Course Outcomes in B.Sc Physics (Honours)

1.1 Nature and extent of UG program in Physics:

The UG programs in Physics builds on the basic Physics taught at the +2 level in all the schools in the country. Ideally, the +2 senior secondary school educations aims a sound grounding in understanding the basic Physics with sufficient content of topics from modern Physics and contemporary areas of exciting developments in physical sciences to ignite the young minds. The curricula and syllabi is framed and implemented in such a way that the basic connection between theory and experiment and its importance in understanding Physics should be apparent to the student. This is very critical in developing a scientific temperament and urge to innovate, create and discover in Physics. Unfortunately the condition of our school system in most parts of the country lacks the facilities to achieve the above goal and it is incumbent upon the college/university system to fill the gaps in the knowledge creation of our young minds created by the lack of infrastructural and academic resources of our school system and strengthen their understanding in all the subjects through the UG programs specially in Physics and other science subjects.

1.2 Aims of UG program in Physics:

The aims and objectives of our UG educational programs in sciences in general and Physics in particular is structured to

- Create the facilities and environment in all the educational institutions to consolidate the knowledge acquired at +2 level and to motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
- Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
- Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
- Expose the student to the vast scope of Physics as a theoretical and experimental science with applications in solving most of the problems in nature spanning from 10^{-15} m to 10^{26} m in space and 10^{-10} eV to 10^{25} eV in energy dimensions.
- Emphasize the discipline of Physics to be the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
- To emphasize the importance of Physics as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

In view of opening the new windows in higher education and research and opening job opportunities at all levels from technicians to innovator scientists and engineers, two undergraduate programs are offered in our universities and other higher education institutions (HEI) at the entry level of our higher education system.

2. Graduate attributes in Physics

Some of the characteristic attributes of a graduate in Physics are

- **Disciplinary knowledge and skills:** Capable of demonstrating

(i) good knowledge and understanding of major concepts, theoretical principles and experimental findings in Physics and its different subfields like Astrophysics and Cosmology, Material science, Nuclear and Particle Physics, Condensed matter Physics, Atomic and Molecular Physics, Mathematical Physics, Analytical dynamics, Space science and other related fields of study, including broader interdisciplinary subfields like Chemistry, Mathematics, Life sciences, Environmental sciences, Atmospheric Physics, Computer science, Information Technology etc.

(ii) ability to use modern instrumentation and laboratory techniques to design and perform experiments is highly desirable in almost all the fields of Physics listed above in (i).

- **Skilled communicator:** Ability to transmit complex technical information relating all areas in Physics in a clear and concise manner in writing and oral ability to present complex and technical concepts in a simple language for better understanding.
- **Critical thinker and problem solver:** Ability to employ critical thinking and efficient problem solving skills in all the basic areas of Physics.
- **Sense of inquiry:** Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics, and planning, executing and reporting the results of a theoretical or experimental investigation.
- **Team player/worker**: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in industry and field-based situations.
- **Skilled project manager:** Capable of identifying/mobilizing appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct; and safety and laboratory hygiene regulations and practices.
- **Digitally Efficient*:*** Capable of using computers for simulation studies in Physics and computation and appropriate software for numerical and statistical analysis of data, and employing modern e-library search tools like Inflibnet, various websites of the renowned Physics labs in countries like the USA, Europe, Japan etc. to locate, retrieve, and evaluate Physics information.
- **Ethical awareness / reasoning*:*** The graduate should be capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or

misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, and adopting objectives, unbiased and truthful actions in all aspects of work.

- **National and international perspective*:*** The graduates should be able to develop a national as well as international perspective for their career in the chosen field of the academic activities. They should prepare themselves during their most formative years for their appropriate role in contributing towards the national development and projecting our national priorities at the international level pertaining to their field of interest and future expertise.
- **Lifelong learners:** Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and re-skilling in all areas of Physics.

3. Qualification descriptors for B.Sc. Physics (Honours)

The qualification descriptors for a B.Sc Physics (Honours) Program may include the following. The graduates should be able to:

- Demonstrate

(i) A systematic, extensive and coherent knowledge and understanding of the academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of Physics;

(ii) Procedural knowledge that creates different types of professionals related to the subject area of Physics, including research and development, teaching and government and public service;

(iii) Skills in areas related to one's specialization area and current developments in the academic field of Physics, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.

- Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to various subfields in Physics, and techniques and skills required for identifying Physics problems and issues in their area of specialization in Physics.
- Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources from the Physics labs around the world, analysis and interpretation of data using methodologies as appropriate to the subject of Physics in the area of his specialization.

- Use knowledge, understanding and skills in Physics for critical assessment of a wide range of ideas and complex problems and issues relating to the various sub fields of Physics.
- Communicate the results of studies undertaken in the academic field of Physics accurately in a range of different contexts using the main concepts, constructs and techniques of the subject of Physics;
- Address one's own learning needs relating to current and emerging areas of study relating to Physics, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge in Physics.
- Apply one's knowledge and understandings relating to Physics and skills to new/unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.
- Demonstrate subject-related and transferable skills that are relevant to some of the Physics related jobs and employment opportunities.

4. Programme learning outcomes in B.Sc Physics (Honours)

The student graduating with the Degree B.Sc Physics (Honours) should be able to

- Acquire

(i) a fundamental/systematic or coherent understanding of the academic field of Physics, its different learning areas and applications in basic Physics like Astrophysics, Material science, Nuclear and Particle Physics, Condensed matter Physics, Atomic and Molecular Physics, Mathematical Physics, Analytical dynamics, Space science, and its linkages with related disciplinary areas/subjects like Chemistry, Mathematics, Life sciences, Environmental sciences, Atmospheric Physics, Computer science, Information Technology;

(ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service;

(iii) skills in areas related to one's specialization area within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.

- Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
- Recognize the importance of mathematical modeling simulation and computing, and the role of approximation and mathematical approaches to describing the physical world.

- Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Physics.

- Demonstrate relevant generic skills and global competencies such as

(i) problem-solving skills that are required to solve different types of Physics-related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary area boundaries;

(ii) investigative skills, including skills of independent investigation of Physics-related issues and problems;

(iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature;

(iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Physics and ability to translate them with popular language when needed;

(v) ICT skills;

(vi) personal skills such as the ability to work both independently and in a group.

- Demonstrate professional behavior such as

(i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism;

(ii) the ability to identify the potential ethical issues in work-related situations;

(iii) appreciation of intellectual property, environmental and sustainability issues; and

(iv) promoting safe learning and working environment.

COURSE OUTCOMES OF PHYSICS

Course Code	*GENERAL Courses*	*Outcomes*
PHY/I/EC/01(T) **Paper-I**	**Properties of Matter, Oscillations & Acoustics**	To build the foundation of Physics, Mechanics is very important. Hence the students learn Newton's Laws of motion, gravitation etc., Mechanics of Solids & Special Relativity, Properties of matter e.g. Elasticity, Fluid motion, Surface tension etc. They also understand about Harmonic oscillations, pendulum etc, Forced & free vibrations, acoustics etc.
PHY/I/EC/02(P)	**LABORATORY – I**	In this lab course, the students will gain hands-on experience in performing different experiments, such as, to determine the acceleration due to gravity by Bar pendulum, to determine the Young's modulus of a wire by Searle method, to determine the refractive index of a liquid by using a Travelling microscope etc, all related to general physics course.
PHY/II/EC/03(T) **Paper-II**	**Thermodynamics & Mathematical Physics-I**	In this paper, students learn about Ideal Gas, Kinetic Theory etc., Laws of thermodynamics. Also basic knowledge of Mathematics is important. So they learn about Vectors, Curvilinear Coordinates & Tensors, Matrices, Beta & Gamma functions
PHY/II/EC/04(P)	**LABORATORY - II**	In this lab course, the students will gain knowledge related to magnetism, e.g. to determine horizontal component H and the magnetic moment M of a bar magnet with the help of a magnetometer, to determine the angle of dip at a place by dip circle, Verification of inverse square law in magnetism, etc.
PHY/III/EC/05(T) **Paper-III**	**Electromagnetism and Optics**	Students Understand the basic laws of Electrostatics, Electric currents, Networks & A.C., Magnetism & E.M. Induction. Also they learn about Optics, especially physical optics : Interference & Polarization, Diffraction
PHY/III/EC/06(P)	**LABORATORY - III**	In this practical paper, students learn about to determine the focal length of two convex lenses and their combination by displacement method, to determine the magnifying power of a telescope, to measure unknown resistance by using Post Office Box, etc. Students now become familiar with Physics Lab.
PHY/IV/EC/07(T) **Paper-IV**	**Atomic, Nuclear Physics -I and Solid State Physics-I**	Students Learn about basics of Modern Physics, particularly Atomic Physics, Nuclear Physics, Crystal structures, X-ray diffraction & Bonding in crystal and Solid state Physics
PHY/IV/EC/08(P)	**LABORATORY - IV**	In this practical paper, students learn about Electronics expts., such as to draw the characteristics curves of semiconductor diode and Zener diode, to determine the energy gap of a diode, to study the various Transistor biasing configurations, to study the static characteristics of a transistor in CE/CB configuration.

Course Code	*CORE Courses*	*Outcomes*
PHY/V/CC/09(T) **Paper-V**	**Mathematical Physics-II**	In this paper, few advanced concepts of Mathematical Physics are taught, namely Complex Variables, Differential Equations, Polynomials & Special functions, Fourier Series & Transform, Laplace Transform. After learning this paper, they become familiar in solving Mathematical problems.
PHY/V/CC/10(T) **Paper-VI**	**Electronics-I**	Here the students learn basics of Electronics- Semiconductors, Diodes & Rectifiers, Transistors and their use as Amplifiers & Oscillators. They also know about OP AMP and its various applications. Also they gain ideas of Boolean algebra, Logic gates and digital electronics.
PHY/V/CC/11(T) **Paper-VII**	**Classical Mechanics and Nuclear Physics-II**	Students gain knowledge on Advanced Classical mechanics, General Properties of Nucleus, Radioactivity, Nuclear models and Reactions, Accelerators and Detectors, Cosmic Rays & Elementary particles.
PHY/V/CC/12(P)	**LABORATORY - V**	After mastering the general experiments, students now can handle difficult experiments, such as to determine the value of g by Kater's pendulum, to determine the modulus of rigidity of a cylindrical body by statical method. The can use the CRO for the study of A.C. supply waveform and compare the frequencies. Also they study a CE amplifier of a given gain (mid-gain) using Voltage divider bias, draw the B-H curve of an iron sample and also draw the plateau of a GM counter and carry out the statistical analysis.
PHY/V/CC/13(P)	**LABORATORY - VI**	In this lab. course, students will perform more difficult experiments, such as to determine the thermal conductivity of a bad conductor by Lee's method, to verify the Stefan's 4^{th} power law, to determine the value of mechanical equivalent of heat by Joule's electrical calorimeter, to determine the thermal conductivity of a metallic rod by Searle's method, etc.
PHY/V/CC/14(P)	**LABORATORY - VII**	Students now enter the Dark room to carry out Optical experiments, such as to measure the width of a single slit from the study of its Fraunhoffer diffraction, to determine the radius of curvature of a convex lens by Newton's rings method, Refractive index of the material of a prism etc.
PHY/V/CC/15(a)(T) **Paper-VII**	**Atomic and Molecular Spectroscopy**	Students understand the structure of Atoms, molecules and the effects of electric and magnetic fields on the atoms and molecules. They also learn X-ray & Laser Spectroscopy and molecular Spectroscopy, Raman effect , Zeeman effect, Stark effect, etc

PHY/V/CC/16(P)	**LABORATORY - VIII**	In this lab. course students learn to use computers and do C++ Programming to solve various mathematical problems, e.g. solving a quadratic equation, matrix addition/multiplication. They also apply numerical techniques like, Newton-Raphson method, Runge-Kutta method to solve different problems.
PHY/VI/CC/17(T) **Paper-IX**	**Quantum Mechanics**	Students gain knowledge of the Origin of the quantum theory, Schrodingers' equation and Applications, Operator method in quantum mechanics, Angular momentum and spin. They also gain basic knowledge of Vector spaces.
PHY/VI/CC/18(T) **Paper-X**	**Electromagnetic Theory**	Course contains Faraday's law for electromagnetic induction, Maxwell's equations, Propagation of electromagnetic waves, Magnetic Scalar potential, Poisson's equation. Students also know about thermal radiation and LASER.
PHY/VI/CC/19(T) **Paper-XI**	**Thermal and Statistical Physics**	It's an advanced course. Here Students learn about Kinetic theory of Matter, transport phenomena, Thermodynamics. They also learn the Statistical mechanics, Statistical basis of thermodynamics, ensembles: Canonical, Micro-canonical, grand-canonical. Finally they learn MB, FD and BE statistics.
PHY/VI/CC/20(P)	**LABORATORY – IX**	In this lab. course, students do few advanced experiments, e.g. to determine the value of e/m of electron, measuring Planck's constant by photocell, to determine the figure of merit of a galvanometer and Calibration of an ammeter and a voltmeter by using a potentiometer.
PHY/VI/CC/21(P)	**LABORATORY – X**	In this advanced lab. course, students do few electronics experiments e.g. to study the Frequency Response and Voltage Gain of a RC-Coupled Amplifier, to measure the capacitance by de Sauty's method, to study the series and parallel resonance circuits with A.C. source and draw the current frequency curve and calculate Q value. They also Study of OP-AMP characteristics and use of OP-AMP as a) Adder and Subtractor b) Differentiator and Integrator.
PHY/VI/CC/22(P)	**LABORATORY - XI**	In this Lab. course, students do expts. on Digital Electronics, e.g. to verify and AND, OR, NOT and XOR gates using NAND gates, to study of Half Adder, Full Adder and Full Subtractor. They also do an expt. on analog to Digital (AD) convertor.
PHY/VI/CC/23(a)(T) **Paper-XII**	**Solid State Physics-II**	In this course, students are expected to gain knowledge on Lattice vibrations, elastic waves & phonons, Magnetic properties of materials, Dielectric materials & properties, Band theory of solids. They know also about Superconductivity.
PHY/VI/CC/24(P)	**LABORATORY - XII**	In this lab. course, students do FORTRAN Programming to solve various mathematical problems, e.g. solving a quadratic equation, matrix addition/multiplication. They also apply numerical techniques like, Newton-Raphson method, Runge-Kutta method to solve different problems.