Teaching & Examination Scheme

For the Examination – 2020

**PHYSICS**

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|  |  | **B.Sc. PART-III** |  |  |  |
|  |  |  |  |  |  |
| **THEORY** |  |  |  |  |  |
|  |  |  | Pd/W | Exam. | Max. |
|  |  |  | (45mts.) | Hours | Marks |
|  |  |  |  |  | 150 |
| Phy.301 | Paper I | Solid State Physics | 2 | 3 | 50 |
| Phy.302 | Paper II | Nuclear Physics | 2 | 3 | 50 |
| Phy.303 | Paper III | Relativity and Electrodynamics | 2 | 3 | 50 |
|  |  |  |  |  |
| **PRACTICAL** |  | 6 | 5 | 75 |
|  |  |  |  |  |  |
|  |  |  | **TOTAL:** | **225** |

B. Sc. Part-III

**Paper I : Solid State Physics**

Note: The question paper for the examination will be divided in three parts i.e., Section – A, Section – B and Section – C.

**Section – A:** Will consist of 10 compulsory questions. There will be two questions from each unit and answer of each question shall be limited upto 30 words. Each question will carry 1 mark.

**Section – B:** Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited upto 250 words. Each question carry 3.5 marks.

**Section – C:** Will consist of total 05 questions. The paper setter will set one question from each Unit and students will answer any 03 questions and answer of each question shall be limited upto 500 words. Each question will carry 7.5 marks.

Unit-1 :

Crystal structure : Different terms of crystal structure, Fundamental types of lattices, Two and three dimensional lattice types; Seven system of crystals, Characteristics of sc, bcc, fcc, hcp; Miller indices, orientation of planes in cubic lattices; Distribution of Atoms in atomic planes of cubic lattices. Distance between successive planes; Von-Laue’s equations of diffraction of X-rays, Bragg’s Law, scattering from lattice of point-atoms. Scattering factor. Geometrical Scattering factor for sc, bcc, fcc. Reciprocal lattice and its properties.

Unit-2 :

Crystal binding and lattice vibrations : Inter-atomic forces of solids. Crystal of inert gases, cohesive energy and bulk modulus. Ionic crystals, Madelung energy and bulk modulus. Covalent crystals. Hydrogen bonded crystals, Atomic radii. Concept of phonons Vibration of monatomic lattices, lattice with two atoms per primitive cell. Local phonon modes. Density of states in one dimension, three dimensions, lattice heat capacity for Einstein model, Debye model.

Unit-3 :

Free Electron theory of metals : Free electron model, Density of states of electron gas, Fermi-Dirac distribution function, effect of temperature on Fermi-Dirac distribution function, Fermi energy at absolute zero temperature and low temperature. Electron heat capacity. Thermionic emission. Boltzmann transport equation, Sommerfeld theory of electrical conductivity, Thermal conductivity, Wiedmann-Franz Law. Hall effect.

Unit-4 :

Band theory : Formation of bands and origin of energy gap, Bloch theorem, Kronig Penney model, crystal momentum and velocity of an electron. Effective mass of electrons. Electrons and holes. Number of states in a band, insulator, semi-conductor and metal. Construction of Brillouin Zones and Fermi-surfaces. Fermi levels in intrinsic, n- type and p- type semi-conductors, Mass action Law. The static dielectric constants of solids. Local electric field at an atom.

Unit-5 :

Magnetism : Diamagnetism and Larmor precession, classical theory of diamagnetism, Para-magnetism and its classical theory, free electron theory. Molecular theory of ferromagnetism.

Experimental Survey of Superconductivity : Zero resistance, persistent currents, effect of magnetic fields, flux exclusion, Intermediate state, Entropy effect, frequency effects, Gyromagnetic ratio, Isotope effect. Occurrence of superconductivity. Thermoelectric effects, thermal conductivity. High temperature oxide, superconductors and their properties. BCS theory (elementary idea without mathematical derivation), Magnetic levitation.

Books suggested :

Kittel : Introduction to Solid State Physics, Wiley Eastern.

A.J. Dekker : Solid State Physics, McMillian India.

L. Azaroff : Theory of Solids.

Paper II: Nuclear Physics

Note: The question paper for the examination will be divided in three parts i.e., Section – A, Section – B and Section – C.

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**Section – B:** Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited upto 250 words. Each question carry 3.5 marks.

**Section – C:** Will consist of total 05 questions. The paper setter will set one question from each Unit and students will answer any 03 questions and answer of each question shall be limited upto 500 words. Each question will carry 7.5 marks.

Unit I:

Rutherford alpha scattering experiment, scattering formula and experimental verification of scattering formula. nuclear charge, Chadwick’s determination of nuclear charge, theories of nuclear composition, nuclear mass, Determination of size of nucleus using Mesonic X ray method, Measurement of potential radius from life time of alpha emitters and scattering of fast neutron. nuclear spin, Determination of nuclear spin from hyperfine splitting of the atomic energy, parity, method of parity investigation, nuclear magnetic moment and electrical moment, relation between quadrupole moment and nuclear spin.

Unit II:

Mass defect, binding energy and packing fraction of nucleus. Liquid drop model of Nucleus, magic number and evidence of it, WEIZSACHER’s Semi Empirical Mass formula, Predication of stability against beta-decay for members of an isobaric family.

Types of nuclear reactions, The balance of Mass and energy in nuclear reactions, conservation law in nuclear reactions, Q equation. Solution of the Q equations, concept of centre of mass in nuclear reaction, proton-proton collision and neutron-nucleus collision in CM frame.

Unit III:

The law of radioactive decay, statistical nature of radioactivity. Radioactive growth and decay. Ideal equilibrium, transient equilibrium and secular equilibrium, Radioactive series, Fundamental law of radioactivity, induced radioactivity, radioactivity dating.

Alpha decay: Disintegration Energy, Range of alpha particles, Geiger Nuttal’s Law, spectrum and fine structure. alpha particles paradox, Barrier penetration, Beta Decay, disintegration energy of Beta Decay, principle, working and uses of beta ray spectrometer.

Unit IV:

Nuclear Energy: Nuclear induced fission, energy released in fission of U235, Fission chain reaction, stability limits against spontaneous fission, Energetic of Symmetric fission, Neutron cycle in a thermal reactor. Four factor formula. Elementary idea of nuclear reactors, types of nuclear reactor, nuclear reactor in India. Nuclear fusion, fusion in stars, carbon and pp cycle, problems of controlled fusion, fissile and fertile materials and their characteristics.

Unit V:

Gas filled ionisation detectors, Detailed description, principle working and uses of (i) proportional counter (ii) Geiger-Muller Counter, dead time, recovery time and paralysis time, principle of acceleration, classification of accelerators, electrostatic accelerators, linear accelerators, cyclotron, synchrocyclotron, betatron.

Properties of elementary particles, Classification of elementary particles, quantum number of elementary particles, conservation laws, experimental evidence of violation of parity conservation in Beta Decay, C.P.T. theorem, types of cosmic rays and properties of primary cosmic rays.

Books suggested:

Alonso & Finn: Fundamental University Physics – Vol. III, Addision Wesley.

S.N. Ghoshal: Atomic & Nuclear Physics – Vol. II, S. Chand, New Delhi.

Satyapraksh: Nuclear Physics, Pragati Prkashan Meerut

R. R. Roy and B. P. Nigam, Nuclear Physics, New Age Int.(P) Ltd

D.C. Tayal: Nuclear Physics, Himalaya Publishing House

**Paper III: Relativity and Electrodynamics**

Note: The question paper for the examination will be divided in three parts i.e., Section – A, Section – B and Section – C.

**Section – A:** Will consist of 10 compulsory questions. There will be two questions from each unit and answer of each question shall be limited upto 30 words. Each question will carry 1 mark.

**Section – B:** Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited upto 250 words. Each question carry 3.5 marks.

**Section – C:** Will consist of total 05 questions. The paper setter will set one question from each Unit and students will answer any 03 questions and answer of each question shall be limited upto 500 words. Each question will carry 7.5 marks.

Unit-1

Electromagnetic Waves: Displacement current, Maxwell’s equations, Electromagnetic wave equation, Poynting theorem, Plane Electromagnetic waves in free space, wave impedance of free space, Propagation of plane Electromagnetic waves in non-conducting and conducting media, Skin depth, propagation of Electromagnetic waves in ionized gases, Polarization of Electromagnetic waves.

Unit-2

Reflection and Refraction of Electromagnetic waves: Boundary conditions at the surface of discontinuity, reflection and refraction of Electromagnetic waves at the interface of non-conducting media, Fresnel’s equations and their experimental verification, reflection and transmission coefficients, Brewster’s Law and degree of polarization, total internal reflection, phase difference between parallel and perpendicular components and polarization of the reflected wave, reflection from a conducting plane.

Unit-3

Interaction of Electromagnetic waves with matter: Normal and anomalous dispersion of light, empirical relations, Lorentz theory of dispersion of gases, experimental demonstration of anomalous dispersion in gases, scattering of electromagnetic waves and scattering parameters, Thomson, resonant and Rayleigh’s scattering cross-section, polarization of scattered light, coherent and incoherent scattered light, dispersion in liquids and solids, Claussius Mossotti equation and Lorentz-Lorentz formula.

Unit-4

Relativistic Mechanics: Coordinate transformation, contravariant and covariant vectors, tensors of second and higher rank, addition, subtraction, contraction, outer and inner product of tensors, covariance of tensor equations, Minkowski space, geometrical interpretation of Lorentz transformation, space like and time like intervals, four vectors, four dimensional gradient, divergence and curl operators, four-velocity, four-acceleration, four-momentum, four-force, relativistic classification of particles.

Unit-5

Relativistic Electrodynamics : Invariance of charge, transformation of surface charge density, transformation of volume-charge density and current density, Equation of continuity in the covariant form, Scalar and vector potentials, Transformation of Electromagnetic potentials, Lorentz condition and its covariant form, Electromagnetic field tensor, Covariance of Maxwell’s equations, Transformation of Electro-Magnetic fields, Lorentz-force in a covariant form, Electromagnetic field due to a moving charge.

Books suggested:

S.P. Puri: Electrodynamics, Tata McGraw Hill

J.D. Jackson: Classical Electro-dynamics, John Wisely, New York

B.B. Laud: Electromagnetic, John Wisely, New York

E.C. Jordan: Electromagnetic waves, PHI, New Delhi

D. J. Griffiths: Introduction to Electrodynamics, PHI

**Practicals of B.Sc. III Year Physics**

Note: These Practicals are divided into two sections, Lab. A & Lab. B.

1. Lab. A is for all students.
2. Lab. B is for all the students except those who offer Electronics as an optional subject.

Examination Scheme for Laboratory Work:

1. Students with Electronics shall be examined in any two experiments from Lab. A.
2. Students with Combinations not involving Electronics shall be examined in one experiment of Lab. A and one experiment from Lab. B

Lab. A: Physics Practicals

1. Determination of Planck’s constant using solar cell/ LED.
2. Verification of Stefan’s Law (Black Body method).
3. Study of characteristics of a GM counter and verification of inverse square law for the same strength of a radioactive source.
4. e/m measurement by Helical Method.
5. Measurement of magnetic field using Ballistic galvanometer and search coil.
6. Measurement of electric charge by Millikan’s oil drop method.
7. To study hysteresis loss of transformer by B-H curve using CRO.
8. Verification of Cauchy’s formula.
9. Study of Lissajous patterns.
10. Determination of separation of plates of Etalon using spectrometer.
11. Determination of Dead Time of GM counter.
12. Determination of difference in wavelength of the two line of Sodium light.
13. Determination of refractive index of ordinary and extra ordinary light using Babinet compensator.
14. Determination of Band Gap of a semi conductor using four probe method.
15. To verify Fresnel’s formula for the reflection of light.
16. Determination of coefficient of rigidity as a function of temperature using torsional oscillator (resonance method).
17. Determination of dielectric constant of solids and liquids.
18. Determination of velocity of sound in air.
19. Verification of Malus law

Lab. B: Electronics

1. Study of ripple factor for shunt capacitor, series inductor, L-section and π section filters using full wave rectifier circuit.
2. Study of frequency response of single stage transistor amplifier (variation of gain with frequency).
3. Study the characteristics of field effect transistor (FET).
4. Study the negative feedback effect on voltage gain, and input and output impedances of the amplifier.
5. Study of operational amplifier (OP-AMP).
6. Study of RC circuits as integrating and differentiating systems with Square input.
7. Study of series and parallel LCR resonance circuit.
8. Design and Voltage study of AND, OR, NOT, NAND and NOR gates circuits using diodes and transistors.
9. Design and study of RC phase shift oscillator.
10. Study of Nano TiO2 Solar Cell.
11. Study of Hybrid Solar and wind energy.
12. Transient Analysis of C-R and L-R circuit.
13. Determination of parameter of transformer.

Note: - New experiments may be added on availability of equipments.