Programme Outcome of Physics Honours (CBCS), University of Calcutta

The Physics Department offers UG physics honours and general programs. The honours program covers topics like Quantum Mechanics, Electricity and Magnetism, Optics, Mathematical Physics, Thermal Physics, Electronics, Statistical Mechanics, Solid State Physics etc. Apart from these we also offer specific elective course on Astronomy and Astrophysics, Laser and Fiber Optics etc. The students also learn advance scientific programing in Python and also scientific writing in LaTeX. We also conduct weekly student seminars and encourage them to participate in seminar, quiz etc. All these enhances the students' skill for communication, problem-solving and logical reasoning.

After obtaining their degree from this department, a large number of students enter into various universities to pursue masters' degree in Physics, Material Sciences, Data Science, etc. Some students also take admission in B.Tech, M.C.A., B.Ed. etc. Many students from our department are in service as school teacher, college professor as well as pursuing active research activity in research institutes of repute besides following other professions. The students from our department can also appear in various competitive examinations like SSC, JAM, JEST, NET, GATE, SET etc.

Course Outcomes of Physics (Honours and General)

Program: B. Sc. Physics (Hons.); **Program Code**: PHSA

Semester	Course Name	Course Code	Credit	Marks	Course outcome
I	Mathematical Physics I	PHSA-CC-1	6 [Theory: 4 Practical: 2]	100	After completion of this course student should be able to learn the basics of mathematical techniques such as vector algebra, vector calculus, infinite series, partial derivatives, differential equations, plotting of graphs etc. He/she will study the matrix algebra in details and its applications in solving differential equations. This course has been formulated in such a way that it will help him/her to work out the mathematics behind different physics problems which he/she will encounter later in the undergraduate course. In the practical part, the student will learn a very powerful yet easy-to-learn programming language PYTHON. He/she will do basic programming using python like sorting different numbers, finding roots of an equation, solving ordinary differential equations, matrix operations. The student will also learn and use plotting software named GNUPLOT to visualize and plot the data. This practical course has an excellent one-to-one correspondence with what he/she learns in the theory portion.
I	Mechanics	PHSA-CC-2	6 [Theory: 4 Practical: 2]	100	After going through the course, the student should be able to understand the concept of Newtonian Mechanics and its application to various dynamical systems. He/she will learn the basics of energy-momentum conservation, central force problems, Gravitation and apply them to basic problems. The student will learn about the rotational dynamics of rigid body problems as well as the simple principles of fluid dynamics. In the laboratory course the students will first revamp their experimental skills using some of the basic tools for measuring

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					length like vernier caliper, screw gauge and traveling microscope, as well as the concept of different errors introduced in different instruments. Then he/she will do some basic mechanical experiments to determine moment of inertia, Young modulus, value of acceleration due to gravity, height of a building etc.
II	Electricity and Magnetism	PHSA-CC-3	6 [Theory: 4 Practical: 2]	100	This course will help students in understanding basic concepts of electricity and magnetism and their applications. The student will learn electric field, potential, application of Gauss's law to solve a variety of problems. He/she will understand the concepts of dielectric properties of matter, magnetic field, magnetic properties of matter, electromagnetic induction and electrical circuits. In the laboratory course the student will get an opportunity to learn different measurement techniques of various quantities related to electricity and magnetism. List of practicals includes how to determine low resistance using Potentiometer, and Carey Foster bridge, study of LCR circuit, mutual inductance between two coils and determination of horizontal component of the Earth's magnetic field.
II	Waves and Optics	PHSA-CC-4	6 [Theory: 4 Practical: 2]	100	In this course the student will develop an understanding of various aspects of harmonic oscillations and waves specially superposition of collinear and perpendicular harmonic oscillations, various types of mechanical waves and their superposition, phase and group velocities. This course in basics of optics will enable the student to understand various optical phenomena, principles, workings and applications optical instruments. In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. He/she will learn how to determine the thickness of a thin paper, to determine the frequency of an electric tuning fork by Melde's experiment. The laboratory

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					course also includes the study of variation of refractive index of the material of a prism with wavelengths and the measurement of the spacing between the adjacent slits in a grating. All these practicals will strengthen his/her knowledge of understanding the theory behind this topic.
III	Mathematical Physics II	PHSA-CC-5	6 [Theory: 4 Practical: 2]	100	This course focuses to develop the basic knowledge in Mathematical Physics. The content of course is very important to qualify the NET, SET and other job oriented examinations for Physics Honours students. The knowledge and conception about the course topics are also essential to understand the higher level physics and engineering. In this course the students learn the Fourier analysis of different periodic functions and their applications in physical problems. They learn about the special functions, such as the Hermite polynomial, Legendre polynomial, the Bessel functions etc. and also their applications in various physical problems. The students also learn some special integrals the beta function, gamma functions and the error functions and their applications. They learn different methods to solve partial differential equations with examples of some important partial differential equations in Physics. They revise the knowledge of probability and probability distribution; acquire knowledge about probability distribution functions, binomial, Gaussian, and Poisson distribution. These basic mathematical structures are essential in solving problems in various branches of Physics. In the practical course, the students learn the fundamentals of the Numerical Python (NumPy) and Scientific Python (SciPy), which are very important for scientific computing. They learn applications of NumPy and SciPy in interpolation, numerical integration, solution of differential equations, curve fitting etc. The students also learn the Mathplotlib which is very useful for data visualization and graph plotting.

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III	Thermal Physics	PHSA-CC-6	6 [Theory: 4 Practical: 2]	100	After the successful completion of the course the students are expected to learn the basic concepts of thermodynamics, the laws of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations, Maxwell's thermodynamic relations. They also learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, thermal conductivity, diffusion and Brownian motion. The students learn about the real gas equations, Van der Waal equation of state, the Joule-Thompson effect, conduction of heat, thermal conductivity, Fourier's equation for heat conduction and its solution. In the laboratory course the students do some basic experiments in thermal physics, and learn how to measure the (i) coefficient of thermal expansion of a metallic rod using an optical lever, (ii) coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method, (iii) boiling point of a liquid using platinum resistance thermometer, and (iv) temperature coefficient of resistance using Carey Foster bridge. The students also learn to calibrate a thermocouple by directly measuring the thermo-emf using a potentiometer.
III	Modern Physics	PHSA-CC-7	6 [Theory: 4 Practical: 2]	100	In this course the students learn the inadequacies of classical mechanics, understand historical development of quantum mechanics and experiments that reveal the dual nature of matter. They learn the theory of quantum measurements, wave packets, and uncertainty principle. They understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, Schrodinger equation, probability density and normalization techniques. They acquire skills on problem solving e.g. one dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier etc. In addition to these the students also study the properties of nuclei like density, size, binding energy, nuclear forces and structure of nucleus, nuclear liquid drop model, shell model, neutrinos and its

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					role in of beta decay, nuclear fission and fusion. They learn to calculate the decay rates and lifetime of radioactive decays like beta and gamma decay. The students are able to understand the spontaneous and stimulated emission of radiation, basic lasing, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser and their working principle. In the practical course, the students get the opportunity to perform few advanced experiments: (i) measurement of Plank constant using LED, (ii) verification of Stefan's law of radiation using a bulb glowing beyond the draper point, (iii) measurement of e/m of electrons by using bar magnet, (iv) verification of photoelectric effect and (v) study the tunneling effect using I-V characteristics of a tunnel diode.
III	Scientific Writing	PHSA-SEC-A1	2 [Theory: 1 Project: 1]	100	The students will learn scientific word processing using the LaTeX software which is very useful in writing articles including mathematical equations and diagrams. They learn to use packages like amsmath, amssymb, graphics, graphicx, geometry, algorithms, color, hyperref etc. The students also acquire the proficiency in effectively using the GUI Windows, the LINUX operating system and also in using the LaTeX software for wring a text file. The students learn about LaTeX word processor, preparing LaTeX input file, compiling LaTeX File, LaTeX tags for creating different environments, defining LaTeX commands and environments. They also learn about document classes, changing the type style, symbols from other languages, page layout, equation representation, addition of tables and figures, generating table of contents, bibliography and citation, etc. For the project work the students get sufficient knowledge about LaTeX so that after finishing the course they are able to write articles, research papers, reports, mathematical equations, simple resume, and documentation of experiments done in laboratory with

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					results, tables and graphs. The students also learn the basics of gnuplot.
IV	Mathematical Physics III	PHSA-CC-8	6 [Theory: 4 Practical: 2]	100	In this course the students will learn about the complex numbers and their properties, graphical representation of complex number, Euler's formula, root of complex numbers, function of complex variables, analyticity, poles and residues. The students are expected to learn the residue theorem and its applications in evaluating definite integrals. The student will also understand variational calculus, variational principle and apply it to simple systems. They will learn basic ideas of functionals, Lagrangian formulation, Euler's equations and apply it simple problems. They will acquire basic concept of cyclic coordinates, symmetries and conservation laws, Legendre transformations, Hamiltonian formulation, canonical equations of motion etc. They will recapitulate and learn the special theory of relativity, Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant, length contraction, time dilation, mass-energy relation, problems involving energy momentum conservations. The students will also understand space-time diagrams, proper time and proper velocity, and Minkowski force. In the laboratory course, the students will learn to apply their knowledge in computer programming language to solve few problems: (i) solution of first and second order ordinary differential equations with appropriate boundary conditions, (ii) solution of some basic partial differential equations, (iii) evaluation of the Gaussian integrals, (iv) evaluation of a converging infinite series up to a desired accuracy, (v) evaluation of the Fourier coefficients of a given periodic function, (v) plotting and verification of the properties of few special functions.

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IV	Analog Electronics	PHSA-CC-9	6 [Theory: 4 Practical: 2]	100	After going through the course, the students should be able to apply various network theorems such as the superposition, Thevenin, Norton, reciprocity, maximum power transfer theorem in electrical circuit analysis. They expected to acquire basic knowledge of the N and P type semiconductors, mobility, drift velocity, fabrication of PN junctions, forward and reverse biased junctions, application of PN junction for different type of rectifiers and voltage regulators. They will get basic idea about the working principle and structure of LED, photodiode, solar cell and varactor diode. They will learn about NPN and PNP transistors and basic configurations namely common base, common emitter and common collector; and also about current and voltage gain, biasing and equivalent circuits; basic structure, principle of operations and characteristics of field effect transistors; coupled amplifiers and feedback in amplifiers. The students are also expected to learn about the operational amplifiers, application of OPAMP in different configurations namely inverting and non-inverting amplifiers, inverting and non-inverting adder, differentiator as subtractor, logarithmic and anti-logarithmic amplifiers, comparator, Schmidt trigger, integrator and differentiator. The students will learn about multivibrators; construction and operation of bistable, monostable and astable multivibrator circuits; oscillators, Barkhausen's Criterion for self-sustained oscillations, RC phase shift oscillator, Wein-bridge oscillator, Hartley's and Colpitt's oscillators, and Relaxation oscillator using OPAMP. In the laboratory course, the students will (i) study the reverse characteristics, load regulation and line regulation of Zener diode; (ii) study the static characteristics of BJT in CE configuration and frequency response of BJT amplifier in CE mode; (iii) study OPAMPs as inverting amplifier, non-inverting amplifier, adder, subtractor, comparator, Schmitt trigger, integrator, differentiator, and relaxation oscillator; (iv) construction of series regulated power supply from an unregulated power supply; and (v) design a Wien bridge oscillator using OPAMP.

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IV	Quantum Mechanics	PHSA-CC-10	6 [Theory: 4 Practical: 2]	100	In this course the students will learn more about different topics of quantum mechanics, description of particle using wave packets, Fourier transforms and momentum space wave-function, position-momentum uncertainty, continuity of wave function, boundary condition and emergence of discrete energy levels. They learn about the quantum mechanics of simple harmonic oscillator, setting up the eigenvalue equation for the Hamiltonian, ground state, zero point energy and uncertainty principle. The students also get knowledge about the time independent Schrodinger equation for a particle moving under a central force, the Schrodinger equation in spherical polar coordinates. Through understanding the behavior of quantum particle encountering a i) barrier, ii) potential, the student gets exposed to solving non-relativistic hydrogen atom, for its spectrum and eigen-functions. In this course they also study electron's magnetic moment and spin angular momentum, gyromagnetic ratio, Bohr magneton, Lande g factor, Larmor's theorem, Stern-Gerlach Experiment. The study of influence of electric and magnetic fields on atoms helps in understanding Stark effect and Zeeman Effect respectively. This basic course will form a firm basis to understand quantum many body problems. This course will develop an understanding of how to model a given problem such as particle in a box, hydrogen atom, hydrogen atom in electric fields, many electron atoms, L-S and J-J couplings. These will help the students in understanding the different quantum systems in atomic and nuclear physics. In the laboratory course, with the exposure in computational programming in the computer lab, the student will be in a position to find the eigenvalues of the bound state particle in a one-dimensional potential well and to plot the eigen-functions, use of shooting algorithm for solving bound state problems for Harmonic oscillator, Morse potential, triangular well etc. The students will also study the time evolution of a wave packet moving in free space by the numerical solution of the time dependent Scrödinger

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					equation.
IV	Arduino	PHSA-SEC-B1	2 [Theory: 1 Project: 1]	100	This course will enable the students to learn basics of Arduino, programming, and they will also get familiar with Arduino boards. They will learn the brief history of the Arduino, open-source electronics prototyping, setting up Arduino board, installation of Arduino Integrated Development Environment (IDE) in PC/ laptop for Arduino programming. In Arduino programming they will learn Arduino data types, variables and constants, operators, control statements, loops, functions, string, etc. They also expected to learn interfacing the Arduino boards for serial communication, digital and analog input/output, getting input from temperature and ultrasonic sensor etc. For the project work the students get sufficient knowledge about Arduino boards and Arduino programming, so that after finishing the course they can do the following projects: (i) LED blinking and fading, (ii) measurement of voltages, (iii) interfacing 7-segment display, (iv) construction of thermometer using a temperature sensor, (v) construct experimental set up for studying simple pendulum and hence determine the acceleration due to gravity, and (vi) construct data logger for studying charging and discharging of RC circuit.
V	Electromagnetic Theory	PHSA-CC-11	6 [Theory: 4 Practical: 2]	100	Course Outcome (Theory) 1. Understand the basic mathematical concepts related to electromagnetic vector fields. 2. Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density. 3. Understand the concepts related to Faraday‘s law, induced emf and Maxwell‘s equations. 4. Understand the unification of electric and magnetic fields and apply Maxwell‘s equations to solutions of problems relating to transmission lines and uniform plane wave propagation. 5. Ability to describe and make calculations of plane electromagnetic waves in homogeneous media, including

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					reflection of such waves in plane boundaries between homogeneous media. 6. Distinguish the different types of aberrations and achromatism and Use different types of eyepieces according to their application. 7. Calculate wavelength difference and fringe width from the interference pattern and. explain diffraction pattern and calculate dispersive power of the grating. <u>Course Outcome (Practical)</u> 1. Students will be able to identify, formulate and solve the problems to dispersive power and resolving power of a plane diffraction grating. 2. To introduce the concepts of Fresnel's formula they will be able to study Fresnel's law by the reflection on the surface of a prism
V	Statistical Physics	PHSA-CC-12	6 [Theory: 4 Practical: 2]	100	<u>Course Outcome (Theory)</u> 1. In this course the statistical description, quantum statistics of ideal gases, irreversible processes and fluctuations are dealt with. 2. Studying the statistical description students get in-depth knowledge and concept about thermodynamics and its applications. 3. Applications of statistical mechanics clarify the understanding of the students regarding number of breakthroughs in modern physics; e.g. Einstein's theory, partition function, theory of equipartition, specific heat of solids, entropy, Gibb's paradox etc. 4. Identical particles and their statistics is the key of the description of the quantum mechanical particles. Studying the Maxwell Boltzmann statistics, Fermi-Dirac statistics and Bose-Einstein statistics the analytical and mathematical concept of the students regarding the statistical behavior of the tiny bodies are developed thoroughly. 5. Finally the introduction of the irreversible processes and

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					fluctuations help students to be groomed for present day statistical physics. <u>Course Outcome (Practical)</u> 1. In this course the Study of Random Numbers and Time series, Applications of Random Numbers, some plots, error, numerical methods and use of computational approach in Physics. 2. The knowledge of numerical methods functions as advantage to the students as they realize the numerical steps of calculus. 3. Finally applications of computational approach in Physics make students ready for the research and development.
V	Laser and Fiber Optics	PHSA-DSE-A1-b	6 [Theory: 5 Tutorial: 1]	100	1. Study of different types of lasers provides in-depth knowledge about the types of laser and their uses, which are badly needed in the current era of technology. 2. The knowledge of basic characterization, threshold conditions and the Q-switching etc. assist students to understand the operation of laser both technical and analytical way. 3. Study of propagation of light in optical media clarifies the knowledge of students regarding the interference, diffraction, polarization and other optical phenomena. 4. Theses train the students to work with different optical media and instruments as well. The study of non-linear optics analytically and mathematically strong about the subject
V	Astronomy and Astrophysics	PHSA-DSE-B1-a	6 [Theory: 5 Tutorial: 1]	100	1. The Course would be helpful in understanding our composition and universe, the dynamics of stars including our solar system and radiation. 2. This Course provides an opportunity to students to know about various experimental techniques astronomical observations; these include Detectors, Photometry and spectroscopic observational instruments, radio astronomical telescope, interferometer etc. Students would also learn about the Galactic system, extragalactic systems, cosmology and gravitation. 3. Use information learned in class and develops observation skills to be able to explain astronomical features and observations

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					obtained via telescopic observations or data provided through computer simulations. 4. Prepare graduates with strong foundation to pursue advanced degree in Astronomy or Physics /Astrophysics or seek career in observatory /science education.
VI	Digital Electronics	PHSA-CC-13	6 [Theory: 4 Practical: 2]	100	<u>Course Outcome (Theory)</u> 1. Student will be able to employ the codes and number systems converting circuits and Compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency. Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods. 2. Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints. 3. Understanding of digital systems. 4. Ability to use IC in different applications like, to verify laws and theorems of Boolean algebra, to study basic combinational circuits etc. 5. Understand working and use of flip-flop circuits, Registers and Counters. <u>Course Outcome (Practical)</u> 1. Students will learn and understand the Basics of digital electronics and able to design basic logic circuits, combinational and sequential circuits such as universal logic gates using ICs 7400, 7432, 7402, 7408, 7486, 7404. 2. They will realize the function of half adder, full adder and Interfacing 7-segment display system with IC 7447 to display 0-9. 3. The student will be able to Simplify the Boolean expression

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					using Boolean algebra and verify NOT, OR, AND, NOR, XOR, XNOR using NAND.
VI	Solid State Physics	PHSA-CC-14	6 [Theory: 4 Practical: 2]	100	Course Outcome (Theory) 1. Understand the basic concepts of force between atoms and bonding between molecules. 2. Understanding of diffraction experiment and reciprocal lattice and crystal vibrations: phonon heat capacity and thermal conductivity 3. Understand free electron Fermi gas: density of states, Fermi level, and electrical conductivity 4. Understand electrons in periodic potential: energy bands theory classification of metals, semiconductors, insulators, band gap, effective masses, charge carrier distributions, doping, pn junctions 5. Understand metals: Fermi surfaces, temperature dependence of electrical conductivity 6. Understand the properties of semiconductors, relationship between semiconductors devices and understand the applications of semiconductor Course Outcome (Practical) 1. The students will learn the Measurement of variation of resistivity in a semiconductor and investigation of intrinsic band gap using linear four probe. 2. The students will learn how to measure the Hall voltage in semiconductor, by four probe method.
VI	Nanomaterials	PHSA-DSE-A2-a	6 [Theory: 5 Tutorial: 1]	100	1. System of nanomaterials exhibits certain unique and special properties which have great significances in industrial applications. 2. The course discusses types of nano-systems such as quantum wire, quantum well etc. and its key differences with respect to its counter part of the bulk system. 3. Different methods for synthesis of nanomaterials which include Top down and Bottom up approaches are discussed at length.

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					4. Characterization of nanostructures is quite challenging. Methodologies such as Electron Microscopy, Scanning Probe Microscopy, Photo luminescence spectroscopy, IR and Raman spectroscopy, X – Ray diffraction methods etc. are studied. 5. The course will enable the student either pursue higher education or apply the acquired knowledge in solving industrial problems 6. The student will gain experience in applying unique properties of nanomaterials to solve problems and challenges in our life. 7. The student will demonstrate the ability to develop case studies of nanomaterials with a focus on fundamentals, fabrication, characterization, and applications.
VI	Advanced Statistical Mechanics	PHSA-DSE-B2-b	6 [Theory: 5 Tutorial: 1]	100	1. The course is of much practical purpose for the students to learn basics of digital electronics. The digital electronics has wide applications in computing, process control, signal processing, communication systems, digital instruments etc. 2. The course is very important for the students to understand the broadcasting of a message signal from transmitter, its radiation mechanism (how modulated electrical signal is propagated in the form of radio waves) and its detection or demodulation (extraction of original message from modulated signal) at receiver. 3. The course includes the study of modulation, demodulation, transmitters, receivers, TL, antenna, propagation of radio waves, TV, Radar systems. 4. The course is gives the basic science of working of a wireless communications system. The course is also useful for the students to understand the basic function of Television and Radar systems.

Program: B. Sc. Physics (Gen.); **Program Code**: PHSG

Semester	Course Name	Course Code	Credit	Marks	Course outcome
I	Mechanics	PHSG-CC-1/GE-1	6 [Theory: 4 Practical: 2]	100	In this course, students will gain knowledge of linear motion, forces, energy, and circular motion, gravitation, surface tension, elasticity, oscillatory motion. They can apply those theories to explain natural physical processes. Basics of algebraic mathematics along with physical principles, learnt in this course can effectively help students to solve problems encountered in everyday life, further study in science, and in the professional world. In mechanics practical, Newtonian mechanics related physics is learnt and the basic instruments handling capabilities are developed.
II	Electricity and Magnetism	PHSG-CC-2/GE-2	6 [Theory: 4 Practical: 2]	100	After completion of this course student will learn the use of Coulomb's law and Gauss' law, electrostatic force, the relationship between electrostatic field and electrostatic potential, Lorentz force law for the magnetic force, Ampere's law to calculate magnetic fields, Faraday's law of induction, Maxell's equations. On completing the practical course, the students will be able to show their practical understanding of the electric field and potential, magnetic field related aspects and electromagnetic induction.
III	Thermal Physics and Statistical Mechanics	PHSG-CC-3/GE-3	6 [Theory: 4 Practical: 2]	100	The students will get to know the basics of thermal physics and the solution of problems related to thermal physics, kinetic theory of gases, Maxwell-Boltzmann distribution law, Brownian motion etc. after completion of the course. This course will also enable students to learn the behavior of real gases. Completion of the practical course will provide students the knowledge of hands on experience on thermal physics, low temperature physics, different statistical methods, thermodynamics, black body radiation, thermal conductivity and entropy.
III	Renewable energy and Energy Harvesting	PHSG-SEC-A2	2 [Theory: 2]	100	After completion of this course, students will get to know about various renewable energies like solar energy, wind energy

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					harvesting, ocean energy, geothermal energy, hydro energy. Also, they will get to know about piezoelectric energy harvesting, electromagnetic energy harvesting and fuel cell.
IV	Waves and Optics	PHSG-CC-4/GE-4	6 [Theory: 4 Practical: 2]	100	At the end of the course, students will be able to understand wave equations, universal nature of waves, interference, Fraunhofer and Fresnel diffraction, principles of measurement and error analysis. In this practical course, students will get the experience to perform wave, sound and optics related practicals by themselves.
IV	Electrical Circuits and Network skills	PHSG-SEC-B2	2 [Theory: 2]	100	On completing this course, students understand the basic working principles of DC generator, transformer, AC motor. Along with this, the theory of wattmeters and its use as energy meters in domestic house, concept of megger, and different faults in the distribution system are also introduced to the students.
V	Renewable energy and Energy Harvesting	PHSG-SEC-A2	2 [Theory: 2]	100	After completion of this course, students will get to know about various renewable energies like solar energy, wind energy harvesting, ocean energy, geothermal energy, hydro energy. Also, they will get to know about piezoelectric energy harvesting, electromagnetic energy harvesting and fuel cell.
V	Modern Physics	PHSG-DSE-A2	6 [Theory: 5 Tutorial: 1]	100	During this course students are introduced with the idea of radiation and its nature, the foundation of Quantum Mechanics, Special Theory of Relativity, basic lasing action and lasers. In Quantum Mechanics, students learn the postulates of Quantum Mechanics, different dynamical variables such as linear Hermitian operators, expectation values of operators and their time evolution, Schrödinger equation as a first principle. In the Special Theory of Relativity students deal with Lorentz transformation, time dilation and length contraction, velocity addition rule, idea of relativistic momentum and relativistic mass, mass-energy equivalence.
VI	Electrical Circuits and Network skills	PHSG-SEC-B2	2 [Theory: 2]	100	On completing this course, students understand the basic working principles of DC generator, transformer, AC motor. Along with this, the theory of wattmeters and its use as energy meters in

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					domestic house, concept of megger, and different faults in the distribution system are also introduced to the students.
VI	Nuclear Physics	PHSG-DSE-B2	6 [Theory: 5 Tutorial: 1]	100	After completion of this course, students will get to know general properties of nuclei, different nuclear models, radioactivity of nucleus and their detection techniques, nuclear reactions. Students are also provided with the knowledge of different type of accelerators, fundamental particles and their families in this course.