Government of West Bengal
Government General Degree College at Kharagpur-II
Department of Physics
Madpur, Paschim Medinipur – 721149

পশ্চিমবঙ্গ সরকার
গভর্ণমেন্ট জেনারেল ডিগ্রী কলেজ খড়্গপুর-২
পদার্থবিদ্যা বিভাগ
মাদপুর, পশ্চিম মেদিনীপুর – ৭২১১৪৯

Ref No: GGDCKGP-II/Physics-59/18-19

Date: 17.08.2019

Programme Outcome (PO) and Course Outcomes (CO) of B.Sc. (General) in Physics (1+1+1)

Programme Specific Outcome (PSO)

The B.Sc. (General) in Physics (1+1+1) program aims to provide introductory concepts in the subject of Physics covering most of the basic topics like Mathematical Physics, Classical Mechanics, Electrodynamics, Thermal Physics and Statistical Mechanics, Quantum Mechanics, Solid State Physics, Electronics, Atomic & Nuclear Physics, and Waves and Optics. They will also gain hand on experience in various instruments through a thorough training via the practical papers. After successful completion of the programme, the students will acquire and gain the following:

- Students can formulate and analyze analytical and numerical problems and solve the same. They can apply these concepts in interdisciplinary platforms.
- Students can record any kind raw data and analyze it to extract desired information using computational tools, and can present the data in graphical representation.
- Students will be able to prepare scientific write-ups (like articles, reports, etc).
- Students can apply in various jobs/competitive examinations of Graduate levels like Civil Services, Clerical and also in corporate sector, technological industries.
- In competitive examinations, the students will have expertise in solving mathematical and physical problems.
- The students can apply for teaching jobs as well after completing B.Ed. program after this course.

Course Outcome (CO) for the Paper-I (Theory, Group-A)

- ✓ The students will learn about the vector analysis including the dot product, cross product, scalar triple product and vector triple product. They will know about the scalar and vector fields, gradient of scalar field, divergence and curl of vector fields. They will also learn about the Gauss divergence theorem and Stokes theorem and will be able to calculate various vector integration (line, surface and volume integrals).
- ✓ The students will learn about the Newton's laws of motion and motion in uniform field. They will know the mathematical tools in expressing velocity and acceleration in Cartesian and polar coordinate systems.
- ✓ The students will learn about the motion of a particle under a central force and its various properties like plane motion, equation of orbit, conservation laws etc.
- ✓ The students will learn about the Kepler's law of planetary motion.
- ✓ The students will be able to calculate the path integral of force owing to the understanding of potential in a conservative force field vis-a-vis conservation of total energy.
- ✓ The students will learn about the rotational motion, angular velocity, angular acceleration, angular momentum, and torque. They will know about fundamental equation of rotational motion, principle of conservation of angular momentum, radial and cross-radial acceleration.
- ✓ The students will learn about the moment of inertia (MI) and radius of gyration of a system of particles including their physical significance. They will know the theorems of parallel and perpendicular axes in calculating the moment of inertia. They will learn about the rotational kinetic energy and its conservation in torque free motion.
- ✓ The students will be able to calculate of moment of inertia for some simple symmetric systems (both discrete and continuous mass distributions).
- ✓ The students will learn about the superposition of two simple harmonic motions of some frequency along the same line and interference. They will also know about the superposition of two mutually perpendicular simple harmonic vibrations of same frequency. The students will be able to draw and analyze some basics Lissajous figures.
- ✓ The students will learn about forced oscillator and damped oscillator. They will be able to solve the equation of motion for the same and find the conditions of critical damping.

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- ✓ The students will learn about the gravitation and Newton's law of gravitation. They will be able to calculate the gravitational potential and intensity due to symmetric mass distributions such as thin uniform spherical shell and solid sphere of uniform density.
- ✓ The students will be able to calculate the escape velocity of planets and stars.
- ✓ The students will learn about elasticity, small deformation and Hooke's Law. They will be able to calculate the relationship among various elastic constants like Young's modulus (Y), modulus of rigidity (n), bulk modulus (k) and Poisson's ratio (σ).
- ✓ The students will learn about the torsion of a cylinder, bending moment, cantilever, and simply supported beam with concentrated load at the centre. They will be able to calculate strain energy.
- ✓ The students will learn about the viscosity of fluids, streamline and turbulent motion. They will be able to derive the Poiseuille's formula. They will know about the critical velocity, Reynolds number, Bernoulli's theorem and Stokes law.
- ✓ The students will learn about surface tension and surface energy including the molecular theory, angle of contact, elevation and depression of liquid columns in a capillary tube. They will be able to calculate excess pressure in a spherical bubble and spherical drop.

Course Outcome (CO) for the Paper-I (Theory, Group-B)

- ✓ The students will learn about ideal gas, kinetic theory of gas including Maxwell's velocity distribution, and Boyle's law, Charles law and Avogadro hypothesis. They will know the interpretation of temperature as a measurement of average kinetic energy of the gas molecules. They will learn about r.m.s. speed, most probable speed and average speed of gas molecules. They will be able to apply the kinetic theory for the study of the Brownian motion.
- ✓ The students will learn about the equipartition of energy. They will be able to calculate the specific heats of gases at constant volume and pressure and relate them to the degrees of freedom.
- ✓ The students will learn about the properties of real gas including equation of state for van der Waals gas and van der Waals forces. They will be able to compare with experimental PV diagram with the van der Waals curve.
- ✓ The students will learn about the critical constants, Joule's experiment of ideal and van der Waals gas, Joule coefficient, and Joule-Thompson cooling.
- ✓ The students will learn about the liquefaction of gases including Boyle temperature and inversion temperature. They will know in detail about the regenerative cooling and cascade cooling.
- ✓ The students will learn about the liquefaction of hydrogen and helium, refrigeration cycles, and efficiency.
- ✓ The students will learn about transport phenomena including molecular collision, mean free path, and collision cross section. They will know about the transport of mass, momentum and energy owing to the emergence of transport coefficients like diffusion coefficient, viscosity and thermal conductivity. They will also learn about the temperature and pressure dependence of the transport coefficients.
- ✓ The students will learn about basics of thermodynamics including the zeroth law of thermodynamics, indicator diagram, work done by and on the system, first law of thermodynamics, and internal energy as state function. They will be able to apply the first law for solving problems related to various thermodynamic system.
- ✓ The students will learn about the reversible and irreversible processes, Carnot cycle, efficiency and Carnot's theorem. They will know the second law of thermodynamics including its different statements and their equivalence. They will learn about the concepts of entropy and principle of increase of entropy.
- ✓ The students will learn about the thermodynamic scale of temperature and ideal gas scale. They will know about the third law of thermodynamics and unattainability of absolute zero temperature.
- ✓ The students will learn about extensive and intensive thermodynamic variables. They will be able to derive various thermodynamic relationships including the Maxwell's general relationship and TdS relations. They will know about the Clausius-Claypron equation, J-T cooling and adiabatic cooling in a general system (van der Waals gas).
- ✓ The students will learn about the blackbody radiation and its spectrum. They will know about the Wien's displacement law and the Rayleigh-Jeans law including their failure to describe the experimental spectrum. They

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will be able to derive the Plank's law of blackbody spectrum and recover the Wien's law and Rayleigh-Jeans law in appropriate limit. They will learn about the Stefan-Boltzman law and the radiation pressure.

Course Outcome (CO) for the Paper-I (Theory, Group-C)

- ✓ The students will learn about the speed of transverse waves on a string, speed of longitudinal waves in fluid, energy density and energy transmission in wave, gravitational waves and ripples. They will know about the group velocity and phase velocity and their relationship.
- ✓ The students will learn about the standing waves including the normal modes of bounded systems. They will know about the harmonics and quality of sound in musical instruments.
- ✓ The students will learn about the noise and music, human ear and its responses, audibility, intensity and loudness, bel and decibel, musical scale, temperament and musical instruments. They will know about the reflection and refraction sound, acoustic impedance, percentage reflection and refraction at a boundary. They will be able to measure the frequency of acoustic vibration.
- ✓ The students will learn about the wave form, intensity and velocity. They will know about the acoustics of halls, and Sabine's formula for reverberation.
- ✓ The students will learn about the reflection and refraction, Fermat's principle, laws of reflection and refraction at a plane surface, refraction at a spherical surface. They will know about the lens formula, combination of thin lenses and equivalent focal length.
- ✓ The students will learn about the optical instruments, dispersion and dispersive power, chromatic aberration and its remedy, different types of Siedel aberration (qualitative) and their remedy. They will know about the eye-piece including the Ramsden and Huygen's type eye-pieces.

Course Outcome (CO) for the Paper-II (Theory, Group-A)

- ✓ The students will learn about the Coulomb's law in free space and electric field of discrete charges. The will be able to calculate the electric due to simple distribution of charges at rest.They will know about the electric dipole and field produced by it at arbitrary point in space. They will learn to calculate torque on a dipole in an uniform external electric field and its energy.
- ✓ The students will learn about work done on a charge in an electrostatic field, conservative nature of the electric field and electric potential. They will be able to calculate the flux of the electric field through symmetric surfaces using surface integration. They will know about the Gauss's law in electrostatics and its applications to calculate the electric field for symmetric charge distributions.
- ✓ The students will learn about conductors and their properties, capacitors, electrostatic field energy. They will be able to calculate the force per unit area at the surface of a charged conductor placed in an electric field.
- ✓ The students will learn about the dielectrics and electrostatics in a dielectric medium. They will know about the parallel plate capacitor filled with a dielectric. They will also learn about the polarization, and displacement vector.
- ✓ The students will learn about the current density, equation of continuity for electric charges in motion, and condition for the steady current. They will be able to apply the Kirchhoff's laws for the analysis of multi-loop circuits.

Course Outcome (CO) for the Paper-II (Theory, Group-B)

- ✓ The students will learn about the magnetostatics including the force on a moving charge and Lorentz force. They will be able to calculate the force on a straight current carrying conductor in a uniform magnetic field, torque on a current loop. They will learn to apply the Biot-Savart law for the calculation of magnetic field due to simple steady current configurations.

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- ✓ The students will learn about the Ampere's circuital law and its application for the determination of magnetic field due to a straight current carrying conductor, a circular coil, a solenoid. They will know about the magnetic field produced due to a small current loop owing to the concept of magnetic dipole as a tiny current loop.
- ✓ The students will learn about magnetostatics in a medium including the concepts of magnetization, magnetic susceptibility and permeability. They will know about the relation between B, H and M. They will also learn about different types of magnetic material such as diamagnetic, paramagnetic and ferromagnetic materials and their various properties like Curie's law and hysteresis in ferromagnetic material.
- ✓ The students will learn about the Faraday's law in both the integral and the differential forms, self and mutual inductances, transformers, energy stored in a coil of self inductance, displacement current and the Maxwell's equations.
- ✓ The students will learn about the transient response in DC including the growth and decay of current in LR circuit, charging and discharging of capacitor in CR circuit and their time constants.
- ✓ The students will learn about the LR and CR circuits, complex number and their applications in analyzing the AC circuits, impedance and reactance, series and parallel resonances, Q-factor, power dissipation in AC circuit and power factor.

Course Outcome (CO) for the Paper-II (Theory, Group-C)

- ✓ The students will learn about the physical optics including the interference of light, principle of superposition, Young's double slit experiment, intensity distribution, conditions of interference, optical path retardation, lateral shift of fringes and interference in thin films. They will also know about the Newton's ring experiment and determination of unknown wavelength from it.
- ✓ The students will learn about the diffraction including the Fresnel's diffraction, half period zones, rectilinear propagation and zone plates. They will also know about the Fraunhofer diffraction, diffraction at a single slit and double slit, and their intensity distribution.
- ✓ The students will learn about the diffraction grating, diffraction at N-parallel slits, intensity distribution, plane diffraction grating. They will know about the Rayleigh criterion, resolving powers of a grating and a prism.
- ✓ The students will learn about the polarization of light including the concepts of uniaxial crystals, Brewster's law, and double refraction phase retardation plates. They will know about the optical activity, rotation of plane of polarization, right-handed and left-handed active substances and specific rotation.
- ✓ The students will learn about the p-n junction diode. They will be able to use the diodes to design rectifier and bridge rectifier. They will learn about the Zener diode, its breakdown and the use of the Zener diode as a voltage regulator.
- ✓ The students will learn about the transistors and its characteristics in CE mode including the graphical analysis of CE configuration. They will know about the DC biasing-selection of Q-point.
- ✓ The students will learn about the basics of digital electronics including the binary number system, conversion from decimal to binary and vice versa. They will know about the logic gates (OR, AND, NOT gates), truth tables, and de Morgan's theorem. They will also be able to design the NOR and NAND gates and know about their universality.

Course Outcome (CO) for the Paper-II (Theory, Group-D)

- ✓ The students will learn about the postulates of special theory of relativity, length contraction and time dilation. They will know about the relativistic velocity addition theorem.
- ✓ The students will learn about variation of mass with velocity and mass-energy equivalence.
- ✓ The students will learn about the basics of atomic physics including the Bohr model, spectra of hydrogen-like atom, vector atom model, concept of quantum numbers and Pauli exclusion principle.
- ✓ The students will learn about the basics of quantum mechanics including the wave particle duality, de Broglie hypothesis, matter waves, Compton effect and Heisenberg uncertainty principle. They will know about the wave-function $\Psi(x,t)$ and its physical interpretations in terms of probability density and probability current density. They will be able to normalize a given wave function.

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- ✓ The students will learn about the Schrodinger equation in one-dimension, and its application to non-relativistic particle in a one dimensional box. They will be able to obtain the eigenfunctions and eigenvalues for such one dimensional quantum systems. They will know about the orthogonality of the eigen functions.
- ✓ The students will learn about basics of nuclear physics including the structure of a nucleus-shell model, concept of binding energy, nuclear reactions, stability, fission and fusion, energy production in stars and nuclear reactors.
- ✓ The students will learn about the basics of solid state physics including the crystal structures, lattice and basis, unit cell, cubic crystal system (SC, FCC and BCC). They will be able to calculate the packing fractions and the relationship between lattice constant and density. They will also know about the X-ray diffraction in a crystal, Laue Equations, Bragg's law and reciprocal lattices.
- ✓ The students will learn about the energy band structure of solids using elementary Kronig-Penny model. They will be able to distinguish among insulators, semiconductors and metals using their band structure.

Course Outcome (CO) for the Paper-III (Practical, Group-A)

- ✓ The students will be able to determine the moment of inertia of a heavy cylinder about its axis of symmetry by torsional oscillation method.
- ✓ The students will be able to determine the rigidity modulus of material in the form of cylindrical wire by dynamical method.
- ✓ The students will be able to determine the Young's modulus of material of a bar using method of bending beam loaded at middle of the bar.
- ✓ The students will be able to determine the temperature coefficient of linear expansion of rod by optical liver method.
- ✓ The students will be able to determine the coefficient of viscosity at room temperature using capillary flow method.
- ✓ The students will be able to measure the resistance of suspended coil galvanometer by half deflection method.
- ✓ The students will be able to measure unknown resistance using Carry Foster's bridge.
- ✓ The students will be able to determine the unknown EMF of a cell by potentiometer with the help of a milli-ammeter.
- ✓ The students will be able to determine the current through a resistance by potentiometer.
- ✓ The students will be able to study of the current-voltage characteristics of simple resistor and forward biased p-n junction diode and compare.

Course Outcome (CO) for the Paper-III (Practical, Group-B)

- ✓ The students will be able to measure the focal length of a concave lens by combination method.
- ✓ The students will be able to determine the refractive index of (i) material of the lens (ii) a wettable liquid.
- ✓ The students will be able to determine the refractive index of material of a prism by spectrometer using method of minimum deviation.
- ✓ The students will be able to measure the horizontal component of earth's magnetic field by magnetometer.
- ✓ The students will be able to study the Newton's ring and determine the wavelength of source .
- ✓ The students will be able to use the bridge rectifier and study its load regulation characteristics.
- ✓ The students will be able to study the forward and reverse bias characteristics of a Zener diode and determine the dynamic resistance before and after breakdown.
- ✓ The students will be able to study the load regulation characteristics of the Zener Diode with specific reference voltage.
- ✓ The students will be able to draw the output characteristic of a transistor in CE mode.
- ✓ The students will be able to verify truth tables of OR, AND and NOT gates.

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Course Outcome (CO) for the Paper-IV(A) (Theory)

- ✓ The students will learn about the production and measurement of high vacuum, rotary and diffusion pump, Mcleod gauge, Pirani and Penning gauge.
- ✓ The students will learn about the heat engines including their thermal efficiency, indicated horse power, brake horse power. They will know about the Otto cycle, diesel Cycle, four-stroke petrol and diesel engine including their efficiency.
- ✓ The students will learn about the ultrasonics and its application. They will also know about the microphones, speakers, recording and reproduction of sound including digital system.
- ✓ The students will be able to convert galvanometer to ammeter and voltmeter. They will know about the digital multimeter.
- ✓ The students will learn about the electric generator, elementary theory of transformer, AC bridges, theory of rotating magnetic field-induction motor, and three-phase electrical power supply
- ✓ The students will learn about the basic concepts of electrical wiring including wiring a room having a tube light, a filament lamp and a ceiling fan. They will be able to make electrical wiring of a house having 3-bed rooms, dressing room and kitchen. They will know about the polarity test, continuity test, earth and ground test.
- ✓ The students will learn about the basics of LASER including its principle, Einstein's A and B coefficient, population inversion, and feedback energy in resonator.
- ✓ The students will learn about different LASER types such as the solid state LASER, Ruby LASER and semi conductor LASER. They will learn about the various applications of LASER in holography, medical, and isotope separation.
- ✓ The students will learn about the basics of camera and photography.
- ✓ The students will learn about the basics of optical fiber including the core and cladding, total internal reflection, optical fiber as waveguide, acceptance angle and numerical aperture, and step index fiber.
- ✓ The students will learn about the p-n junction and Zener diode characteristics, half-wave rectifier, full-wave rectifier, bridge rectifier and filter. They will be able to use the Zener as voltage regulator owing to designing of DC power supply.
- ✓ The students will learn about the bipolar junction transistors including the method of their operation, current components, input and output characteristics. They will know about the hybrid model of transistor and the hybrid parameters. They will also be able to design CE amplifier using transistor.
- ✓ The students will learn about the OPAMP and its use as inverting, non-inverting amplifier, adder, subtractor, differentiator and integrator.
- ✓ The students will learn about some advanced topics of digital electronics including XOR gate, XNOR gates, half adder, full adder, product of sum (POS), sum of product (SOP) technique, and simplification of binary expressions using Karnaugh Map.
- ✓ The students will learn about the the communication principle including the basic idea about modulation and demodulation.
- ✓ The students will learn about the basic building blocks of computer, computer software, and operating systems (DOS, UNIX, WINDOWS).
- ✓ The students will learn the elementary programming with FORTRAN including flow chart, control statement, do loops, functions and subroutines, input output statements.
- ✓ The students will be able to write simple programs in FORTRAN such as
  - (i) To find the area of a circle.
  - (ii) To print out all natural even odd numbers between its limits.
  - (iii) To find the maximum, minimum and range of a set of numbers.
  - (iv) To evaluate mean of some numbers.
  - (v) To evaluate sum of finite series (simple series).

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Course Outcome (CO) for the Paper-IV(B) (Project)

- ✓ The students will be able to convert an ammeter into a voltmeter and a voltmeter into an ammeter.
- ✓ The students will be able to construct an adjustable voltage power supply using IC & to study its regulation.
- ✓ The students will be able to measure the internal resistance of an analog voltmeter and toincrease its internal
- ✓ resistance using on OPAMP.
- ✓ The students will be able to use OPAMP as inverting, non inverting, differential amplifier and as an adder.
- ✓ The students will be able to construct and verify the truth tables of half-adder and full-adder.
- ✓ The students will be able to write various computer program in FORTRAN.

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