B.Sc.(Hons.)Physics

PAPER NAME	COURSE LEARNING OUTCOME
CC-I: Mathematical Physics-1	After completing this course, student will be able to • Draw and interpret graphs of various functions. • Solve first and second order differential equations and apply these to physics problems. • Understand the concept of gradient of scalar field and divergence and curl of vectorfields. • Perform line, surface and volume integration and apply Green's, Stokes' and Gauss'sTheorems to compute these integrals. • Apply curvilinear coordinates to problems with spherical and cylindrical symmetries. • Understand elementary probability theory and the properties of discrete and continuousdistribution functions. • In the laboratory course, the students will be able to design, code and test simple programs in C++ in the process of solving various problems.
CC-II: Mechanics	Upon completion of this course, students are expected to • Understand laws of motion and their application to various dynamical situations. • Learn the concept of inertial reference frames and Galilean transformations. Also, the concept of conservation of energy, momentum, angular momentum and apply them to basic problems. • Understand translational and rotational dynamics of a system of particles. • Apply Kepler's laws to describe the motion of planets and satellite in circular orbit. • Understand concept of Geosynchronous orbits • Explain the phenomenon of simple harmonic motion. • Understand special theory of relativity - special relativistic effects and their effects onthe mass and energy of a moving object. • In the laboratory course, the student shall perform experiments related to mechanics: compound pendulum, rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity), fluid dynamics, estimation of random errors in theobservations etc.
CC-III: Electricity and Magnetism	At the end of this course the student will be able to • Demonstrate the application of Coulomb's law for the electric field, and also apply it to systems of point charges as well as line, surface, and volume distributions of charges. • Demonstrate an understanding of the relation between electric field and potential, exploit the potential to solve a variety of problems, and relate it to the potential energy of a charge distribution. • Apply Gauss's law of electrostatics to solve a variety of problems. • Calculate the magnetic forces that act on moving charges and the magnetic fields due tocurrents (Biot- Savart and Ampere laws)

	• Understand the concepts of induction and self-induction, to solve problems usingFaraday's and Lenz's laws. • Understand the basics of electrical circuits and analyze circuits using NetworkTheorems. In the laboratory course the student will get an opportunity to verify network theorems and study different circuits such as RC circuit, LCR circuit. Also, different methods to measure low and high resistance, capacitance, self-inductance, mutual inductance, strength of a magnetic field and its variation in space will be learnt.
CC-IV: Waves and Optics	On successfully completing the requirements of this course, the students will have the skilland knowledge to: • Understand Simple harmonic oscillation and superposition principle. • Understand different types of waves and their velocities: Plane, Spherical, Transverse,Longitudinal. • Understand Concept of normal modes in transverse and longitudinal waves: theirfrequencies and configurations. • Understand Interference as superposition of waves from coherent sources derived fromsame parent source. • Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction. • 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. Resolving power of optical equipment can be learnt first hand. The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.
CC-V: Mathematical Physics-II	On successfully completing this course, the students will be able to • Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc. • Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method. • Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations and apply these to various physical problems such as in quantum mechanics. • Learn about gamma and beta functions and their applications. • Solve linear partial differential equations of second order with separation of variablemethod. • In the laboratory course, the students will learn the basics of the Scilab software/Python interpreter and apply appropriate numerical method to solve selected physics problems both using user defined and inbuilt functions from Scilab/Python. They will also learn to generate and plot Legendre polynomials and Bessel functions and verify their recurrence relation.
CC-VI: Thermal Physics	At the end of the course, students will be able to:

	• Comprehend the basic concepts of thermodynamics, the first and the second law ofthermodynamics. • Understand the concept of entropy and the associated theorems, the thermodynamicpotentials and their physical interpretations. • Know about reversible and Irreversible processes. • Learn about Maxwell's relations and use them for solving many problems inThermodynamics • Understand the concept and behavior of ideal and real gases. • Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion. • In the laboratory course, the students are expected to do some basic experiments in thermal Physics, viz., determination of Mechanical Equivalent of Heat (J), coefficientof thermal conductivity of good and bad conductor, temperature coefficient of resistance, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.
CC-VII: Digital Systems and Applications	• This course lays the foundation for understanding the digital logic circuits and their use in combinational and sequential logic circuit design. It also imparts information about the basic architecture, memory and input/output organization in a microprocessor system. The students also learn the working of CRO. • Course learning begins with the basic understanding of active and passive components. It then builds the concept of Integrated Chips (IC): its classification and uses. • Differentiating the Analog and Digital circuits, the concepts of number systems like Binary,BCD, Octal and hexadecimal are developed to elaborate and focus on the digitalsystems. • Sequential Circuits: Basic memory elements Flips-Flops, shift registers and 4-bits counters leading to the concept of RAM, ROM and memory organization. • Timer circuits using IC 555 providing clock pulses to sequential circuits and develop multivibrators. • Introduces to basic architecture of processing in an Intel 8085 microprocessor and to Assembly Language. • Also impart understanding of working of CRO and its usage in measurements ofvoltage, current, frequency and phase measurement. • In the laboratory students will learn to construct both combinational and sequential circuits by employing NAND as building blocks and demonstrate Adders, Subtractors, Shift Registers, and multivibrators

	using 555 ICs. They are also expected to use µP 8085 to demonstrate the same simple programme using assembly language and execute the programme using a µP kit.
CC-VIII: Mathematical Physics III	After completing this course, student will be able to • Determine continuity, differentiability and analyticity of a complex function, find thederivative of a function and understand the properties of elementary complex functions. • Work with multi-valued functions (logarithmic, complex power, inverse trigonometric function) and determine branches of these functions • Evaluate a contour integral using parametrization, fundamental theorem of calculus andCauchy's integral formula. • Find the Taylor series of a function and determine its radius of convergence. • Determine the Laurent series expansion of a function in different regions, find the residues and use the residue theory to evaluate a contour integral and real integral. • Understand the properties of Fourier and Laplace transforms and use these to solve boundary value problems. • In the laboratory course, the students will learn the basics of the Scilab software/Pythoninterpreter and apply appropriate numerical method to solve selected physics problems both using user defined and inbuilt functions from Scilab/Python.
CC-IX: Elements of Modern Physics	After getting exposure to this course, the following topics would be learnt: • Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. • Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions. • The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing • The properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula. • Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino,its properties and its role in theory of beta decay. • Fission and fusion: Nuclear processes to produce nuclear energy in

	nuclear reactor andstellar energy in stars. • In the laboratory course, the students will get opportunity to measure Planck's constant, verify photoelectric effect, determine e/m of electron, Ionization potential of atoms, study emission and absorption line spectra. They will also find wavelength of Laser sources by single and Double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.
CC-X: Analog Systems and Applications	At the end of this course, the following concepts will be learnt • Characteristics and working of pn junction. • Two terminal devices: Rectifier diodes, Zener diode, photodiode etc • NPN and PNP transistors: Characteristics of different configurations, biasing,stabilization and their applications. • CE and two stage RC coupled transistor amplifier using h-parameter model of thetransistor. • Designing of different types of oscillators and their stabilities. • Ideal and practical op-amps: Characteristics and applications. • In the laboratory course, the students will be able to study characteristics of various diodes and BJT. They will be able to design amplifiers, oscillators and DACs. Also different applications using Op-Amp will be designed.
CC-XI: Quantum Mechanics &Applications	The Students will be able to learn the following from this course: □ Methods to solve time-dependent and time-independent Schrodinger equation. □ Quantum mechanics of simple harmonic oscillator. □ Non-relativistic hydrogen atom: spectrum and eigenfunctions. □ Angular momentum: Orbital angular momentum and spin angular momentum. □ Bosons and fermions - symmetric and anti-symmetric wave functions. □ Application to atomic systems □ In the laboratory course, with the exposure in computational programming in the computer lab, the student will be in a position to solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one- dimensional and three dimensional potentials.
CC-XII: Solid State Physics	On successful completion of the module students should be able to □ Elucidate the concept of lattice, crystals and symmetry operations. □ Understand the elementary lattice dynamics and its influence on the properties ofmaterials. □ Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic

	behavior. • Explain the origin of dia-, para-, and ferro-magnetic properties of solids. • Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability. • Understand the basics of phase transitions and the preliminary concept and experimentsrelated to superconductivity in solid. • In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresisloop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.
CC-XIII: Electromagnetic Theory	At the end of this course the student will be able to: • Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density. • Understand electromagnetic wave propagation in unbounded media: Vacuum, dielectric medium, conducting medium, plasma. • Understand electromagnetic wave propagation in bounded media: reflection and transmission coefficients at plane interface in bounded media. • Understand polarization of Electromagnetic Waves: Linear, Circular and Elliptical Polarization. Production as well as detection of waves in laboratory. • Learn the features of planar optical wave guide. • Understand the fundamentals of propagation of electromagnetic waves through opticalfibres. • In the laboratory course, the student get an opportunity to perform experiments with Polarimeter, Babinet Compensator, Ultrasonic grating, simple dipole antenna. Also, to study phenomena of interference, refraction, diffraction and polarization.
CC-XIV: Statistical Mechanics	By the end of the course, students will be able to: • Understand the concepts of microstate, macrostate, phase space, thermodynamic probability and partition function. • Understand the use of Thermodynamic probability and Partition function forcalculation of thermodynamic variables for physical system (Ideal gas, finite level system). • Difference between the classical and quantumstatistics • Understand the properties and Laws associated with thermal radiation. • Apply the Fermi- Dirac distribution to model problems such

	as electrons in solids andwhite dwarf stars • Apply the Bose-Einstein distribution to model problems such as blackbody radiation and Helium gas. • In the laboratory course, with the exposure in computer programming and computational techniques, the student will be in a position to perform numerical simulations for solving the problems based on Statistical Mechanics.
DSE: Experimental Techniques	Upon successful completion of the course, students will be able to: □ Learn the measurement systems, errors in measurements and statistical treatment ofdata. □ About Noise and signal, signal to noise ratio, different types of noises andtheir identification. □ Concept of electromagnetic interference and necessity of grounding. □ Understand principle of working and industrial applications of various transducers like Electrical, Thermal and Mechanical systems commonly used to measure Temperature and Position in industry. □ Develop an understanding of construction and working of different measuring instruments. □ Develop an understanding of construction, working and use of different AC and DC bridges and its applications.
DSE: Advanced Mathematical Physics - I	At the end of this course, students will be able to □ Understand algebraic structures in n-dimension and basic properties of the linear vectorspaces. □ Represent Linear Transformations as matrices and understand basic properties ofmatrices. □ Apply vector spaces and matrices in the quantum world. □ Learn basic properties of Cartesian and general tensors with physical examples such as moment of inertia tensor, energy momentum tensor, stress tensor, strain tensor etc. □ Learn how to express the mathematical equations for the Laws of Physics in their co- variant forms. □ In the laboratory course, the students are expected to solve the problems using the Scilab/C++/Python computer language: Eigenvalues and Eigenvectors of given matrix, determination of wave functions for stationary states as eigenfunctions, eigen energy values of Hermitian differential operators, Lagrangian formulation in classical dynamics etc.
DSE: Nuclear and Particle Physics	□ To be able to understand the basic properties of nuclei as well as knowledge ofexperimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance □ To appreciate the formulations and contrasts between different

	nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support. • Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays. • Familiarization with different types of nuclear reactions, Q-values, compound and direct reactions. • To know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter. Through the section on accelerators students will acquire knowledge about Accelerator facilities in India along with a comparative study of a range of detectors and accelerators which are building blocks of modern day science. • It will acquaint students with the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model. • The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.
DSE: Physics of Devices and Communication	At the end of this course, students will be able to • Develop the basic knowledge of semiconductor device physics and electronic circuits along with the practical technological considerations and applications. • Understand the operation of devices such as UJT, JFET, MOS, various bias circuits of MOSFET, Charge coupled Devices and Tunnel Diode. • Learn to analyze MOSFET circuits and develop an understanding of MOSFET I-Vcharacteristics and the allowed frequency limits. • Learn the IC fabrication technology involving the process of diffusion, implantation, oxidation and etching with an emphasis on photolithography and electron-lithography. • Apply concepts for the regulation of power supply by developing an understanding of various kinds of RC filters classified on the basis of allowed range of frequencies. • Learn basic principles of phase locked loop (PLL) and understand its operation. • Gain understanding of Digital Data serial and parallel Communication Standards.Knowledge of USB standards and GPIB. • Understand different blocks in communication system, need of modulation, modulationprocesses and different modulation schemes.
DSE: Astronomy and Astrophysics	Students completing this course will gain an understanding of

	Different types of telescopes, diurnal and yearly motion of astronomical objects, and astronomical coordinate systems and their transformations. Brightness scale for stars, types of stars, their structure and evolution on HRdiagram. Components of Solar System and its evolution The large scale structure of the Universe and its history Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life.
DSE: Atmospheric Physics	At the end of this course, students will be able to Learn and understand structure of temperature profiles and fine scale features in thetroposphere using observations. Understand Atmospheric waves: surface water waves, atmospheric gravity waves,accoustic waves etc Learn remote sensing techniques such as radar, lidar, and satellite to exploreatmospheric processes. Understand properties of aerosols, their radiative and health effects.
DSE: Biological Physics	After completing this course, students will Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective. Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution. Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes. Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behavior. Perform mathematical and computational modelling of certain aspects of living systems.
DSE: Embedded systems - Introduction to Microcontroller	At the end of this course, students will be able to : Know the major components that constitute an embedded system. Understand what is a microcontroller, microcomputer embedded system. Describe the architecture of a 8051 microcontroller.

	• Write simple programs for 8051 microcontroller in C language. • Understand key concepts of 8051 microcontroller systems like I/O operations, interrupts, programming of timers and counters. • Interface 8051 microcontroller with peripherals • Understand and explain concepts and architecture of embedded systems • Implement small programs to solve well-defined problems on an embedded platform. • Develop familiarity with tools used to develop an embedded environment • Learn to use the Arduino Uno (an open source microcontroller board) in simpleapplications. • In the laboratory, students will program 8051 microcontroller and Arduino to perform various experiments.
DSE: Linear Algebra and Tensor Analysis	At the end of this course, students will be able to • Understand algebraic structures in n-dimension and basic properties of the linear vectorspaces. • Represent Linear Transformations as matrices and understand basic properties ofmatrices. • Apply vector spaces and matrices in the quantum world. • Learn basic properties of Cartesian and general tensors with physical examples such as moment of inertia tensor, energy momentum tensor, stress tensor, strain tensor, geometrical applications etc. • Learn how to express the mathematical equations for the Laws of Physics in their co- variant forms.
DSE: Nano Materials and Applications	On successful completion of the module students should be able to • Explain the difference between nanomaterials and bulk materials and their properties. • Explain the role of confinement on the density of state function and so on the various properties exhibited by nanomaterials compared to bulk materials. • Explain various methods for the synthesis/growth of nanomaterials including top downand bottom up approaches. • Analyze the data obtained from the various characterization techniques • Explain the concept of Quasi-particles such as excitons and how they influence theoptical properties. • Explain the Interger Quantum Hall Effect and the concept of Landau Levels, and edge states in conductance quantization. • Explain the conductance quantization in 1D structure and its difference from the 2DEGsystem.

	• Explain various applications of nano particles, quantum dots, nano wires etc • Explain why nanomaterials exhibit properties which are sometimes very opposite, like magnetic, to their bulk counterparts. • In the Lab course students will synthesize nanoparticles by different chemical routes and characterize them in the laboratory using the different techniques, learnt in the theory. They will also carry out thin film preparation and prepare capacitors and evaluate its performance. They will fabricate a PN diode and study its I-V characteristics.
DSE: Communication System	At the end of this course, students will be able to • Understand of fundamentals of electronic communication system and electromagnetic communication spectrum with an idea of frequency allocation for radio communication system in India. • Gain an insight on the use of different modulation and demodulation techniques used inanalog communication • Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing. • Gain an in-depth understanding of different concepts used in a satellite communication system. • Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA. • Understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations. • In the laboratory course, students will apply the theoretical concepts to gain hands on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.
DSE: Medical Physics	This course will enable the student to • Focus on the application of Physics to clinical medicine. • Gain a broad and fundamental understanding of Physics while developing particularexpertise in medical applications. • Learn about the human body, its anatomy, physiology and BioPhysics, exploring itsperformance as a physical machine. • Learn diagnostic and therapeutic applications like the ECG, Radiation Physics, X- ray technology, ultrasound and magnetic resonance imaging. • Gain knowledge with reference to working of various diagnostic tools, medicalimaging techniques • Understand interaction of ionizing radiation with matter - its effects on living organisms and its uses as a therapeutic technique and also radiation safety practices.

	• Gain functional knowledge regarding need for radiological protection and the sources of an approximate level of radiation exposure for treatment purposes. • In the laboratory course, the student will be exposed to the workings of various medicaldevices and getting familiarized with various detectors used in medical imaging, medical diagnostics. The hands-on experience will be very useful for the students from job perspective.
DSE: Applied Dynamics	Upon successful course completion, a student will be able to: • Demonstrate understanding of the concepts that underlay the study of dynamicalsystems. • Understand fractals as self-similar structures. • Learn various forms of dynamics and different routes to chaos. • Understand basic Physics of fluids and its dynamics theoretically and experimentally and by computational simulations • In the Lab course, students will be able to perform Simulations/Lab experiments on: coupled Oscillators, Simulation of Simple Population , Predator-Prey Dynamics, Simple genetic circuits, rate equations for some simple chemical reactions, Fractal Formation in Deterministic Fractals, Fluid Flow Models.
DSE: Digital Signal Processing	At the end of this course, students will be able to • Learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems. • Understand use of different transforms and analyze the discrete time signals andsystems. • Realize the use of LTI filters for filtering different real world signals. The concept oftransfer • Learn to solve Difference Equations. • Develop an ability to analyze DSP systems like linear-phase, FIR, IIR, All-pass,averaging and notch Filter etc. • Understand the discrete Fourier transform (DFT) and realize its implementation usingFFT techniques. • Design and understand different types of digital filters such as finite & infinite impulse response filters for various applications. • In the Lab course, the students will realize various concepts using Scilab simulations like Digital Filters and their classifications based on the response, design and algorithm, Fluency in using Fast Fourier Transform, Signal generation, realization of systems and finding their transfer function, characterization using pole-zero plots and designing digital filters.

DSE: Physics of Earth	At the end of this course student will be able to • Have an overview of structure of the earth as well as various dynamical processesoccurring on it. • Develop an understanding of evolution of the earth. • Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure. • Understand the origin of magnetic field, Geodynamics of e a r t hq u ake s and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top. • Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth • In the tutorial section, through literature survey on the various aspects of health of Earth, project work / seminar presentation, the students will be able to appreciate need to 'save' Earth.
DSE: Advanced Mathematical Physics-II	After the successful completion of the course, the students shall be able to • Understand variational principle and its applications: Geodesics in two and three dimensions, Euler Lagrange Equation and simple problems in one and two dimensions. • Acquire basic concept of Hamiltonian, Hamilton's principle and Hamiltonian equation of motion, Poisson and Lagrange brackets. • Learn elementary group theory: definition and properties of groups, subgroups, Homomorphism, isomorphism, normal and conjugate groups, representation of groups, Reducible and Irreducible groups. • Learn the theory of probability: Random variables and probability distributions, Expectation values and variance.
DSE: Classical Dynamics	At the end of this course, students will be able to: • Understand the physical principle behind the derivation of Lagrange and Hamiltonequations, and the advantages of these formulations. • Understand small amplitude oscillations. • Understand the intricacies of motion of particle in central force field. Critical thinkingand problem-solving skills • Recapitulate and learn the special theory of relativity extending to Four – vectors. • Learn the basics of fluid dynamics, streamline and turbulent

	flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation.
DSE: Dissertation	Exposure to research methodology • Picking up skills relevant to dissertation project, such as experimental skills in thesubject, computational skills, etc. • Development of creative ability and intellectual initiative • Developing the ability for scientific writing • Becoming conversant with ethical practices in acknowledging other sources, avoidingplagiarism, etc.
DSE: Verilog and FPGA based system design	At the end of this course, students will be able to • Understand the steps and processes for design of logic circuits and systems. • Differentiate between combinational and sequential circuits. • Design various types of state machines. • Understand various types of programmable logic building blocks such as CPLDs andFPGAs and their tradeoffs. • Write synthesizable Verilog code. • Write a Verilog test bench to test various Verilog code modules. • Design, program and test logic systems on a programmable logic device (CPLD or FPGA) using Verilog.
DSE: Advanced Quantum Mechanics	At the end of this course, students will be able to • Learn to represent quantum states by ket vectors, physical observables as operators andtheir time evolution. • Understand commutator brackets between observables and their properties. • Learn concept of system of identical non- interacting particles: dynamics of two levelsystems, qubits. • Understand the addition of orbital and spin angular momenta. • Gain the basic idea of variational method.
SEC: Physics Workshop Skills	After completing this course, student will be able to : • Learning measuring devices like Vernier callipers, Screw gauge, travelling microscope and Sextant for measuring various length scales. • Acquire skills in the usage of multimeters, soldering iron, oscilloscopes, powersupplies and relays. • Developing mechanical skill such as casting, foundry, machining, forming and welding and will become familiar with common machine tools like lathe, shaper, drilling, milling, surface machines and Cutting tools. • Getting acquaintance with prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axle. Lever mechanism. Lifting of heavy weight using lever. braking systems, pulleys.

SEC: Computational Physics Skills	Students will be able to • Use computers for solving problems in Physics. • Prepare algorithms and flowcharts for solving a problem. • Use Linux commands on terminal • Use an unformatted editor to write sources codes. • Learn "Scientific Word Processing", in particular, using LaTeX for preparing articles, papers etc. which include mathematical equations, picture and tables. • Learn the basic commands of Gnuplot.
SEC: Electrical circuits and Network Skills	At the end of this course, students will be able to • Demonstrate good comprehension of basic principles of electricity including ideas about voltage, current and resistance. • Develop the capacity to analyze and evaluate schematics of power efficient electrical circuits while demonstrating insight into tracking of interconnections within elements while identifying current flow and voltage drop. • Gain knowledge about generators, transformers and electric motors. The knowledge would include interfacing aspects and consumer defined control of speed and power. • Acquire capacity to work theoretically and practically with solid-state devices. • Delve into practical aspects related to electrical wiring like various types ofconductors and cables, wiring-Star and delta connections, voltage drop and losses. • Measure current, voltage, power in DC and AC circuits, acquire proficiency infabrication of regulated power supply. • Develop capacity to identify and suggest types and sizes of solid and stranded cables, conduit lengths, cable trays, splices, crimps, terminal blocks and solder.
SEC: Basic Instrumentation Skills	At the end of this course the students will learn the following: • The student is expected to have the necessary working knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements. • Course learning begins with the basic understanding of the measurement and errors in measurement. It then familiarizes about each and every specification of a multimeter, multimeters, multivibrators, rectifiers, amplifiers, oscillators and high voltage probes and their significance with hands on mode. • Explanation of the specifications of CRO and their significance. Complete explanation of CRT. • Students learn the use of CRO for the measurement of voltage (DC and AC), frequency and time period. Covers the Digital Storage Oscilloscope and its principle of working. • Students learn principles of voltage measurement. Students

	should be able to understand the advantages of electronic voltmeter over conventional multimeter in terms of sensitivity etc. Types of AC millivoltmeter should be covered. • Covers the explanation and specifications of Signal and pulse Generators: low frequency signal generator and pulse generator. Students should be familiarized with testing and specifications. • Students learn about the working principles and specifications of basic LCR bridge. • Hands on ability to use analog and digital instruments like digital multimeter and frequency counter.
SEC: Renewable Energy and Energy harvesting	At the end of this course, students will be able to achieve the following learning outcomes: • Knowledge of various sources of energy for harvesting • Understand the need of energy conversion and the various methods of energy storage • A good understanding of various renewable energy systems, and its components. • Knowledge about renewable energy technologies, different storage technologies, distribution grid, smart grid including sensors, regulation and their control. • Design the model for sending the wind energy or solar energy plant. • The students will gain hand on experience of: (i) different kinds of alternative energy sources, (ii) conversion of vibration into voltage using piezoelectric materials, (iii) conversion of thermal energy into voltage using thermoelectric modules.
SEC: Engineering Design and Prototyping/Technical Drawing	This course will enable the student to be proficient in: • Understanding the concept of a sectional view – visualizing a space after being cut by a plane. How The student will be able to draw and learn proper techniques for drawing an aligned section. • Understanding the use of spatial visualization by constructing an orthographic multi view drawing. • Drawing simple curves like ellipse, cycloid and spiral, Orthographic projections of points, lines and of solids like cylinders, cones, prisms and pyramids etc. • Using Computer Aided Design (CAD) software and AutoCAD techniques.
SEC: Radiation Safety	This course will help students in the following ways: • Awareness and understanding the hazards of radiation and

	the safety measures to guardagainst these hazards. • Learning the basic aspects of the atomic and nuclear Physics, specially the radiations that originate from the atom and the nucleus. • Having a comprehensive knowledge about the nature of interaction of matter with radiations like gamma, beta, alpha rays, neutrons etc. and radiation shielding by appropriate materials. • Knowing about the units of radiations and their safety limits, the devises to detect and measure radiation. • Learning radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards, 'International Commission on Radiological Protection' (ICRP) its principles, justification, optimization, limitation, introduction of safety and risk management of radiation. nuclear waste and disposal management, brief idea about Accelerator driven Sub-Critical System' (ADS) for waste management. • Learning about the devices which apply radiations in medical sciences, such as MRI, PET. • Understanding and performing experiments like Study the background radiation levels using Radiation detectors, Determination of gamma ray linear and mass absorption coefficient of a given material for radiation shielding application.
SEC: Applied Optics	Students will be able to : • Understand basic lasing mechanism qualitatively, types of lasers, characteristics of laser light and its application in developing LED, Holography. • Gain concepts of Fourier optics and Fourier transform spectroscopy. • Understand basic principle and theory of Holography. • Grasp the idea of total internal reflection and learn the characteristics of optical fibers.
SEC: Weather Forecasting	The student will gain the following: • Acquire basic knowledge of the elements of the atmosphere, its composition at various heights, variation of pressure and temperature with height. • Learn basic techniques to measure temperature and its relation with cyclonesand anti-cyclones. • Knowledge of simple techniques to measure wind speed and its directions,humidity and rainfall. • Understanding of absorption, emission and scattering of radiations inatmosphere; Radiation laws. • Knowledge of global wind systems, jet streams, local thunderstorms, tropical cyclones, tornadoes and

	hurricanes. • Knowledge of climate and its classification. Understanding various causes ofclimate change like global warming, air pollution, aerosols, ozone depletion, acid rain. Develop skills needed for weather forecasting, mathematical simulations, weather forecasting methods, types of weather forecasting, role of satellite observations in weather forecasting, weather maps etc. Uncertainties in predicting weather based on statistical analysis. • Develop ability to do weather forecasts using input data. • In the laboratory course, students should be able to learn: Principle of the working of a weather Station, Study of Synoptic charts and weather reports, Processing and analysis of weather data, Reading of Pressure charts, Surface charts, Wind charts and their analysis.
SEC: Introduction to Physical Computing	The student will be able to □ Understand the evolution of the CPU from microprocessor to microcontroller and embedded computers from a historical perspective. □ Operate basic electronic components and analog and digital electronics building blocks including power supply and batteries. □ Use basic laboratory equipment for measurement and instrumentation. □ Understand the Arduino ecosystem and write simple Arduino programs (sketches) □ Understand sensor characteristics and select a suitable sensor for various applications. □ Read digital and analog data and produce digital and analog outputs from an embeddedcomputer. □ Understand how to interface an embedded computer to the physical environment. □ Visualize the needs of a standalone embedded computer and
SEC: Numerical Analysis	**Theory:** After completing this course, student will be able to: □ approximate single and multi-variable function by Taylor's Theorem. □ Solve first order differential equations and apply it to physics problems. □ solve linear second order homogeneous and non-homogeneous differential equationswith constant coefficients. □ Calculate partial derivatives of function of several variables □ Understand the concept of gradient of scalar field and

	divergence and curl of vector fields. perform line, surface and volume integration - Use Green's, Stokes' and Gauss's Theorems to compute integrals **Practical:** After completing this course, student will be able to : - design, code and test simple programs in C++ learn Monte Carlo techniques, - fit a given data to linear function using method of least squares find roots of a givennon-linear function - Use above computational techniques to solve physics problems
GE: Electricity and Magnetism	At the end of this course, students will be able to • Gain the concept of vector analysis. • Apply Gauss's law of electrostatics to solve a variety of problems. • Articulate knowledge of electriccurrent, resistance andcapacitance in terms of electric field and electric potential. • Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents(Biot- Savart and Ampere laws) • Gain brief idea of dia, para and ferro-magnetic materials • Understand the concepts of induction and self-induction, to solve problems using Faraday's andLenz's laws • Have an introduction to Maxwell's equations. • In the laboratory course the student will get an opportunity to verify network theorems and study different circuits such as RC circuit, LCR circuit. Also, different methods to measure low and high resistance, capacitance etc.
GE: Mathematical Physics	At the end of this course, the students will be able to - Find extrema of functions of several variables. - Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc.. - Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method. - Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their

	differential equations and apply these to various physical problems such as in quantum mechanics. • Learn about gamma and beta functions and their applications. • Solve linear partial differential equations of second order with separation of variablemethod. • Understand the basic concepts of complex analysis and integration. • In the laboratory course, the students will be able to design, code and test simple programs in C++ in the process of solving various problems.
GE: Digital,Analog and Instrumentation	• Differentiating the Analog and Digital circuits, the concepts of number systems like Binary,BCD, Octal and hexadecimal are developed to elaborate and focus on the digitalsystems. • Characteristics and working of pn junction. • Two terminal devices: Rectifier diodes, Zener diode, photodiode etc • NPN and PNP transistors: Characteristics of different configurations, biasing,stabilization and their applications. • CE and two stage RC coupled transistor amplifier using h-parameter model of thetransistor. • Designing of different types of oscillators and their stabilities. • Ideal and practical op-amps: Characteristics and applications. • Timer circuits using IC 555 providing clock pulses to sequential circuits and develop multivibrators.. • Also impart understanding of working of CRO and its usage in measurements of voltage, current, frequency and phase measurement. In the laboratory students will learn to construct both combinational and sequential circuits by employing NAND as building blocks. They will be able to study characteristics of various diodes and BJT. They will also be able to design amplifiers (using BJT and Op-Amp), oscillators and multivibrators. They will also learn working of CRO.
GE: Applied Dynamics	Upon successful course completion, a student will be able to: • Demonstrate understanding of the concepts that underlay the study of dynamicalsystems. • Understand fractals as self-similar structures. • Learn various forms of dynamics and different routes to chaos. • Understand basic Physics of fluids and its dynamics theoretically and experimentally and by computational simulations • In the Lab course, students will be able to perform Simulations/Lab experiments on: coupled Oscillators, Simulation of Simple Population , Predator-Prey Dynamics, Simple genetic circuits, rate equations for some simple chemical reactions, Fractal Formation in Deterministic

	Fractals, Fluid Flow Models.
GE: Medical Physics	This course will enable the student to • Focus on the application of Physics to clinical medicine. • Gain a broad and fundamental understanding of Physics while developing particularexpertise in medical applications. • Learn about the human body, its anatomy, physiology and BioPhysics, exploring itsperformance as a physical machine. • Learn diagnostic and therapeutic applications like the ECG, Radiation Physics, X-ray technology, ultrasound and magnetic resonance imaging. • Gain knowledge with reference to working of various diagnostic tools, medicalimaging techniques • Understand interaction of ionizing radiation with matter - its effects on living organisms and its uses as a therapeutic technique and also radiation safety practices. • Gain functional knowledge regarding need for radiological protection and the sources of an approximate level of radiation exposure for treatment purposes. • In the laboratory course, the student will be exposed to the workings of various medical devices and getting familiarized with various detectors used in medical imaging, medical diagnostics. The hands-on experience will be very useful for the students from job perspective.
GE: Mechanics	Upon completion of this course, students are expected to • Understand the role of vectors and coordinate systems in Physics. • Learn to solve Ordinary Differential Equations: First order, Second order Differential Equations with constant coefficients. • Understand laws of motion and their application to various dynamical situations. • Learn the concept of inertial reference frames and Galilean transformations. Also, the concept of conservation of energy, momentum, angular momentum and apply them to basic problems. • Understand translational and rotational dynamics of a system of particles. • Apply Kepler's laws to describe the motion of planets and satellite in circular orbit. • Understand concept of Geosynchronous orbits • Explain the phenomenon of simple harmonic motion. • Understand special theory of relativity - special relativistic effects and their effects onthe mass and energy of a moving object. • In the laboratory course, the student shall perform experiments related to mechanics: compound pendulum, rotational dynamics (Flywheel), elastic properties (YoungModulus and Modulus of Rigidity),

	fluid dynamics, estimation of random errors in the observations etc.
GE: Elements of Modern Physics	After getting exposure to this course, the following topics would be learnt: • Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics. • Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions. • The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing • The properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula. • Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay. • Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars. • In the laboratory course, the students will get opportunity to measure Planck's constant, verify photoelectric effect, determine e/m of electron, Ionization potential of atoms, study emission and absorption line spectra. They will also find wavelength of Laser sources by single and Double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.
GE: Solid State Physics	On successful completion of the module students should be able to • Elucidate the concept of lattice, crystals and symmetry operations. • Understand the elementary lattice dynamics and its influence on the properties ofmaterials. • Describe the main features of the physics of electrons in solids: origin of energy bands, and their influence electronic behavior. • Explain the origin of dia-, para-, and ferro-magnetic properties of solids. • Explain the origin of the dielectric properties exhibited by solids and the concept ofpolarizability. • Learn the properties of superconductivity in solid. • In the laboratory students will carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresisloop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

GE: Embedded System: Introduction to Microcontroller	At the end of this course, students will be able to : • Know the major components that constitute an embedded system. • Understand what is a microcontroller, microcomputer embedded system. • Describe the architecture of a 8051 microcontroller. • Write simple programs for 8051 microcontroller in C language. • Understand key concepts of 8051 microcontroller systems like I/O operations, interrupts, programming of timers and counters. • Interface 8051 microcontroller with peripherals • Understand and explain concepts and architecture of embedded systems • Implement small programs to solve well-defined problems on an embedded platform. • Develop familiarity with tools used to develop an embedded environment • Learn to use the Arduino Uno (an open source microcontroller board) in simpleapplications. • In the laboratory, students will program 8051 microcontroller and Arduino to perform various experiments.
GE: Biological Physics	After completing this course, students will • Know basic facts about biological systems, including single cells, multicellular organisms and ecosystems from a quantitative perspective. • Gain familiarity with various biological processes at different length and time scales, including molecular processes, organism level processes and evolution. • Be able to apply the principles of physics from areas such as mechanics, electricity and magnetism, thermodynamics, statistical mechanics, and dynamical systems to understand certain living processes. • Gain a systems level perspective on organisms and appreciate how networks of interactions of many components give rise to complex behavior. • Perform mathematical and computational modelling of certain aspects of living systems. • Acquire mastery of the fundamental principles and applications of various branchesof Physics in understanding biological systems. • Learn relevance of chemistry principles and thermodynamics in understanding energy transfer mechanism and protein folding in biological systems. • Get exposure to complexity of life at i) the level of Cell,

	ii) level of multi cellular organism and iii) at macroscopic system – ecosystem and biosphere • Get exposure to models of evolution.
GE: Waves and Optics	On successfully completing the requirements of this course, the students will have the skilland knowledge to: • Understand Simple harmonic oscillation and superposition principle. • Understand different types of waves and their velocities: Plane, Spherical, Transverse,Longitudinal. • Understand Concept of normal modes in transverse and longitudinal waves: theirfrequencies and configurations. • Understand Interference as superposition of waves from coherent sources derived fromsame parent source. • Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from aperture, understand Fraunhoffer and Fresnel Diffraction. • 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. Resolving power of optical equipment can be learnt first hand.The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.
GE: Quantum Mechanics	The Students will be able to learn the following from this course: • Methods to solve time-dependent and time-independent Schrodinger equation. • Quantum mechanics of simple harmonic oscillator. • Non-relativistic hydrogen atom: spectrum and eigenfunctions. • Angular momentum: Orbital angular momentum and spin angular momentum. • Bosons and fermions - symmetric and anti-symmetric wave functions. • Application to atomic systems • In the laboratory course, with the exposure in computational programming in the computer lab, the student will be in a position to solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one- dimensional and three dimensional potentials.
GE: Communication System	At the end of this course, students will be able to • Understand of fundamentals of electronic communication system and electromagnetic communication spectrum with

	an idea of frequency allocation for radio communication system in India. • Gain an insight on the use of different modulation and demodulation techniques used inanalog communication • Learn the generation and detection of a signal through pulse and digital modulation techniques and multiplexing. • Gain an in-depth understanding of different concepts used in a satellite communication system. • Study the concept of Mobile radio propagation, cellular system design and understand mobile technologies like GSM and CDMA. • Understand evolution of mobile communication generations 2G, 3G, and 4G with their characteristics and limitations. • In the laboratory course, students will apply the theoretical concepts to gain hands on experience in building modulation and demodulation circuits; Transmitters and Receivers for AM and FM. Also to construct TDM, PAM, PWM, PPM and ASK, PSK and FSK modulator and verify their results.
GE: Verilog and FPGA based system design	At the end of this course, students will be able to • Understand the steps and processes for design of logic circuits and systems. • Differentiate between combinational and sequential circuits. • Design various types of state machines.. • Understand various types of programmable logic building blocks such as CPLDs andFPGAs and their tradeoffs. • Write synthesizable Verilog code. • Write a Verilog test bench to test various Verilog code modules. • Design, program and test logic systems on a programmable logic device (CPLD or FPGA) using Verilog.
GE: Nano Materials and Applications	On successful completion of the module students should be able to • Understand the basic concepts of Quantum Mechanics and solve Schrodinger waveequation for simple problems. • Explain the difference between nanomaterials and bulk materials and their properties. • Explain the role of confinement on the density of state function and so on the various properties exhibited by nanomaterials compared to bulk materials. • Explain various methods for the synthesis/growth of nanomaterials including top downand bottom up approaches. • Analyze the data obtained from the various characterization techniques. • Explain various applications of nano particles, quantum dots, nano wires etc. • Explain why nanomaterials exhibit properties which are sometimes very opposite, like magnetic, to their bulk

	counterparts. • In the Lab course students will synthesize nanoparticles by different chemical routes and characterize them in the laboratory using the different techniques, learnt in the theory. They will also carry out thin film preparation and prepare capacitors and evaluate its performance. They will fabricate a PN diode and study its I-V characteristics.
GE: Thermal Physics and Statistical Mechanics	At the end of this course, students will • Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations. • Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermalconductivity, diffusion and Brownian motion. • Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances. • Learn the quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics. • In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature co- efficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc
GE: Digital Signal Processing	At the end of this course, students will be able to • Learn basic discrete-time signal and system types, convolution sum, impulse and frequency response concepts for linear time-invariant (LTI) systems. • Understand use of different transforms and analyze the discrete time signals andsystems. • Realize the use of LTI filters for filtering different real world signals. The concept oftransfer • Learn to solve Difference Equations. • Develop an ability to analyze DSP systems like linear-phase, FIR, IIR, All-pass,averaging and notch Filter etc. • Understand the discrete Fourier transform (DFT) and realize its implementation using FFT techniques. • Design and understand different types of digital filters such as finite & infinite impulse response filters for various applications. • In the Lab course, the students will realize various concepts using Scilab simulations like Digital Filters and their classifications based on the response, design and algorithm,

	Fluency in using Fast Fourier Transform, Signal generation, realization of systems and finding their transfer function, characterization using pole-zero plots and designing digital filters.
GE: Nuclear and Particle Physics	□ To be able to understand the basic properties of nuclei as well as knowledge ofexperimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance □ To appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support. □ Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays. □ Familiarization with different types of nuclear reactions, Q-values, compound and direct reactions. □ To know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter. Through the section on accelerators students will acquire knowledge about Accelerator facilities in India along with a comparative study of a range of detectors and accelerators which are building blocks of modern day science. □ It will acquaint students with the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model. □ The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.
GE: Astronomy and Astrophysics	Students completing this course will gain an understanding of □ Different types of telescopes, diurnal and yearly motion of astronomical objects, and astronomical coordinate systems and their transformations. □ Brightness scale for stars, types of stars, their structure and evolution on HRdiagram. □ Components of Solar System and its evolution □ The large scale structure of the Universe and its history □ Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life.
GE: Atmospheric Physics	At the end of this course, students will be able to: □ Learn and understand structure of temperature profiles and fine scale features in thetroposphere using observations. □ Understand Atmospheric waves: surface water waves,

	atmospheric gravity waves,accoustic waves etc • Learn remote sensing techniques such as radar, lidar, and satellite to exploreatmospheric processes. • Understand properties of aerosols, their radiative and health effects.
GE: Physics of Earth	At the end of this course student will be able to • Have an overview of structure of the earth as well as various dynamical processesoccurring on it. • Develop an understanding of evolution of the earth. • Apply physical principles of elasticity and elastic wave propagation to understand modern global seismology as a probe of the Earth's internal structure. • Understand the origin of magnetic field, Geodynamics of earthquakes and the description of seismic sources; a simple but fundamental theory of thermal convection; the distinctive rheological behaviour of the upper mantle and its top. • Explore various roles played by water cycle, carbon cycle, nitrogen cycles in maintaining steady state of earth leading to better understanding of the contemporary dilemmas (climate change, bio diversity loss, population growth, etc.) disturbing the Earth • In the tutorial section, through literature survey on the various aspects of health of Earth, project work / seminar presentation, the students will be able to appreciate need to 'save' Earth.