Program Name: **B. Sc. Physics**

Program specific Outcomes

A student completing this program will be able to:

PSO1: Graduates will acquire a comprehensive knowledge and sound understanding of fundamentals of Physics.

PSO2: Graduates will develop practical, analytical and mathematical skills in Physics.

PSO3: Graduates will be prepared to acquire a range of general skills, to solve problems, to evaluate information, to use computers productively, to communicate with society effectively and learn independently.

PSO4: Graduates will acquire necessary skills to enable them to crack competitive examination for career progression or seeking employment.

Course outcomes for all courses offered by the department:

Semester	Course Code	Course name	Course Outcomes Student completing this course is able to
1	PH-1501	Basic Physics-I	**1:** Apply knowledge of travelling waves, sound waves and ultrasonic waves to explain natural physical processes and related technological advances. **2:** This course makes students in capacity to have skill in vectors for: triple product, Curl, gradient and divergence, differentiation of vectors. **3:** Understanding about Green's theorem, divergence theorem, Stokes theorem, and Gauss law. **4:** Explain the matrix and their multiplication, zero matrix, inverse matrix etc. **5:** Describe interference due to reflected light and transmitted light in a thin film & explain colours exhibited in reflection by thin film of oil, mica & soap bubbles. **6:** Explain formation of Newton's rings & demonstrate Newton's ring experiment to find unknown wave length of light & to find refractive index of liquid. **7:** Apply Fermat's principle of least time to obtain law of reflection & law of refraction (Snell's law). **8:** Define Cardinal points & Cardinal planes of an optical system & Construct image of an object using cardinal points.

			9: Describe and differentiate among thermoelectric electric effects like Seeback, Peltier and Thomson **10:** Use thermoelectric diagram to calculate parameters like neutral temperature, Peltier coefficient, Thomson coefficient. **11:** Will be able to solve the numericals of the above mentioned topics
1	PH-1502L	Physics Lab-I	**1 :** This course makes students in capacity to have skill for: taking observations, representing data graphically, doing calculation from the data and graph and finding out the results/outcome/conclusions about the performed experiment. **2:** By pursuing this course students understand the mechanical instrument to measure at accuracy 0.01cm and 0.001 cm. They also learn to read and use the digital multi-meter. **3:** In this course students can describe the error specification among the experimental reading/observation using two techniques namely least square method and analysis of error.
2	PH-2501	Basic Physics-II	**1:** Describe and design HW, FW and Bridge rectifier and designing of various filters for power supply, Analyze the DC circuit having R, L and C and explain the phenomenon of the charging and discharging of the capacitor. **2:** Evaluate the electric field of continuous charge-linear charge, surface charge and volume charge distributions. Describe Divergence and Curl of Electrostatic fields **3:** Apply Gauss's law for spherical, cylindrical and plane symmetry, Discuss Electric potential and line integration of electric field, Relate electric field with gradient of potential. **4:** Apply the principles of potential and electric field to formulate Poisson's equation and Laplace's equation, Apply Boundary condition to investigate the normal component of electrostatic field. **5:** Evaluate the energy of a point charge and continuous charge distributions, Identify the basic properties of Conductors, describe capacitors and

			deduce the capacitance of a given electrostatic system. **6:** Understand behaviour of charge particle in magnetic field, Explain cycloid motion of charge particle. **7:** Know the use of current density, State and interpret the physical meaning of laws of magneto statics. **8:** Define a Nuclear reaction and understand its various varieties, know the difference between a Natural and Artificial radioactivity and the different kinematics associated with it. **9:** Apply the formulae's in various applications in Geo sciences and Nuclear Physics **10:** Understand the basic properties of Nucleus such as density, Magnetic moment, Electric dipole etc. **11:** Will be able to design simple electronic RLC circuits and solve the numericals of the above mentioned topics
2	PH-2502L	Physics Lab-II	**1:** By pursuing this course students understand the mechanical instrument to measure at accuracy 0.01cm and 0.001 cm. They also learn to read and use the digital multi-meter. **2:** This course makes students in capacity to have skill for: taking observations, representing data graphically, doing calculation from the data and graph and finding out the results/outcome/conclusions about the performed experiment. **3:** In this course students can describe the error specification among the experimental reading/observation using two techniques namely least square method and analysis of error.
3	PH-3501	Advanced Physics-I	**1:** Understanding the crystalline, polycrystalline and glassy materials and study of unit cell structures and its operations. **2:** Study of classification of crystal types and the indices of a lattice direction and plane, understanding the common crystal structures. **3:** Use of cohesion of atoms in the different types of bonds and its Madelung energy of ionic crystal.

			4: Understand the reciprocal lattice and crystal diffraction with its importance of Bragg Law and the construction of reciprocal lattice. **5:** Understand the basic characteristics of the transistor and two diode analogy for a transistor with its input characteristics. **6:** Study of class A amplifier and its input and output resistance with input waveform consideration. **7:** Understand the Black body radiation, Compton effect and Frank-Hertz experiment. **8:** Understand the correspondence principle and Bohr atom and Quantization of the orbits. **9:** Study diffraction of light with Frensnel's half period zones and difference between interference and diffraction. **10:** Understand and use of resolving power of optical instruments with Rayleigh's criterion of resolution and study of power grating with comparison of pate rism & grating spectra. **11:** Calculate numericals based on the above concepts and theory
3	PH-3502	Advanced Physics-II	**1:** Differentiate different types of motion and know how to calculate their KE, PE, Amplitude, Velocity, Acceleration, average value of any function. **2:** To write fourier series using sine cosine functions and in their complex form, find coefficients of various harmonics, sketch any given function and apply this knowledge in various fields associated with waves and oscillations. **3:** Calculate optimum reverberation time for any room and know whether it is a live room or dead room. This knowledge can be applied to day-to-day life in Architectural Acoustics. **4:** Apply knowledge of forces such as Coriolis force to explain natural physical processes such as the formation of cyclones and related technological advances. **5:** Use an understanding of elementary mathematics along with physical principles to effectively solve problems in collision encountered in everyday life, further study in science, and in the professional world.

			6: Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies. **7:** Define interaction of particles with matter which shall help him in the Study of various nuclear detectors. **8:** Analyse the working and construction of various nuclear accelerators used in the nuclear reaction. **9:** Define a macroscopic and microscopic state and understand the equilibrium state, Describe Phase space and will be able to find phase space trajectory. **10:** Apply Liouville's theorem to find the rate of the change in density of phase points at the point of interest-Liouville's, Derive Maxwell and Boltzmann distribution from Gibb's Distribution, Apply the principle of Boltzmann distribution for describing the variation of pressure with altitude **11:** Will be able to solve the numericals of the above mentioned concepts and theory.
3	PH-3503L	Physics Practicals	**1:** The strength of materials such as brass, iron etc. by determining their Young's Modulus, lattice constants of different crystals, fill factor of solar cells, and understand the applications of resonance in everyday life **2:** Wavelength of spectral lines using the phenomena of diffraction, curvature of plates using the phenomena of interference, resolving power of optical instruments, absorption coefficients of materials and distinguish first order and second order spectrum **3:** Current and voltage sensitivity of moving coil Galvanometers, capacitance and inductance in ac and dc bridge circuits and design voltage regulators, Power supplies, apply thermal runaway to design the biasing of circuits.
4	PH-4501	Modern Physics	**1:** Describe Lattice vibration as elastic wave in crystal, the propagation of this wave in 1-D monoatomic and diatomic crystal, Phonons and its characteristics.

			2: Describe specific heat using three models Dulong-Petit's model, Einstein's model and Debye's mode, and also derive thermal conductivity and thermal expansion. **3:** Deduce the existence of Entropy, potential functions of thermodynamics and state their characteristics. **4:** Use Maxwell relations to establish relations among difficult to measure and easy to measure thermodynamic quantities and solve problems related with TdS equations, Internal energy equations and specific heats **5:** Describe liquefaction of gases by throttling process. **6:** Know the factor causes thermal instability of Bipolar transistor. **7:** Design amplifier using BJT with different bias circuit, Analyze transistor amplifier using h parameters **8:** Measure the h parameters of transistor amplifier, find unknown L and C using AC bridges. **9:** Differentiate between the merits and demerits of various atomic models, with special thrust on vector model, utilize vector model to explain Atomic spectra. **10:** Utilize atomic spectra in understanding the modification of atomic spectra under the influence of magnetic field and electric field. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
4	PH-4502	Classical Physics	**1:** Define a macroscopic and microscopic state and understand the equilibrium state, Describe Phase space and will be able to find phase space trajectory. **2:** Apply Liouville's theorem to find the rate of the change in density of phase points at the point of interest-Liouville's, Derive Maxwell and Boltzmann distribution from Gibb's Distribution. **3:** Apply the principle of Boltzmann distribution for describing the variation of pressure with altitude.

			4: Able to differentiate between polarized and unpolarized light and explain pictorially the vibrations of E vectors in each case and demonstrate experiment to explain various optical phenomena. **5:** Explain the difference between Plane, Circularly and Elliptically polarized light and the methods to produce and detect them. The student will have understanding about half wave plate and quarter wave plate. And will be able to explain their applications. **6:** Describe geometry of calcite crystal and Nicol Prism and state their applications. **7:** Able to demonstrate the difference between ordinary and extra ordinary rays **8:** Explain construction and differentiate between different types of polaroid's and will be able to relate this concept with sun glasses available in the market. **9:** Systematic analysis of polarized light and the student will be able to demonstrate an understanding of the basic principles of special theory of relativity of space, time and mass. **10:** Student will be able to derive the mass energy relation and will develop explicit problem-solving techniques to solve problems of the relativistic mechanics. **11:** Will be able to solve the numericals of the concepts and theory in this course
4	PH-4503L	Physics Practical	**1:** Permeability of free space, high resistance by the method of leakage and explain the characteristics and applications of FET and UJT. **2:** The position of Cardinal points in optical lens system, resolving power of optical instruments, refractive index of extraordinary and ordinary rays, interpret the type of polarization, identify unknown elements in line spectra. **3:** Capacitance and inductance in ac and dc bridge circuits and design voltage regulators and interpret the characteristics of a transistor in CE mode

5	PH-5401	Introduction to Plasma Physics	**1:** Will be able to understand the plasma physics, concept of temperature and the plasma as fourth state of matter. **2:** Understand the types of plasma, plasma behavior and quasi-neutrality in detail. **3:** Will be able to understand Debye shielding, criteria for existence of plasma with its basic plasma diagnostics. **4:** Understand the single particle dynamics with charged particle motion in electric field and magnetic field. **5:** Will be able to understand combined electric and magnetic field, basics of drift of guiding center and gradient drift. **6:** Will be able to understand the curvature drift and magnetic mirror. **7:** Understand of plasma production and breakdown of gases with I-V characteristic of electrical discharge. **8:** Will be able to understand the Paschen curve and the Plasma devices and machines. **9:** Get an overview of glow discharge and DC and RF Sputtering. **10:** Will be able to understand the plasma application as Tokamaks, Space & Astrophysical plasmas.
5	PH-5501	Mathematical Physics, Classical Physics & Quantum Mechanics	**1:** Understand the importance of mathematical physics and apply it in various other branches of physics and in inter disciplinary studies. **2:** Apply the principle of method of separation of variables to any function with more than 1 variable apart from Helmholtz and Laplace equation. **3:** Understanding and apply the knowledge of choice of a coordinate system for separation of any given equation and analyse the problems using creative and critical thinking. **4:** Acquire the skill of problem solving and be in a position to tackle open ended problems that may cross disciplinary area boundaries. **5:** Understand the concept of homogeneous, linear, second order differential equation and be able to assess the nature of any given point where the solution of a given problem needs to be found and

			determine whether the solution for the given problem will exist or not. **6:** To solve any second order differential equation around an ordinary point and a regular singular point from all branches of physics and other disciplines. **7:** Acquire the skill of problem solving using creative and critical thinking and be in a position to analyse and tackle open ended problems that may cross disciplinary area boundaries. **8:** Apply their knowledge of classical mechanics to explain natural physical processes and related technological advances and they will be able to effectively solve problems involving macroscopic bodies encountered in everyday life, design experiments to explore physical principles, effectively communicate results, and critically evaluate related scientific studies. **9:** Describe linear vector space and explain Hilbert Space and define linear operator and Hermitian Operator and describe the Schmidt Orthogonalization procedure, calculate eigen values and eigen functions of the operators and Discuss the postulates of Quantum mechanics. **10:** Explain the general uncertainty relation and deduce Heisenberg's uncertainty relation. Evaluate the Fourier transform of function in the coordinate space. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
5	PH-5502	Molecular Spectroscopy, Statistical Mechanics & Solid State Physics	**1:** Give an account of the Salient features of Rotational spectra & Vibrational spectra, specify condition (molecular requirement) under which Rotational spectra of a molecule is observable, investigate characteristics of Pure rotational spectrum by considering rotating molecule as a Rigid rotator. **2:** Distinguish between Rotational spectrum of Rigid rotator & Non rigid rotator, know which information is provided by the study of Rotational spectra regarding the diatomic molecule, analyse expected vibrational spectra of diatomic molecule

			by considering it as a Harmonic oscillator & Anharmonic oscillator. **3:** Explain how the study of vibrational spectra of a diatomic molecule enable to determine Anharmonic constant & frequency of vibration, Descibe fine-structure of Infrared bands (P-branch & R-branch) by considering molecule as a vibrating-rotator, Distinguish between Stokes' Raman line & Antistokes' Raman line. **4:** Describe classical & quantum theory of Raman effect, investigate characteristics of vibrational Raman spectra & pure Rotational Raman spectra, Determine information regarding the structure of diatomic & polyatomic molecules from the study of Raman spectra. (e.g., CO2 is a linear molecule, while H2O is bent.) **5:** Point out the similarity & difference in Infrared spectra & Raman spectra, give examples that the occurrence of Raman spectra depends on the polarisability of the molecule but is entirely independent of the presence of a permanent dipole moment, understand why Raman spectra arise for visible light. **6:** Explain the fine structure observed in X-ray emission spectra, Describe the characteristics of X-ray spectra in emission & absorption. **7:** Differentiate system based on symmetry and anti-symmetry of their wavefunctions and derive appropriate distribution function (M-B, B-E or F-D) for them, Derive partition functions for ideal system with translational, rotational, vibrational, electronic and nuclear degrees of freedom and solve related problems. **8:** Apply tools of statistical mechanics to Bosonic system to derive important results for photons and phonon gas, to describe elastic waves in solids, stress and strains in cubic crystals, elastic constants for cubic crystals and elastic energy. **9:** To identify electrical properties in metal crystals using free electron gas theory in 1D and 3D further analysis with Fermi Derac statistics.

			10: To classify the resistivity of metal influenced by scattering of electrons and thermal conductivity and thermal expansion too. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
5	PH-5503	Electricity, Magnetism and Nuclear Physics-1	**1:** The student will learn a variety of advanced boundaries conditions by solving Poison`s and Laplace equations from which electric field can be evaluated. **2:** The student will learn to understand the behavior of electric charge to describe the electric field in specified region. **3:** The student will learn multipole expansion of electric potential and understanding of complex electric field and its impact on charges. **4:** The student will be able to distinguish between the various types of magnetic materials, namely diamagnetic, paramagnetic, ferromagnetic, ferrimagnetic etc. **5:** The student will learn to calculate the forces, torque and magnetic field at external point due to various types of magnetic materials **6:** Learn a variety of advanced mathematical methods and apply it to develop skill to solve numerical problems on it. **7:** The student will be able to understand the interaction of Alpha particles with matter and alpha spectrum. **8:** The student will be able to understand the Alpha decay paradox - barrier penetration, They will learn formulation of continuous Beta ray spectrum and Fermi's theory. **9:** The student will be able to distinguish between Liquid drop model and derivation of the Semi-empirical mass model of nucleus. **10:** The student shall explain B/A versus A curve using Liquid drop model and predicting stable element of a isobar family and fission problem. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
5	PH-5504	Electronics -I	**1:** Do the analytical study of the low, mid and high frequency response of the amplifier.

			2: Describe the square wave and step response of the cascade amplifier and transformer amplifier. **3:** Understand the concept of feedback used in the amplifier. **4:** Explain the advantages and disadvantages of negative feedback. **5:** Analyze the LC and RC oscillator. **6:** Design and analyze combinational digital circuit using K- map. **7:** Understand the function and applications of different types of the flip-flops. **8:** Analyze and design the series and parallel resonance circuit. **9:** Apply the network theorems to analyse the complex circuit. **10:** Study the bandwidth of antiresonant circuits.
5	PH-5505L	Physics Lab-V	**1:** Differentiate between bar pendulum, Kater's pendulum and report the main sources of error in the determination of acceleration due to gravity (g) using Kater's pendulum, Measure the temperature of the unknown substance by studying the variation of resistance of platinum wire and demonstrate the working of a Callendar Griffith Bridge, Operate Gieger Muller Tube (GM Tube) and demonstrate its characteristic **2:** Operate and the instruments and Demonstrate the Interference fringes obtained by Fabry Perot Etalon, Michelson's Interferometer, Bi prism and measure the wavelengths of the light used. Demonstrate the diffraction pattern of a spring and measure its diameter and helical pitch, obtain absorption spectrum of Iodine molecule and evaluate its disassociation energy and force constant. **3:** Determine the Mutual inductance of two coils and measure very low capacitance using Bridge circuits, to Investigate the Curie temperature of ferroelectric ceramic. Describe Molecular refraction and estimate dipole moment of water molecule. **4:** Understand the design and test the circuits of series parallel resonance, Hartley and Wein

			Bridge Oscillators, CE Amplifiers and to study the phenomenon of resonance
6	PH-6401	Project	**1:** Will be trained in identifying Projects by doing literature survey in forms of Research papers, journals and looking for ideas in internet. **2:** He/She is also encouraged to come with original ideas which explain the concepts of Physics and electronics. **3:** Will be trained in having "Hands on experience" with designing projects using various instruments, collecting data and in its analyses. **4:** Will be able to document his project by writing synopsis and project report **5:** Will be able to present his work in the form of PPT and in the process develops presentation skills.
6	PH-6501	Advanced Quantum Mechanics	**1:** Understand the importance of mathematical physics and will be able to apply it in various other branches of physics and in inter disciplinary studies. **2:** Understand and will be in a position to apply and analyze several new functions given below in open ended problems that may cross disciplinary area boundaries using creative and critical thinking. **3:** Apply their knowledge of Classical Mechanics to explain natural physical processes and related technological advances. **4:** They will be able to effectively solve problems encountered in everyday life, design experiments to explore physical principles, effectively communicate results, and critically evaluate related scientific studies. **5:** Describe Bloch waves in periodic potential, Solve Kronig- Penny Square-Well Periodic potential and evaluate the energy values in the Kronig- Penny model. **6:** Describe Linear Harmonic Oscillator (LHO) and apply Schrödinger method to determine energy levels, wave function and probability density of the various quantum states of LHO.

			7: Calculate the expectation value of potential energy and kinetic energy for the different states of Harmonic oscillator. **8:** Describe Hydrogen atom and apply Schrödinger method to determine energy levels, wave function and radial probability density of the various quantum states of Hydrogen atom. **9:** Describe particle moving in a spherically symmetric potential, Describe System of two interacting particles and illustrate rigid rotator. **10:** Discuss three-dimensional square well potential, Apply three-dimensional square well potential to describe the ground state of deuteron nucleus. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
6	PH-6502	Molecular Spectroscopy, Lasers and Statistical Mechanics	**1:** Classify the different electronic states of a diatomic molecule & Explain meaning of the various symbols in the notations used in the electronic spectrum of a diatomic molecule. **2:** Explain the vibrational structure of Electronic band system in Emission & Construct Deslandre table to analyse these bands. **3:** Demonstrate the experimental arrangement to record absorption spectrum of I_2- molecule & explain importance of the study of absorption spectra over that of emission spectra. **4:** Describe rotational fine structure of electronic vibrational transitions & Fortrate parabola. **5:** Describe Franck-Condon principle in emission & absorption& Explain intensity distribution in absorption bands & emission bands. **6:** Give wave mechanical interpretation of Franck-Condon principle & explain how does it help in understanding the intensity distribution in the vibrational structure of the electronic transitions of a diatomic molecule. **7:** Describe transport phenomena like viscosity, thermal conduction, thermionic emission, photoelectric effect, molecular collision, effusion, diffusion and Brownian motion and derive necessary fundamental questions for them.

			8: Describe the requirements for a system to act as a laser, Differentiate the various types of lasers and their means of excitation. **9:** Describe the structure and properties of various lasers, understand their performance and intended applications. **10:** Assess which laser would best meet the need for a particular industrial or research task, Demonstrate an awareness of the safety responsibilities involved in working with lasers. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
6	PH-6503	Electromagnetism, Solid State Physics and Nuclear Physics-II	**1:** In the study of Electrodynamics Maxwell`s equations and time varying Electromagnetic fields Describe various electromagnetic phenomena which is evolved. **2:** At the end of the study Concept of electromagnetic wave and its characteristics, energy flux and momentum of fields, and radiation pressure can be understood. **3:** Various optical phenomena like Reflection, refraction and polarization though Electromagnetic wave could be related. **4:** In this course students will be able to classify the magnetism by classical model of diamagnetic system and classical, Weiss and quantum model of paramagnetic system. **5:** Overview of ferromagnetism with hysteresis behavior of ferromagnetic materials and characteristics. **6:** Account for the fission and fusion processes and the basic properties of the nuclear fission and fusion reactor and analyze the design of a reactor with the four-factor formula. **7:** Explain the Mossbauer effect and understand its application to study hyperfine structure, calculate the quadrupole moment and magnetic splitting energy, describe the hyperfine structure. **8:** Describe various types of forces, describe the various particles existing in this universe **9:** Describe the interaction between particles and the Physics which governs their existence.

			10: Describe the Quark hypothesis and standard model. **11:** Will be able to solve the numericals of the above mentioned concepts and theory
6	PH-6504	Electronics -II	**1:** Differentiate between BJT and FET. **2:** Analyze and design different types of the FET amplifier. **3:** Describe characteristics and parameters of the OPAMP. **4:** Design the binary Adder and Subtractor circuits. **5:** Design and analyze the logic circuit using multiplexer and decoder combinational circuit. **6:** Design, test and troubleshoot problems in voltage regulators, power supplies and electrostatic/magnetic cathode ray tubes /oscilloscopes. **7:** They will be able to use an understanding of electronic devices to effectively solve problems encountered in everyday life, design experiments to explore physical principles, effectively communicate results, and critically evaluate related scientific studies. **8:** Explain the modulation process. Differentiate between AM, FM and PM wave. **9:** Analyze the AM wave and gets the importance of the sideband in communication. **10:** Summarized the different technique like DSBSC, SSB used in AM.
6	PH-6505L	Physics Lab-VI	**1:** Employ power transistor to investigate the variation of collector current against temperature and determine the ratio of ‘e/k’. **2:** Calibrate spectrometer using Edser -Butler plate and find unknown wavelength. Analyze elliptically polarized light using Babinate’s Compensator. Demonstrate the Millikan’s experiment and determine the charge of electron. **3:** Set up heavy side bridge and determine mutual inductance and self inductance. Employ Rayleigh’s Bridge to determine self inductance of inductor. **4:** Understand the concepts of magnetism like hysteresis and susceptibility and Hall Effect and Determine permeability of free space ,

			susceptibility and Hysteresis of ferromagnetic substance. **5:** Learn to Design and test electronic circuits like Common source FET amplifier and determine Band width, Colpitt's oscillator , negative feedback CE Amplifier, voltage regulator circuit using IC-7805 and investigate load regulation, OP AMP as inverting amplifier. **6:** Develop skill for data analysis and graph plotting using Excel.