SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2017-18

Syllabus for M.Sc. (Physics)

Semester II

Course No. PS02CPHY21
CLASSICAL AND QUANTUM MECHANICS

Unit: 1

A brief review of Lagrange's & Hamilton's formalism- conservation theorem, Noether's theorem and symmetry properties, Lagrangian and Hamiltonian formulation of relativistic mechanics, Canonical transformations, Equations of Canonical transformations, Canonical transformations for the Harmonic Oscillator, Poisson brackets and canonical invariants, equations of motion, Infinitesimal CT and conservation theorems in the Poisson bracket formulation.

Unit: 2

Hamilton Jacobi theory,Application to harmonic oscillator problem, Transition to quantum mechanics.Transition from a Discrete to a continuous system, Lagrangian formulation for continuous system.

Types of equilibrium, Theory of Small Oscillations, Secular equation, eigenvectors and eigen-frequencies, Orthogonality of eigenvectors; Normal coordinates; coupled Oscillation,; Linear triatomic molecule. Small oscillations of particles on string.Introduction to nonlinear oscillations.

Unit: 3

Representation of state vectors.Dynamical variables as matrix operators.Product of operators Self-adjointness and Hermiticity, diagonalization, Continuous basis, The Schrödinger representation.Degeneracy-Labeling by commuting observables. Change of basis,Unitarytransformations. Unitary transformations induced by change of coordinate system-translations,Unitary transformation induced by rotation of coordinate system.The algebra of rotation generators and the transformations of dynamical variables, concept of parity.

Unit: 4

Quantum theory of angular momentum and its eigenvalue spectrum. Matrix representation of angular momentum operators, spin angular momentum, Pauli matrices and their properties, total wave function, non-relativistic Hamiltonian including spin. Addition of angular momenta, definition of Clebsch-Gordan coefficients, Phase convention, spin-wave function for a system of two spin-1/2 particles, Identical particles with spin, addition of spin and orbital angular momenta.

Books:

1. Classical Mechanics – System of particles and Hamiltonian Dynamics, by Greiner :Springer International Ed. 2006
2. Classical Mechanics, 3rd Ed by Goldstein, Pole &Safko, Pearson Education, Pte. Ltd, Indian Branch, Delhi, India, 2002.
3. Classical Mechanics, by V. B. Bhatia; Narosa
4. Introduction to Classical Mechanics by R. G. Takwaleand P. S. Puranik; TMH
5. A text book of Quantum Mechanics, by P.M. Mathews and K. Venkatesan (TMH)
6. Introduction to Quantum Mechanics, by David J. Griffiths.
7. Quantum Mechanics by Ghatak&Loknathan; McMillan India Publication
8. Quantum Mechanics by G. Aruldas, Prentice-Hall India, Pvt., Ltd.

Course Code: PS02CPHY22
THEORETICAL CONDENSED MATTER PHYSICS

UNIT – 1

Introduction, electron moving in a one-dimensional potential well, three-dimensional potential well, quantum state and degeneracy, the density of states, Fermi-Dirac statistics, effect of temperature on Fermi distribution function, the electronic specific heat, the electrical conductivity of metals, relaxation time and mean free path, electrical conductivity and Ohm,s law, Wiedemann_Franz-Lorentz law, the electrical resistivity of metals, thermionic emission, the Hall effect.

UNIT-2

Bloch theorem, the Kronig-Penny model, construction of Brillouin zones, symmetry properties of the energy function, extended, reduced and periodic zone schemes, effective mass of an electron, the nearly free electron model, tight binding approximation, Orthogonalized Plane Wave (OPW) method, the pseudopotential method, conductors, semiconductors and insulators.

UNIT- 3

Semiconductor Crystals: Band gap, Equations of motion, Holes, Effective mass: physical interpretation, Effective masses in semiconductors.

Dielectrics: Macroscopic electric field, depolarization field, Local electric field at an atom, Lorentz field , Field of dipoles inside cavity, dielectric constant and Polarisability, electronic polarizabiltiy, classical theory of electronic polarizability, Magnetism: Langevin's diamagnetism equation, Paramagnetism–Quantum theory, Cooling by isentropic demagnetization, Nuclear demagnetization, Paramagnetic susceptibility of conduction electrons, Ferromagnetic order, Curie point and exchange integral.

UNIT- 4

Superconductivity-its occurrence and experimental survey, Meissner effect, Heat capacity, energy gap, Microwave and infrared properties, Isotope effects, Theoretical survey, Thermodynamics of superconducting transition and London equation, Coherence length, BCS theory of superconductivity, Flux quantization in a superconducting ring, Type II superconductors, single particle tunneling and Josephson superconductor tunneling, Fullerenes.

Books:

Introduction to Solid State Physics by C. Kittle (John Wiley & Sons)
Elements of Solid State Physics by J.P. Srivastava (Prentice Hall of India)
Solid State Physics: Structure and Properties of Materials by M. A. Wahab (Narosa Publishers).
Solid State Physics (Theory, Applications and problems) by S.L.Kakani& C. Hemrajani (Sultan Chand & Sons, New Delhi)
Principles of Solid State Physics by R. A. Levy (Academic Press)
Elementary Solid State Physics by M. A. Omar (Addison-Wesley Publishing Company).
Elements of X-ray Diffraction- B. D. Cullity

Course Code : PS02CPHY23
Electrodynamics

Unit: 1

Maxwell's equations in matter, Continuity equation, Poynting theorem – Momentum conservation, Maxwell's stress tensor – Angular momentum. Electromagnetic Waves in Vacuum: Wave equation for E and B fields, Monochromatic plane waves – Energy & momentum in electromagnetic waves, Polarization of electromagnetic waves: linear and circular polarization. Electromagnetic waves in matter: Propagation in linear media- Boundary conditions Reflection and Refraction – Snell's law. Reflection and Transmission at normal and oblique incidence – Fresnel's equations.

Unit: 2

Total internal reflections, EM waves in isotropic linear conducting media – Reflection at conducting surface.

Wave Guides and Resonant Cavities: Bounded waves – TE, TM, TEM modes, Rectangular wave guides –Circular cylindrical wave guides – Resonant cavities, Q of a cavity Dielectric wave guides (Optical fiber): H E Modes.

Unit: 3

Electromagnetic Radiation: Electromagnetic potentials Scalar and vector potentials Gauge transformations Gauge conditions (Lorentz and Coulomb gauges). Retarded Potentials – Jefimenko's equations for the E and B fields.

Radiations from extended sources: Electric dipole radiation Magnetic dipole and electric quadrupole radiations, Center-fed linear antenna- Hertzian dipole antenna – Small loop antenna. Rayleigh's scattering at long wavelength and blueness of sky- Scalar diffraction theory.

Unit: 4

Radiation from Moving point charges: Lienard-Wiechert potentials- Fields of a moving point charge- Power radiated by a point charge (Larmor formula), Radiation from a slowly moving charges, Radiation from relativistically moving charges, Larmor's generalization to relativistic case – Synchrotron radiation – Bremsstrahlung radiation. Thomson Scattering – Scattering of radiation from quasi free charges –Cerenkov radiation, Radiation Reaction: Abraham –Lorentz formula – Physical basis of radiation reaction.

Basic Text & Reference Books:

1. Classical Electrodynamics by J D Jackson, 2nd Ed; Wiley Eastern Ltd. 1975.
2. Introduction to Electrodynamics by David J Griffiths, 3rd Ed Prentice Hall, India, 2002.
3. Classical electromagnetic Theory by Jack Vanderlinde, John Wiley & sons,Inc.1993.
4. Elements of Electromagnetics by Sadiku 2ndEd.OxfordUniv.Press. Inc. 1995.
5. Classical Electrodynamics by Griener, Springer Verlag, New York, Inc. 1998.

Course No. PS02EPHY21
ELEMENTS OF EXPERIMENTAL PHYSICS

Unit: 1

Classification of vacuum pumps, Rotary pump, Diffusion pump, Molecular drag pump, Gettering and ion pumping, Sputter ion pump, measurement of pumping speed: constant pressure method, constant volume method.

Classification of gauges, McLeod gauge, Thermal conductivity gauge, Thermocouple gauge, Hot cathode ionization gauge, Bayard-Alpert gauge, Cold cathode ionization gauge, Penning gauge, Magnetron gauge.

Unit: 2

X-ray Diffraction: X-ray sources, Production of X-rays, continuous X-rays, characteristics X-rays, X-ray filters, X-ray absorbers, Scattering by electrons, atom and unit cell, Electron Diffraction: Introduction to electron diffraction, Transmission Electron microscopes, Neutron Scattering: Slow neutron scattering in solid, Elastic Scattering, Cross – section, Coherent Scattering.

Unit - 3

Thermal Analysis: Thermo gravimetric analysis, Differential thermal analysis and Differential scanning calorimetry, X-ray photoelectron spectroscopy, X-ray fluorescence spectroscopy, UV-Visible spectroscopy, atomic absorption spectroscopy.

Unit: 4

Ionization Chamber, Proportional Counter, Geiger-Mueller Counter, Scintillation detector: organic scintillator, Inorganic scintillator, Light guides, Photomultiplier tubes, Scintillation Spectrometer, Energy resolution of a scintillation spectrometer,

Semiconductor detectors: Diode detector, Diffused junction detector, Surface barrier detector, Ion implanted layer detectors, Fully depleted detectors, Lithium doped germanium detector [Ge(Li)], High purity germanium detector (HPGe), Cherenkov Detector, Photographic emulsion, Cloud Chamber, Bubble Chamber, Spark Chamber.

Books:

1. Vacuum Science and Technology V.V. Rao, T.B. Ghosh and K.L. Chopra Allied Publishers Limited (India)
2. Elements of X-ray diffraction Cullity and Stock
3. An introduction to lattice dynamic L.S Kothari
4. Biomedical instrumentation & measurements L. Cromwell
5. Instrumental method of analysis Willard
6. Fundamentals of Nuclear Physics. Jagdish Varma, Roop Chand Bhandary, D.R.S. Somayajulu.

Course Code: PS02EPHY22
Title of Paper: Solid State Electronics Devices & Solar Cells

Unit: 1 Contact between materials and pn Junctions, Contact between two materials Metals Semiconductors contacts, I/V characteristics, thermoelectric effects, The pn Junction – equilibrium conditions, zero bias, forward bias and reverse bias, The effect of temperature on diode characteristics, diode equivalent circuits, properties of the depletion layer, abrupt junction, junction potential, width of depletion layer and depletion layer capacitance, reverse breakdown mechanism.

Unit: 2 Graded junctions, practical pn junction , Bipolar junction Transistor -emitter efficiency and base transport factor, d.c. characteristics of a transistor, C-B characteristic, distribution of excess charge in base, variation of current gain with collector current, common emitter characteristics, transistor breakdown voltages, The Ebers-Moll model, charge control of a transistor, measurement of _B and _C.

Unit: 3 The hybrid _ equivalent circuit of BJT and equivalent circuit of FET, light absorption in semiconductors, working principle LDR, photo-diode, photo-transistor and LED, liquid crystal display devices. IC operational amplifiers, frequency compensation, op-Amp switching application, op-Amp inverter, precision rectifier, peak clipper, Schmitt trigger, UTP, LTP and adjustment, comparator, monostable, astable multivibrator.

Unit: 4 Introduction to the photovoltaic systems, merits and limitations of solar PV systems, prospects of solar PV systems-principle of a photovoltaic cell, V-I characteristics of a solar cell-Inter connections of solar cells, efficiency of solar cell and its spectral response, -Configuration of a solar PV systems, PV cell technology, Structures of solar cells-M-S solar cells, MIS solar cells, solid – liquid junction solar cells, comparison of p-n junction, Schottky junction, M-S, M-I-S solar cells.

Basic Text & Reference Books:

1 Electronic Devices and Components, by J. Seymore (Longmann Scientific & Technical).

2 Integrated Electronics, by K. R. Botkar, (Khanna Publishers.)

3 Integrated Electronics: Analog and Digital Circuits Systems, by J. Millman and C. C. Halkias (Tata McGraw -Hill Publishing Company Ltd.).

4 Solid State Pulse Circuits, by David A. Bell (Prentice Hall of India Pvt. Ltd).

5 Energy Technology (Non conventional, Renewable and conventional), by S. Rao and Dr. P. B. Parrulkar (Khanna Publishers.)