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

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

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

Programme Specific Outcome (PSO)

The B.Sc. (General) in Physics (CBCS) program aims to provide introductory concepts in the subject of Physics covering most of the basic topics like Classical Mechanics, Electrodynamics, Thermal Physics and Statistical Mechanics, Waves and Optics. Moreover, students optionally learn some advanced concepts from the elective subjects such as Mathematical Physics, Quantum Mechanics, Modern Physics, Solid State Physics, Digital and Analog Circuits and Instrumentation and Nuclear & Particle Physics. The Skill Enhancement Courses (SEC) such as Computational Physics, Electrical Circuits and Network Skills, and Weather Forecasting provide hands on training of on various contemporary aspects in applied physics. 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: DSC-1AT (CC-1) (Mechanics)

- ✓ Students will learn the basic mathematical tools like concepts of vectors and vector algebra, ordinary differential equations of 1st and 2nd order. They will learn basics concepts of vector differentiation including gradient, divergence and curl of scalar/vector fields.
- ✓ Students will learn about inertial and non-inertial frames of references, Newton's laws of motion and its application in various dynamical problems having multiple masses. They also learn about the mechanics of a singe particle and mechanics of a system of particles.
- ✓ The students will learn the concept of centre of mass. They will be able to calculate the centre of mass of a system with discrete masses as well as of continuous mass distribution. While learning this, they will be able to tackle the evaluation of line, surface and volume integrals.
- ✓ The students will learn about the momentum and the conservation of momentum that follows from the Newton's laws.
- ✓ The students will learn about the concept of work done. For this, they will gain the knowledge of evaluating line integrals of vector fields followed by the Stokes theorem. They will learn about the conservative and non-conservative force field.
- ✓ The students will learn about the kinetic and potential energy as well as energy conservation.They will learn to apply these and Newton's laws to study the motion of rockets having time dependent mass.
- ✓ The students will learn about the angular velocity, angular momentum, conservation of angular momentum, and torque. They will learn about the rotational frame as non-inertial frame, and the concepts of centrifugal and centripetal force including applications such as banking of roads etc.

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- ✓ The students will learn about the Newton's law of gravitation and its universality. They will learn about the more general concepts of central force field emphasizing on the special case of inverse square laws (such as the gravitation). They will learn about the plane motion of a particle moving in a central force field in which the angular momentum vis-a-vis areal velocity of the particle are conserved.
- ✓ The students will learn the Kepler's laws of planetary motion and its deduction from the Newton's laws. They will be able to apply the theoretical and mathematical tools to study the motion of the planets and satellites in circular and geosynchronous orbits.
- ✓ The students will learn about the concept of weightlessness in a free falling frame. They will learn about the basics of the global positioning system (GPS).
- ✓ The students will learn about the simple harmonic motion, and the differential equation for the same (equation of motion). They will be able to solve the equation of motion which is second order ordinary differential equation using Frobenius method as well as trial solution method.
- ✓ The students will be able to calculate the time dependence of the kinetic and potential energy of a simple harmonic oscillator (SHO). They will learn about the conservation of total energy of a SHO.
- ✓ The students will be able to formulate the differential equation of a damped oscillator and solve the same. They will understand about the concepts of over-damped, critically damped and under-damped motions of such a oscillator under different conditions.
- ✓ The students will learn about the Hooke's law in elasticity and stress-strain diagrams. They will learn about different elastic constants such as the Young's modulus (Y), modulus of rigidity (n), bulk modulus (k) and Poisson's ratio (σ). They will be able to derive the relationship among elastic constants Y, n, k and σ. They will learn about the range of Poisson's ratio: $-1 < \sigma < 0.5$.
- ✓ The students will learn about the strain energy and will be able to calculate the work done in stretching and twisting of wire.
- ✓ The students will learn about the twisting couple of a cylinder. They will be able to calculate the rigidity modulus by static torsion. They will learn about torsional pendulum.
- ✓ The students will be able to determine the rigidity modulus and moment of inertia by Searle's method.
- ✓ The students will learn about the basics of special theory of relativity (STR) including the constancy of speed of light, postulates of STR. They will know about the phenomena of length contraction and time dilation including experimental evidence of muon decay. They will also be able to add two relativistic velocities.

Course Outcome (CO) for the Paper: DSC-1AP (CC-1) (Mechanics)

- ✓ The students will be able to measure the length (or diameter) using vernier caliper, screw gauge and travelling microscope.
- ✓ The students will be able to determine the Height of a Building using a Sextant.
- ✓ The students will be able to determine the Moment of Inertia of a Flywheel.
- ✓ The students will be able to determine the Young's Modulus of a Wire by Optical Lever Method.
- ✓ The students will be able to determine the Modulus of Rigidity of a Wire by Maxwell's needle.
- ✓ The students will be able to determine the Elastic Constants of a Wire by Searle's method.
- ✓ The students will be able to determine g by Bar Pendulum.
- ✓ The students will be able to determine g by Kater's Pendulum.
- ✓ The students will be able to determine g and velocity for a freely falling body using Digital Timing Technique.
- ✓ The students will be able to study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g.

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Course Outcome (CO) for the Paper: DSC-1BT (CC-2) Electricity and Magnetism

- ✓ The students will learn about the basics of vector algebra including scalar and vector product, gradient of a scalar field, divergence, curl of vector fields and their physical significance. They will learn about the vector Integration including the line, surface and volume integrals of vector fields. They will be able to apply the Gauss's divergence theorem and Stoke's theorem in vector Integration.
- ✓ The students will learn about basic electrostatics containing discrete and continuous charge distribution, Coulomb's law, electric field and electric flux. They will learn about the Gauss's theorem of electrostatics. They will be able to apply the Gauss's theorem to calculate the electric field due to symmetric charge distribution like point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet.
- ✓ The students will learn about the properties of a conductor and electric dipole.
- ✓ The students will learn about the electric potential as line integral of electric field. They will be able to calculate the electrostatic potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere.
- ✓ The students will be able to calculate the electric field from potential by taking gradient.
- ✓ The students will learn about the capacitance of an isolated spherical conductor. They will learn about parallel plate, spherical and cylindrical condenser/capacitor and the energy stored in the capacitor.
- ✓ The students will be able to calculate the energy density of an electrostatic field.
- ✓ The students will learn about the electrostatic in a medium in particular a dielectric medium. They will learn about the polarization, displacement vector, and Gauss's theorem in dielectrics.
- ✓ The students will learn about the magnetostatics including the Biot-Savart's law and its applications to calculate the magnetic field due to steady currents in straight conductor, circular coil and solenoid.
- ✓ The students will be able to calculate the divergence and curl of magnetic field. They will learn about the magnetic vector potential. and Ampere's circuital law.
- ✓ The students will learn about the magnetic properties of materials including the magnetic intensity, magnetic induction, permeability, and magnetic susceptibility.
- ✓ The students will learn about various magnetic materials such as the diamagnetic, paramagnetic, ferromagnetic and anti-ferromagnetic materials.
- ✓ The students will learn about basics of electrodynamics including the Faraday's laws of electromagnetic induction and Lenz's law. They will learn about the self and mutual inductance. They will be able to calculate the energy stored in magnetic field.
- ✓ The students will learn about the Maxwell's equations and electromagnetic wave propagation including the Equation of continuity for charges in motion, displacement current, Maxwell's equations and Poynting vector. They will be able to calculate the energy density of a electromagnetic field.
- ✓ The students will learn about the electromagnetic wave propagation through vacuum and isotropic electric medium. They will know about the transverse nature of electromagnetic wave. They will also know about the polarization of electromagnetic wave like plane and circular polarization.

Course Outcome (CO) for the Paper: DSC-1BP (CC-2): Electricity and Magnetism

- ✓ The students will be able to use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
- ✓ The students will be able to use Ballistic Galvanometer for the (i) measurement of charge and current sensitivity, (ii) measurement of CDR, (iii) determination of a high resistance by Leakage Method, and (iv) determination of Self Inductance of a Coil by Rayleigh's Method.
- ✓ The students will be able to compare capacitances using De'Sauty's bridge.
- ✓ The students will be able to measure the field strength B and its variation in a Solenoid (determination of dB/dx).
- ✓ The students will be able to study the Characteristics of a Series RC Circuit.

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- ✓ The students will be able to study the a series LCR circuit and determine its (a) resonant Frequency, and (b) Quality Factor.
- ✓ The students will be able to study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
- ✓ The students will be able to determine a Low Resistance by Carey Foster's Bridge.
- ✓ The students will be able to verify the Thevenin and Norton theorem.
- ✓ The students will be able to verify the superposition, and maximum power transfer theorem.

Course Outcome (CO) for the Paper: DSC-1CT (CC-3) Thermal Physics and Statistical Mechanics

- ✓ The students will learn about the basic thermodynamic description of system including the Zeroth Law of thermodynamics, concepts of temperature, first law of thermodynamics and internal energy.
- ✓ The students will learn about the conversion of heat into work and various thermodynamical processes like expansion/compression of gas, magnetizing of material, expansion of thin films etc.
- ✓ The students will be able to apply the first law of thermodynamics to calculate various bulk properties of system.
- ✓ The students will learn about the general relation between specific heats C_P and C_V. They will be able to calculate the work done during isothermal and adiabatic processes. They will learn about compressibility and expansion coefficient of a gas.
- ✓ The students will learn about the reversible and irreversible processes. They will learn about the second law of thermodynamics (various statements) and the concept of the entropy including the entropy changes in reversible and irreversible processes.
- ✓ The students will learn about the Carnot's cycle and Carnot theorem. They will be able to interpret the Entropy-temperature (T-S) diagrams.
- ✓ The students will learn about the third law of thermodynamics including the unattainability of absolute zero temperature.
- ✓ The students will learn about the thermodynamic potential, enthalpy, Gibbs free energy, Helmholtz free energy and Internal Energy functions. They will learn about the Maxwell's relations and their applications.
- ✓ The students will learn about the Joule-Thompson Effect, Clausius-Clapeyron equation. They will be able to derive expressions of different thermodynamic quantities such as difference and ratio of specific heats, TdS equations.
- ✓ The students will learn about the kinetic theory of gases including the derivation of Maxwell's law of velocity distribution and energy distribution. They will be able to calculate the mean velocity, most probable velocity and r.m.s. velocity.
- ✓ The students will learn about the concept of mean free path. They will be able to understant the various transport phenomena and will be able to calculate the transport coefficients like viscosity, conductivity and diffusion coefficients using a simplistic Drude type model.
- ✓ The students will learn about law of equipartition of energy and its applications to specific heats of monoatomic and diatomic gases. They will be able to calculate the degree of freedom of thermodynamic system.
- ✓ The students will learn about the theory of radiation including the blackbody radiation and its spectral distribution. They will learn about the Wien's distribution law and Rayleigh-Jeans Law failing to describe the experimental blackbody spectrum. They will learn about the Stefan Boltzmann Law.
- ✓ The students will learn about the Planck's law of blackbody radiation, and they will be able to derive the Wien's law and Rayleigh-Jeans laws from Planck's law in appropriate limit.
- ✓ The students will learn the basics of statistical mechanics including the concepts of the phase space, macrostate, microstate and ensembles. They will learn the basic relations between the thermodynamics (entropy) and the number of microstates (Boltzmann hypothesis). They will be able to derive the Maxwell-Boltzmann statics from maximizing the entropy vis-a-vis number of microstates for equilibrium system in microcanonical ensemble.

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- ✓ The students will learn about the quantum statistics including the Fermi-Dirac and Bose-Einstein distribution and their application on electron gas and photon gas at particular temperature. They will know about chemical potential and Fermi-level for a Fermionic quantum system. They will know about the Bose-Einstein condensation.

Course Outcome (CO) for the Paper: DSC-1CP (CC-3) Thermal Physics and Statistical Mechanics

- ✓ The students will be able to determine Mechanical Equivalent of Heat by Callender and Barne's constant flow method.
- ✓ The students will be able to measure the Planck's constant using black body radiation.
- ✓ The students will be able to determine Stefan's Constant.
- ✓ The students will be able to determine the coefficient of thermal conductivity of copper by Searle's apparatus.
- ✓ The students will be able to determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
- ✓ The students will be able to determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
- ✓ The students will be able to determine the temperature co-efficient of resistance by Platinum resistance thermometer.
- ✓ The students will be able to study the variation of thermo emf across two junctions of a thermocouple with
- ✓ temperature.
- ✓ The students will be able to record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
- ✓ The students will be able to calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Course Outcome (CO) for the Paper: DSC-1DT (CC-4) Waves and Optics

- ✓ The students will learn about the superposition of two collinear harmonic oscillators including the concepts of linearity and superposition principle corresponding to the (i) oscillations having equal frequencies and (ii) oscillations having different frequencies (formation of beats).
- ✓ The students will learn about the superposition of two perpendicular harmonic oscillators including the graphical and analytical methods. They will know about the Lissajous figures with equal an unequal frequency and their uses.
- ✓ The students will learn about the transverse waves on a string, travelling and standing waves on a string, the normal modes of a string, formation of nodes and anti-nodes.
- ✓ The students will learn about the concepts of group velocity and phase velocity. They will know about the plane waves, spherical waves and wave intensity.
- ✓ The students will learn about the basics of fluid mechanics including the surface tension, synclastic and anticlastic surface, and excess of pressure. They will be able to solve mathematical problems related to spherical and cylindrical drops and bubbles.
- ✓ The students will learn about variation of surface tension with temperature and Jaegar's method.
- ✓ The students will learn about the viscosity of fluid including the calculation of rate of flow of liquid in a capillary tube (Poiseuille's formula). They will be able to determine the coefficient of viscosity of a liquid.
- ✓ The students will learn about the variations of viscosity of a liquid with temperature.
- ✓ The students will learn about the physics of low pressure including the production and measurement of low pressure rotary pump, diffusion pump, molecular pump, Knudsen absolute gauge, penning and pirani gauge.
- ✓ The students will learn about basics of acoustics and sound including the simple harmonic motion, forced vibrations and resonance. They will know the Fourier's theorem and Fourier series. They will be able to obtain the Fourier series of elementary periodic functions such as the saw tooth wave and square wave, etc.

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- ✓ The students will learn about the intensity and loudness of sound, their measurement in decibels. They will know about the intensity levels, musical notes and musical scale.
- ✓ The students will learn about acoustics of buildings including reverberation and time of reverberation, absorption coefficient and Sabine's formula to measure the reverberation time. They will know about the acoustic aspects of halls and auditorium.
- ✓ The students will learn about about the wave optics including the electromagnetic nature of light, definition and properties of wave front and corresponding Huygens principle. They will be able to apply the Huygens principle to arrive at the laws of reflection and refraction.
- ✓ The students will learn about the interference including division of amplitude and division of wavefront. They will know about the Young's double slit experiment, Lloyd's mirror and Fresnel's Biprism. They will be able to calculate the phase change on reflection applying the Stokes relation. They will learn about the interference in thin films including the parallel and wedge-shaped films.
- ✓ The students will learn about the fringes of equal inclination (Haidinger Fringes) and fringes of equal thickness (Fizeau fringes). They will know about the Newton's Rings and how to measure the wavelength and refractive index using Newton's Rings.
- ✓ The students will learn about the Michelson's interferometer and its application to determine the wavelength, wavelength difference, refractive index.
- ✓ The students will learn about the diffraction phenomena including the Fraunhofer diffraction in single slit, double slit, multiple slits and diffraction grating. They will also learn about the Fresnel diffraction including the half-period zones and zone plate. They will know about the Fresnel diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.
- ✓ The students will learn about the polarization including the concepts of transverse nature of light waves, plane, circular and elliptical polarization of electromagnetic waves. They will also know about the production and analysis of plane polarized light.

Course Outcome (CO) for the Paper: DSC-1DP (CC-4) Waves and Optics

- ✓ The students will be able to investigate the motion of coupled oscillators.
- ✓ The students will be able to determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 –T Law.
- ✓ The students will be able to study Lissajous Figures.
- ✓ The students will get familiar with Schuster's focussing and will be able to determine the angle of prism.
- ✓ The students will be able to determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
- ✓ The students will be able to determine the Refractive Index of the Material of a given Prism using Sodium Light.
- ✓ The students will be able to determine Dispersive Power of the Material of a given Prism using Mercury Light.
- ✓ The students will be able to determine the value of Cauchy Constants of a material of a prism.
- ✓ The students will be able to determine the Resolving Power of a Prism.
- ✓ The students will be able to determine wavelength of sodium light using Fresnel Biprism.
- ✓ The students will be able to determine wavelength of sodium light using Newton's Rings.
- ✓ The students will be able to determine the wavelength of LASER light using diffraction of single slit.
- ✓ The students will be able to determine wavelength of (i) sodium and (ii) spectrum of Mercury light using plane diffraction grating.
- ✓ The students will be able to determine the resolving power of a plane diffraction grating.
- ✓ The students will be able to measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

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Course Outcome (CO) for the Paper: DSE1T - Elements of Modern Physics

- ✓ The students will learn about the concepts of Planck's quantum and the light as a collection of photons. They will know about the photo-electric effect and Compton scattering.
- ✓ The students will learn about the wave-particle duality, de-Broglie hypothesis, and concepts of wavelength and matter waves. They will know about the Davisson-Germer experiment.
- ✓ The students will learn about the atomic structure including the Rutherford model and its problems owing to the instability of atoms and observation of discrete atomic spectra. They will know the Bohr's quantization rule and atomic stability. They will be able to calculate the energy levels for hydrogen like atoms and their spectra.
- ✓ The students will learn about the position measurement and gamma ray microscope gedanken/thought experiment, Heisenberg uncertainty principle and impossibility of a particle following a particular trajectory. They will be able to estimate the minimum momentum/energy of a confined particle using uncertainty principle. They will also learn about the energy-time uncertainty principle and its application.
- ✓ The students will learn about the two slit interference experiment with photons, atoms and particles. They with know about the linear superposition principle, matter waves and wave amplitude.
- ✓ The students will learn about the Schrodinger equation for non-relativistic particles, momentum and energy operators and stationary states. They will know the physical interpretation of wave function in terms of probabilities, normalization of wave function, continuity equation and the probability current densities in one dimension. They will learn about expectation values.
- ✓ The students will be able to solve Schrodinger equation for single particle in one dimensional infinitely rigid box and obtain energy eigenvalues and normalized eigen functions. They will know about orthonormality of the eigen functions. They will learn the basics of quantum dot
- ✓ The students will be able to solve Schrodinger equation for single particle moving in one dimension across a step potential and across a rectangular potential barrier and know about the quantum mechanical scattering and tunneling.
- ✓ The students will learn about the basics of nuclear physics including the size and structure of atomic nucleus and its relation with atomic weight. They will know about the impossibility of an electron to stay inside the nucleus as a consequence of the uncertainty principle.
- ✓ The students will learn about the nature of nuclear force, N-Z graph, semi-empirical mass formula and binding energy of a nucleus.
- ✓ The students will learn about the basics of radioactivity including stability of nucleus, law of radioactive decay, mean life and half-life. They will know about α decay, β decay and γ decay including their energy spectrum. They will learn about the Pauli's prediction of neutrino from the analysis of β-spectrum.
- ✓ The students will learn about the basics of fission and fusion including the mass deficit, relativity and generation of energy. They will know about the nature of fragments and emission of neutrons in fission events.
- ✓ The students will learn about the nuclear reactor including slow neutrons interacting with Uranium-235. They will know about the fusion and thermonuclear reactions.

Course Outcome (CO) for the Paper: DSE1P - Elements of Modern Physics

- ✓ The students will be able to determine value of Boltzmann constant using V-I characteristic of PN diode.
- ✓ The students will be able to determine work function of material of filament of directly heated vacuum diode.
- ✓ The students will be able to determine value of Planck's constant using LEDs of at least 4 different colours.
- ✓ The students will be able to determine the ionization potential of mercury.
- ✓ The students will be able to determine the wavelength of H_α emission line of Hydrogen atom.
- ✓ The students will be able to determine the absorption lines in the rotational spectrum of Iodine vapour.
- ✓ The students will be able to study the diffraction patterns of single and double slits using LASER source and measure its intensity variation using Photo-sensor and compare with incoherent source of sodium light.

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- ✓ The students will be able to study the photocurrent versus intensity and wavelength variation of light as well as maximum energy of photo-electrons versus frequency of light.
- ✓ The students will be able to determine the value of e/m by magnetic focusing.
- ✓ The students will be able to setup the Millikan oil drop apparatus and determine the charge of an electron.

Course Outcome (CO) for the Paper: DSE-2T: Solid State Physics

- ✓ The students will learn about the crystal Structure including concepts of amorphous and crystalline materials. They will know about the lattice, basis, unit cell and lattice translation vectors. They will also learn about the central and non-central elements.
- ✓ The students will learn about the Miller indices including various notations for planes, directions and set of them. They will know about 14 different types of Bravais lattices.
- ✓ The students will learn about the reciprocal lattice, Brillouin zones, and calculations of reciprocal lattice for SC, BCC and FCC lattices. They will know about the diffraction of X-rays by crystals including the Bragg's law. They will also learn about the atomic and geometrical factor.
- ✓ The students will learn about the elementary lattice dynamics including the lattice vibrations and phonons. They will be able to calculate the dispersion relations of vibrations in linear monoatomic and diatomic chains. They will know about the acoustical and optical phonons.
- ✓ The students will learn about some of the qualitative description of the phonon including the spectrum in solids They will know about the Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids and Debye's T^3 law.
- ✓ The students will learn about the magnetic properties of matter including various types of magnetic materials such as the diamagnetic, paramagnetic, Ferrimagnetic and Ferromagnetic Materials.
- ✓ The students will learn about the classical Langevin Theory of diamagnetic and paramagnetic domains and they will be able to calculate magnetic susceptibility using the Langevin Theory. They will also know about the quantum mechanical treatment of paramagnetism.
- ✓ The students will learn about the Curie's law, Weiss's Theory of ferromagnetism and ferromagnetic domains. They will know about the B-H Curve, hysteresis loop and energy loss.
- ✓ The students will learn about the basics of dielectric properties of materials including the concepts of polarization. local electric field, depolarization field and electric susceptibility. They will know about the polarizability and will be able to derive the Clausius Mosotti Equation.
- ✓ The students will learn about the classical theory of electric polarizability including the normal and anomalous dispersion, Cauchy and Sellmeir relations. They will know about the Langevin-Debye equation, complex dielectric constant, optical phenomena. They will be able to apply these to understand the plasma oscillations, plasma frequency and plasmons.
- ✓ The students will learn about the elementary band theory including the Kronig Penny model for a Dirac comb like potential in one dimension. They will learn about the band/forbidden gaps in band structure.
- ✓ The students will learn about the conductors, semiconductors and insulators in light of band theory. They will know about the intrinsic and extrinsic semiconductors, dopping, p and n type semiconductors, and mobility of charge carriers. They will be able to calculate the conductivity of semiconductors ,
- ✓ The students will learn about the Hall Effect. They will be able to calculate the Hall coefficients for p and n type intrinsic semiconductors.
- ✓ The students will learn about the superconductivity including some experimental results. They will know about the critical temperature and critical magnetic field. They will also learn about the Meissner effect.
- ✓ The students will learn about the Type-I and Type-II superconductors. They will be able to derive the London's equation. They will know about the penetration depth and the isotope effect.

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Course Outcome (CO) for the Paper: DSE-2P: Solid State Physics

- ✓ The students will be able to measure the susceptibility of paramagnetic solution (Quinck`s Tube Method)
- ✓ The students will be able to measure the Magnetic susceptibility of Solids.
- ✓ The students will be able to determine the Coupling Coefficient of a Piezoelectric crystal.
- ✓ The students will be able to measure the Dielectric Constant of a dielectric Materials with frequency
- ✓ The students will be able to determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR).
- ✓ The students will be able to determine the refractive index of a dielectric layer using SPR.
- ✓ The students will be able to study the PE Hysteresis loop of a Ferroelectric Crystal.
- ✓ The students will be able to draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
- ✓ The students will be able to measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe method and will be able to determine its band gap.
- ✓ The students will be able to determine the Hall coefficient of a semiconductor sample.

Course Outcome (CO) for the Paper: SEC-1T: Computational Physics

- ✓ The students will learn about the importance of computers in Physics, paradigm for solving physics problems for solution and usage of linux as an Editor.
- ✓ The students will learn about algorithm, its definition, properties and development. They will learn about flowchart, its various symbols, guidelines and types. They will be able to write algorithm and flowcharts for simple physical problems such as (i) Cartesian to spherical polar coordinates transformation, (ii) finding roots of quadratic qquation, (iii) finding sum of two matrices, (iv) finding sum and product of a finite series, (v) calculation of sin(x) as a series.
- ✓ The students will learn the algorithm for plotting (i) Lissajous figures and (ii) trajectory of a projectile thrown at an angle with the horizontal.
- ✓ The students will learn about some fundamental Linux commands (Internal and External commands).
- ✓ The students will learn about the development of FORTRAN, basic elements of FORTRAN such as character set, constants and their types, variables and their types, keywords, variable declaration and concept of instruction and program. They will know about the FORTRAN operators like arithmetic, relational, logical and assignment operators. They will know about the FORTRAN expressions like arithmetic, relational, logical, character and assignment expressions.
- ✓ The students will learn about the FORTRAN Statements of I/O, unformatted/formatted executable and non-executable statements. They will know about the layout of Fortran Program, format of writing program and concept of coding including the initialization and replacement logic.
- ✓ The students will learn about types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file.
- ✓ The students will learn about syntax on usage of FORTRAN, usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
- ✓ The students will be able to print out all natural even/ odd numbers between given limits.

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- ✓ The students will be able to find maximum, minimum and range of a given set of numbers.
- ✓ The students will be able to calculate the Euler number using exp(x) series evaluated at x=1.
- ✓ The students will learn about the TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, changing the type style, Symbols from other languages.
- ✓ The students will be able to use the TeX/LaTeX for writing formulae and equations, including figures and other floating bodies, lining in columns, Tabbing and creating tabular environment, generating table of contents, bibliography and citation, making an index and glossary, list making environments, fonts, picture environment and colors, errors.
- ✓ The students will learn about graphical analysis of data and its limitations and Gnuplot. They will know the importance of visualization of computational data.
- ✓ The students will learn about basic Gnuplot commands such as simple plots, plotting data from a file, saving and exporting, multiple data sets per file. They will be able to use Gnuplot for creating equations, building functions, user defined variables and functions.

Course Outcome (CO) for the Paper: SEC-1P: Computational Physics

- ✓ The students will be able to compile a frequency distribution and evaluate mean, standard deviation etc.
- ✓ The students will be able to evaluate sum of finite series and the area under a curve.
- ✓ The students will be able to find the product of two matrices
- ✓ The students will be able to find a set of prime numbers and Fibonacci series.
- ✓ The students will be able to write program to open a file and generate data for plotting using Gnu plot.
- ✓ The students will be able to plot trajectory of a projectile projected horizontally.
- ✓ The students will be able to plot trajectory of a projectile projected making an angle with the horizontally.
- ✓ The students will be able to create an input Gnuplot file for plotting a data and saving the output for seeing on the screen. The students will be able to save it as an .eps file and as a .pdf file.
- ✓ The students will be able to find the roots of a quadratic equation.
- ✓ The students will be able to study the motion of a projectile using simulation and plot the output for visualization.
- ✓ The students will be able to numerical solve the equation of motion of simple harmonic oscillator and plot the outputs for visualization.
- ✓ The students will be able to numerical solve the equation of motion of particle in a central force field and plot the output for visualization.

Course Outcome (CO) for the Paper: SEC2T: Electrical Circuits and Network Skills

- ✓ The students will learn about the basic electricity principles including the concepts of voltage, current, resistance, and Power. They will know about the Ohm's law, Series, parallel, and series-parallel combinations in circuits. They will learn the differences between the AC electricity and DC electricity. They will get familiar with instruments like multimeter, voltmeter and ammeter.
- ✓ The students will learn about the main electric circuit elements and their combination. They will know the rules to analyze DC sourced electrical circuits. They will be able to measure the current and voltage drop across the DC circuit elements. They will learn the differences between the single-phase and three-phase alternating current sources. They will know the rules to analyze AC sourced electrical circuits. They also learn about the real, imaginary and complex power components of AC source. They will be able to calculate the power factor of the circuits.

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- ✓ The students will be able to draw the symbols and blueprints of electrical circuits, read the schematics and ladder diagrams. They will know about the power circuits and control circuits. They will be able to read the circuit schematics, track the connections of elements and identify current flow and voltage drop.
- ✓ The students will learn about the DC power sources, AC/DC generators, inductance and the peration of the transformers.
- ✓ The students will learn about the single-phase, three-phase and DC motors including their basic designs. They will know about the interfacing DC or AC sources to control heaters and motors. They will learn about the speed and power of the AC motor.
- ✓ The students will learn about the solid state electronic devices including the resistors, inductors, capacitors, diode and rectifiers. They will know about using the electronic components in series or in shunt. They will also learn about the response of inductors and capacitors with DC or AC sources.
- ✓ The students will learn about the electrical protection including the concepts of relays, fuses, disconnect switches, and circuit breakers. They will know about the overload devices, ground-fault. They will learn about the grounding and isolating.
- ✓ The students will learn about the phase reversal, Surge protection. They will be able to control elements by interfacing DC or AC sources (relay protection device).
- ✓ The students will learn about basics of electrical wiring including the different types of conductors and cables, star and delta connection. They will be able to measure the voltage drop and losses across cables and conductors.
- ✓ The students will be able to use the instruments to measure current, voltage, and power in DC and AC circuits.
- ✓ The students will learn about the importance of insulation, solid and stranded cable, cable trays. They will be able to use splices including wire nuts, crimps, terminal blocks, split bolts, and solder. They will be able to prepare extension board from scratch.

Course Outcome (CO) for the Paper: SEC4T: Weather Forecasting

- ✓ The students will learn about the physical structure and composition of the atmosphere, and compositional layering of the atmosphere. They will know about the variation of pressure and temperature with height.
- ✓ The students will learn about the air temperature and atmospheric pressure and how to measure them. They will know about the temperature sensors. They will learn about the cyclones and anticyclones including their characteristics.
- ✓ The students will learn about wind and forces acting to produce wind. They will know about the wind speed direction including its magnitude and direction. They will learn about the humidity of air, clouds and rainfall.
- ✓ The students will learn about the radiation in atmosphere including absorption, emission and scattering and the corresponding radiation laws.
- ✓ The students will learn about the global wind systems, air masses and fronts. They will be know about the jet streams, local thunderstorms and tropical cyclones including the tornadoes and hurricanes.
- ✓ The students will learn about the climate including its classification. They will know about the causes of climate change, global warming and its outcomes. They will learn about the environmental issues related to climate such as the air pollution, aerosols, ozone depletion and acid rain.
- ✓ The students will learn about the basics of weather forecasting including the analysis and its historical background. They will know about the types of weather forecasting, weather forecasting methods, criteria of choosing weather station and basics of choosing site and exposure.
- ✓ The students will learn about the satellites observations in weather forecasting and weather maps. They will know about the uncertainty and predictability of the forecasts.

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Course Outcome (CO) for the Paper: SEC4P: Weather Forecasting

- ✓ The students will be able to study of synoptic charts & weather reports, working principle of weather station.
- ✓ The students will be able to process and analysis the weather data and
  (i) calculate the sunniest time of the year,
  (ii) study the variation of rainfall amount and intensity by wind direction,
  (iii) observe the sunniest/driest day of the week,
  (iv) examine the maximum and minimum temperature throughout the year,
  (v) evaluate the relative humidity of the day,
  (vi) examine the rainfall amount month wise.
- ✓ The students will be able to plot the constant pressure charts, surfaces charts, upper wind charts and analyse them.

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