala, Tata- McGraw Hill, 2004).
4. Numerical Methods in EM fields, V. Subbarao (Narosa Pub. House Pvt. Ltd.)

2PHY-2 : QUANTUM MECHANICS – II

UNIT-I : Time independent perturbation theory, non-degenerate and degenerate cases, secular equation, first and second order corrections to energy and wave functions, simple examples, Zeeman effect – normal and anomalous, Stark effect, example of hydrogen.

UNIT-II : Time dependent perturbation theory, transition probabilities, harmonic perturbation, Fermi's golden rule. Transition probabilities for induced emission and absorption; Electric dipole interaction, forbidden transitions, selection rules; Application to atomic spectra.

UNIT-III : Scattering from finite range potentials, differential and total scattering, cross-sections; Scattering in a central potential; Partial wave analysis, phase shifts, Born approximation, scattering from a square well potential and a perfectly rigid sphere.

UNIT-IV : Systems of identical particles, symmetry with respect to interchange, indistinguishability of particles, Symmetric and antisymmetric wave functions, spin functions for many particles, spin-statistics relations; Creation and annihilation

operators and their algebra for fermions and bosons; Representation of general one and two particle operators in this algebra.

UNIT-V : Semi classical theory of radiation, Relativistic Wave Equations – The first order wave equations, the Dirac Equation. Properties of Dirac Matrices. Free Dirac Particles equation of continuity. Second order wave equations. The Klein-Gordon Equation.

Books :

1. Quantum Mechanics, L I Schiff.
2. Quantum Mechanics, Eugene Merzbacher (John-Wiley, 3rd Ed, 2005)
3. Quantum Mechanics, P M Mathews and K Venkatesan (Tata- McGraw Hill, 1976)
4. Quantum Physics, S. Gasiorowicz
5. Quantum Mechanics, L. D. Landau and E. M. Lifshitz
6. Advanced Quantum Theory and Fields, S.I.Gupta and I.D. Gupta, S.Chand and Company Ltd.

2PHY-3: SOLID STATE PHYSICS

UNIT-I : Crystallography: Single Crystal and Poly Crystals, Crystal Symmetry, Symmetry Elements, Crystal Types, Bravais Lattices in 2D and 3D, Point Groups and Space Groups in 2D and 3D.

UNIT-II : Diffraction of X-Rays: Bragg's Law in 1D and 3D, Laue Diffraction Equation, Atomic Scattering Factor, Structure Factor. X-Ray Diffractions Techniques: Laue, Rotating Crystal Method, Oscillation and Burger Precession Method, Powder-Photograph Method,

UNIT-III : Interpretation of Powder Photograph, Measurement of Bragg's Angle, Interplaner Spacing (d), Accurate Lattice Parameter Determination. Analytical and Graphical Methods for (Known Unit Cell), Bernel Chart, Interpretation of Oscillation Photographs. Concept of Reciprocal Lattice, Vector Demonstration of Reciprocal Lattice In Two Dimensions, Bragg's Diffraction Condition In Terms of Reciprocal Lattice, Brllioun Zones. Diffraction of Electrons and Neutrons, Inelastic Scattering, Applications.

UNIT-IV : Inter-Atomic Forces Cohesive Energy of a Solid, Molecular Crystals, Ionic Crystals and Madelung Constant, Covalent Crystals and Metals, Lattice Dynamics of Mono Atomic and Diatomic Lattices. Infrared Absorption by Ionic Crystal Lattice, Localized Lattice Vibrations, Localized States and Associates Wave Function, Anharmonicity and Thermal Expansion, Thermal Conductivity.

UNIT-V : Specific Heat: Dulong and Petit Law, Lattice Specific Heat, Temperature Dependence of Specific Heat, Einstein and Debye Theories, Electronic and Lattice Contributions to Specific Heat.

References:

1. Crystallography Applied to Solid State Physics, Verma, A.R., Srivastava, O.N., New Age International.
2. Solid State Physics,N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd, 2009).
3. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).
4. Introduction to Solids, L V Azaroff (Tata-McGraw Hill, 1984).
5. Introduction to Modern Solid State Physics, Yuri M Galperin.
6. Solid State Physics, R. L.Sighal, Ram Nath Kedar Nath & Co., Publishers Meerut.

2PHY-4(i) : NET WORK THEOREMS AND SOLID STATE DEVICES

Unit-I : Network Analysis: Kirchoff's Voltage Law, Kirchoff's Current Law, Loop and Node Method, Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum Power Transfer Theorem,
Passive Components: Resistors, Capacitors, Inductors, Transformers, Relays, Fuses (their types, applications, common faults & testing).
Unit-II : Introduction to Semiconductors: Energy Band Diagram, Conductors, Semiconductors, Insulators, Intrinsic and Extrinsic Semiconductors(P&N), currents in semiconductors, Diffusion Junction, Depletion Layer, Barrier Potential.
Junction Diodes: Rectifying diode, Forward and reverse bias characteristics, breakdown phenomenon, Zener
Diodes, Varactor Diode, Photo Diode, Light Emitting Diode.
Unijunction Transistor: Basic Working Principle, Characteristics, Applications as a switch and as time base
generator.
Field Effect Transistors: JFET, basic working principle, I/O Characteristics, pinch off voltage, parameters, MOSFET, basic working principle, Characteristics
Unit-III : Rectifiers: Half wave, Full wave, Bridge (calculation of ripple factor and rectification efficiency), Filters (L, C, LC, π), Clipping and Clamping circuits.
Power Supplies: Regulated power supply, zener regulated power supply, transistorised series and shunt regulated power supply, Voltage Regulator IC's Fix Voltage Regulators 78XX series and 79XX series, Adjustable Voltage Regulators ICs 317 and its applications. IC based power supply study.
Power Control Devices: Four Layer Diode (PNPN), Silicon Controlled Rectifier (SCR), Triac, Diac (Principle, Characteristics and Applications).
Unit-IV : Bipolar Junction Transistor: Basic working principle, Input and Output Characteristics, Basic configurations. Biasing, Operating point, Load line, Stabilization of Operating Point, Self-Bias Arrangement.
Amplifiers: Classification of amplifiers, Class-A, B, AB and C Amplifiers, Cascading of amplifiers, RC Coupled amplifiers. Properties of amplifiers (distortion, noise, thermal noise, shot noise, noise figure).
Feedback in Amplifiers: Feedback concept, transfer gain with feedback, Effect of Negative Feedback on amplifiers performance.

Unit-V : Transducers: Basic idea of Transducers, Resistive transducers (PTC-PT-100, NTC-thermisters, capacitive (microphone) transducers, Inductive (LVDT) Transducers, Pressure transducers-Strain Gauge, photo voltaic cell, LDR, Photodiode and phototransistors (qualitative only).
Basic Measuring Instruments: Analogue Multimeter, Digital Multimeter, Cathode Ray Oscilloscope, Function Generator (functional block diagram, basic working principle, measuring quantities).

Reference books.:
1. Basic Electronics and Linear Circuits by Bhargava & Kulshreshtha (TTTI)
2. Integrated Electronics by Millman and Helkian
3. Circuits and Networks by A. Sudhakar and Shyam Mohan
4. Instrumentation Repair and Maintenance by R.G. Gupta

OR

2PHY-4(ii) : LASERS AND LASER APPLICATIONS

UNIT-I : Spontaneous emission, Stimulated emission, Population inversion, Fabry Perot etalon, Stable two mirror optical resonators, Longitudinal and transverse modes of laser cavity, Mode selection, Gain in a regenerative laser cavity.
UNIT-II : Two level laser system, Threshold for three and four level laser systems, Mode locking, Pulse shortening- pico second and femto second operation, Spectral narrowing and stabilization, Gaussian beam and its properties
UNIT-III : Ammonia maser, Nitrogen laser, Carbon dioxide laser, Excimer laser, Dye laser, Ruby laser, Nd-YAG laser, Diode – pumped solid state lasers, Semiconductor lasers, High power laser systems,.
UNIT IV : Laser induced fluorescence, Raman scattering and its applications, Non-linear interaction of light with matter, Laser induced multi-photon processes and their applications.
UNIT V : Ultra high resolution spectroscopy with lasers and its applications, Propagation of light in a medium with variable refractive index, Optical fibers, Light wave communication, Qualitative treatment of medical and engineering applications of lasers, Material processing.

TEXT AND REFERENCE BOOKS
1. Introduction to laser physics Koichi Shimoda
2. Introduction to laser physics B A Lengyl
3. Lasers Svelto
4. Optical electronics Yariv
5. Laser spectroscopy Demtroder
6. Nonlinear laser spectroscopy Letekhove
7. Laser physics Silfrast
8. An Introduction to Lasers : M.N.Avdahanulu

9. Theory and Applications (S.Chand & Co.)

2PHY-5: LABORATORY COURSE-1

It is necessary to perform atleast seven experiments from the list given below.
The experiments based on theory course are desirable.

1. Determination of e/m by Magnetron.
2. Determination of Lande's factor of DPPH using Electron Spin Resonance Spectrometer.
3. Determination of Magnetic Susceptibility of Material by Quincke's Method.
4. Characteristics of G.M.Tube.
5. Determination of dead time of G.M. counter
6. Determination of e/m by Helical Method.
7. Measurement of Hall coefficient of given semiconductor.
8. Determination of Rydberg constant.
9. Directional characteristics of Yagi Antenna.
10. Study of Transmission line.
11. Study of microphone / loud speaker characteristics.
12. Determination of 'e' by Millikan's oil drop method.
13. Determination of Current sensitivity of B.G.
14. Determination of e/m by Thomson Method.
15. Study of Magnetic Properties (Coercively, retentivity, saturation magnetisation and hysteresis loops) of ferromagnetic samples (soft iron, hard steel & nickel).

2PHY-6: LABORATORY COURSE-2

It is necessary to perform atleast seven experiments from the list given below.
The experiments based on theory course are desirable.

1. Verification of Network theorems : Thevenin's, Norton's, Milliman's and Maximum Power transfer theorem.
2. Practical use of:

(a) Multimeter (measurement of voltage, current, resistance).
(b) Power Supply (study the variation in line and load voltage)
(c) Oscilloscope (voltage and frequency measurement).

3. Study of Electronic Components:

(a) Resistor (study the types, colour coding, wattage rating, potential divider arrangement).
(b) Capacitors (study the types, colour coding, working voltage).
(c) Switches, Relays, Fuse (basic function, types, usage, testing).

4. P-N Junction Diode (study the types, testing, manual study, V-I Characteristics and parameters).
5. Study of PN diode as wave clipping element.
6. Study of Zener Diode (testing, V-I Characteristics, design & study of voltage regulating properties).
7. To study characteristics and application(s) of UJT.

8. Characterization and applications of SCR
9. To study characteristics and applications of SCR.
10. Study of Amplifiers (Design of CB/CE/CC, find Rin, Ro, Av, frequency response).
11. Design and study of the Characteristics of JFET amplifier
12. Design and study of Characteristics of MOSFET amplifier
13. Study if Astable, monostable and bistable multivibrators by using BJT.
14. Design and testing of transistorised oscillators (any two):
(a) RC-phase shift (b) Wein Bridge
(c) Hartley's (d) Colpitt's