Course Outcomes for the B. Sc. Program in Physics

The Board of Studies in Physics (UG) recognizes that curriculum, course content and assessment of scholastic achievement play complementary roles in shaping education. The committee is of the view that assessment should support and encourage the broad instructional goals such as basic knowledge of the discipline of Physics including phenomenology, theories and techniques, concepts and general principles. This should also support the ability to ask physical questions and to obtain solutions to physical questions by use of qualitative and quantitative reasoning and by experimental investigation. The important student attributes including appreciation of the physical world and the discipline of Physics, curiosity, creativity and reasoned skepticism and understanding links of Physics to other disciplines and to societal issues should gave encouragement. With this in mind, we aim to provide a firm foundation in every aspect of Physics and to explain a broad spectrum of modern trends in physics and to develop experimental, computational and mathematics skills of students.

The programme also aims to develop the following abilities:

1. Read, understand and interpret physical information-verbal, mathematical and graphical.
2. Impart skills required to gather information from resources and use them.
3. To give need based education in physics of the highest quality at the undergraduate level.
4. Offer courses to the choice of the students.
5. Perform experiments and interpret the results of observation, including making the B. Sc. Programme in Physics, an assessment of experimental uncertainties.

6. Provide an intellectually stimulating environment to develop skills and enthusiasm of students to the best of their potential.
7. Use Information Communication Technology to gather knowledge at World level.
8. Attract outstanding students from all backgrounds.
9. At the completion of B. Sc. in Physics students are able to: Demonstrate a rigorous understanding of the core theories & principles of Physics, which includes Mechanics, Electricity, Thermodynamics, & Quantum mechanics.

10. Learn the Concepts as Statistical Mechanics, Relativity, introduced at degree level in order to understand nature at atomic levels. Provide knowledge about material properties and its application for developing technology to ease the problems related to the society. Understand the set of physical laws, describing the motion of bodies, under the influence of a system of forces.

11. Understand the relationship between particles & atoms, as well as their creation & decay. Relate the structure of atoms & subatomic particles understand physical properties of molecules, the chemical bonds between atoms as well as molecular dynamics. Analyze the applications of mathematics to the problems in Physics & develop suitable mathematical methods for such application & for formulation of physical theories. Learn the structure of solid materials & their different physical properties along with metallurgy, cryogenics, electronics & material science. Understand the fundamental theory of nature at small scale & levels of atom & subatomic particles.

Objectives: The syllabi are framed in such a way that it bridges the gap between the plus two and postgraduate levels of Physics by providing a more complete and logical framework in almost all areas of basic Physics. By the end of the first year (IInd semester), the students should have attained a common

level in basic mechanics, a secure foundation in mathematics, Chemistry(otherwise specified), Languages and other relevant subjects to complement the core for their future courses and developed their experimental and data analysis skills through experiments at laboratories. By the end of the second year (IVth semester), the students should have been introduced to powerful tools for tackling a wide range of topics in Optics, Laser, Fiber Optics, Semiconductor devices and circuits. By the end of the third year (VIth semester), the students should have developed their understanding of core Physics by covering a range of topics in almost all areas of physics including Classical and Quantum Mechanics, Electricity and Electrodynamics, Relativity and Spectroscopy, Thermal and Statistical Physics, Nuclear and Particle physics, Solid State Physics, Digital Electronics etc. along with one choice based courses and had experience of independent work such as projects; seminars etc. and thereby developing their experimental skills through a series of experiments which also illustrate major themes of the lecture courses.

The Course outcomes for the courses provided by Department of Physics, Nevjabai Hitkarini College Bramhapuri are as follows:

SEMESTER I (CBCS)

PAPER-I: USPHT01: MECHANICS AND RELATIVITY

This course will be an introduction to the pursuit of Physics, its history and methodology. The course also aims to make the students understand the basic concepts of Mechanics and Relativity as core parts of the subject. This course would empower the student to acquire engineering skills and practical knowledge, which help the students in their everyday life**.** The course explains

the true nature of Newtonian mechanics and Lorentz transformation equations. Theory of relativity provides intellectual food for students interested in theoretical studies and provides students with knowledge and proof of the validity of Physical Laws and non existence of the hypothetical stationary ether.

PAPER-II: USPHT02: GRAVITATION, OSCILLATION & PROPERTIES OF MATTER

Students should understand the concept related with Gravitation and Properties of Matter. The properties of solids, especially knowledge of elasticity, help the students to identify the materials suitable for the construction of buildings, houses etc. Properties of fluids, especially knowledge of viscosity and surface tension, help the students in their daily life and agriculture. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas.

SEMESTER II (CBCS)

PAPER-I: USPHT03: VECTOR ANALYSIS AND ELECTROSTATICS

This course will be introduced to make the students understand the basic concepts of vectors and vector analysis and its applications in electrostatics as a core part of the subject. The purpose of the course is to provide an understanding of the basic relations of vector analysis, to demonstrate practical applications of vector analysis and to train the student in problem formalization and in methods of solution. Apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances.

PAPER-II: USPHT04: MAGNETOSTATICS & EM WAVES

Students will learn scientific, mathematical and engineering principles that enable them to understand forces, fields, and waves; know how devices work that use those principles and phenomena; and be familiar with the historical context in which development of knowledge and devices occurred. This is an intermediate level course in electromagnetic fields and assumes a background in electrostatics, magnetostatics and introductory knowledge in electrodynamics. The main objective is to introduce electromagnetic fields with emphasis on analytical rigor and physical reasoning required for solving problems having direct application. The course will also provide sufficient background to motivate students to take up advanced levels courses such as, electromagnetic scattering, computational electrodynamics, etc.

SEMESTER III

PAPER-I: USPHT05: THERMAL PHYSICS

This course will provide a theoretical basis for doing experiments in related areas and fundamental understanding of the first and second laws of thermodynamics and their application to a wide range of systems. Thermodynamics is a course that explores the concepts of heat and how it can be converted to power, and covers all aspects of energy and energy transfer. The course also gives an introduction to signal analysis and measurement techniques as well as human response to sound and vibration. The goal is to give the student a good understanding of thermodynamics and their related properties.

PAPER-II: USPHT06: RADIATION & STATISTICAL PHYSICS

Students will have achieved the ability to find the connection between statistics and thermodynamics, differentiate between different ensemble theories used to explain the behavior of the systems, differentiate between classical statistics and quantum statistics & explain the statistical behavior of ideal Bose and Fermi systems.

On satisfying the requirements of this course, students will have the knowledge and skills to: 1. Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, free energies, and partition functions. 2. Use the statistical physics methods, such as Boltzmann distribution, Gibbs distribution, and Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems. 3. Apply the concepts and principles of black-body radiation to analyze radiation phenomena in thermodynamic systems.

SEMESTER IV

PAPER-I: USPHT07: WAVES, ACOUSTIC & LASER

This course is intended to provide an introduction to Waves, Acoustic & Laser in detail. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas of Waves, Acoustics and Laser.

PAPER-II: USPHT08: OPTICAL PHYSICS

Students will be familiar with the important and fascinating areas of interference with many experiments associated with it. Differentiate between Fraunhofer and Fresnel diffraction & apply skill to find the wavelength of

spectral lines using Plane diffraction grating, Distinguish the methods of polarization by reflection, refraction and scattering, explain the Brewster's law and Malus law. Upon successful completion, students will have the knowledge and skills to: 1. Understand and be able to explain the principles and operation of a laser Gain hands-on experience in working with lasers, 2.understand and be able to apply the principles of optical modulation and detection as well as evaluate its performance. 3. Understand nonlinear optics and photonics phenomena and how they impact modern advanced technological systems. 4. Generate succinct laboratory reports based on experimental observations and theoretical analysis. 5. Demonstrate effective team work in laboratory experiments.

SEMESTER V

Paper-I: USDSEPHT09: ELEMENTS OF MODERN PHYSICS

Students will be familiar with the main aspects of the historical development of quantum mechanics and be able to discuss and interpret experiments that reveal the wave properties of matter, as well as how this motivates replacing classical mechanics with a wave equation. Spectroscopic studies were central to the development of Quantum mechanics and study of atoms and molecules. The concepts of Quantum Mechanics lie at the heart of what we understand science to be. The first part of this course will explain and describe the fundamental mathematical and scientific framework that underpins Quantum Mechanics. The second part of this course will describe the structure of atoms, and the interactions between atoms, as well as the effects of electric and magnetic fields on atomic and molecular structure.

PAPER-II: USDSEPHT09: SOLID STATE PHYSICS

This course is intended to provide an introduction to the physics of Solid Matter. This study attempts to explain various types of phenomena like electro-magnetic properties, superconductivity and superfluidity. Material science is a very wide branch where extensive research is going on. Thermal, electrical, optical and magnetic properties of matter provide a strong foundation in that direction. Understand the crystal structure, thermal properties and magnetic properties of materials. Recognize the applications of X-ray crystallography. The structure of materials is the key deciding factor for different kinds of properties, such as thermal, electrical, optical, magnetic, dielectric etc. In this course we will learn the structure of solid materials and their different physical properties along with underlying physics.

SEMESTER VI

PAPER-I: USDSEPHT13: NUCLEAR & PARTICLE PHYSICS

This course intended to explore the interior of the nucleus and interaction between nucleons. Students will get good theoretical basis of nuclear fission, which is the basis of atom bomb and nuclear fusion, basis of hydrogen bomb and energy production in stars. This course introduces students to the fundamental concepts of building up complexity from elementary constituents in the framework of nuclear and subnuclear physics. Starting with an overview of the development of nuclear and particle physics, the course builds on previous learning in quantum mechanics and electromagnetism to develop students' understanding of the properties of the strong and weak forces.

PAPER-II: USDSEPHT14: DIGITAL & ANALOG CIRCUIT & INSTRUMENTATION

This course is expected to provide necessary background for applications of electronics in mathematical computation. Students will familiarize themselves with logic circuits and their applications which enable them to design logic circuits of their own.

Learning Outcomes for the B. Sc. Undergraduate program in Physics

Physics of B.Sc. students will be able to understand:

- ***Content:*** Demonstrate conversance with many topics in each of Classical & Relativistic Mechanics, Quantum Mechanics, Electromagnetism/Optics, Thermodynamics/Statistical Mechanics, and Mathematical Physics, as defined by the commonly-used undergraduate textbooks that we used. Not all topics in each subfield will be mastered or even addressed, but enough will be presented that students will be able to self-teach those not covered.
- ***Multiple representations of scientific information:*** Demonstrate the ability to translate a physical description to a mathematical equation, and conversely, explain the physical meaning of the mathematics, represent key aspects of physics through graphs and diagrams, and use geometric arguments in problem-solving.
- ***Organized knowledge:*** Students will be able to describe the big ideas in physics and articulate how these central concepts recur in physics – oscillations & waves, eigenstates, conservation laws, energy, symmetry, and discrete-to-continuous descriptions.

- ***Communication:*** Demonstrate the ability to justify and explain their thinking and/or approach, both written and oral. Demonstrate the ability to present clear, logical and succinct arguments, including prose and mathematical language. Write and speak using professional norms, and demonstrate an ability to collaborate effectively.
- ***Problem-solving strategy:*** Demonstrate the ability to organize and carry out long, complex physics problems, articulate expectations for, and justify reasonableness of solutions, state strategy/model and assumptions, and demonstrate an awareness of what constitutes sufficient evidence or proof.
- ***Intellectual maturity:*** Demonstrate the ability to be aware of what they don't understand, as evidenced by asking sophisticated, specific questions; articulating where they experience difficulty; and taking actions to move beyond that difficulty.
- ***Research:*** Make the measurements on physical systems understanding the limitations of the measurements and the limitations of models used to interpret the measurements, computationally model the behavior of physical systems, and understand the limitations of the algorithm and the machine. Complete an experimental, computational or theoretical research project under the guidance of faculty and report on this project in writing and orally to an audience of peers and faculty.

In Addition to above

- Students will be able to demonstrate their understanding of the foundations in physics by demonstrating competence in the major through appropriate homework assignments and examinations, particularly in their upper-level physics courses. Homework assignments within this learning outcome refer specifically to more traditional forms of mathematical and

problem solving activities common to all physics classes (including lower-level introductory classes).

- Students will be able to demonstrate competency in experimental design and scientific data collection and analysis.
- Students will be able to demonstrate competency in their understanding of scientific information, both orally and in writing.
- Upon taking the foundational courses in physics (Classical Mechanics, Computational Physics, Electricity and Magnetism, Modern Physics, Waves and Optics, and Quantum Mechanics) students will be able to integrate competently the knowledge and skills acquired in the major and have adequate preparation to succeed in post-undergraduate studies or a professional career.
- Students will demonstrate written and oral communication skills in communicating physics-related topics.
- Students will design and conduct an experiment (or series of experiments) demonstrating their understanding of the scientific method and processes. Students will demonstrate an understanding of the analytical methods required to interpret and analyze results and draw conclusions as supported by their data.
- Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.
- Students will utilize a wide range of printed and electronic resources and information technologies to support their research on physical systems and present those results in the context of the current understanding of physical phenomena.

- Students will demonstrate understanding of the applications of numerical techniques for modeling physical systems for which analytical methods are inappropriate or of limited utility.
- Students will demonstrate a thorough understanding of the analytical approach to modeling of physical phenomena.
- Students will demonstrate an understanding of the impact of Physics and science on society.
- Demonstrate proficiency in the collection, analysis and interpretation of data.
- Communicate scientific information in oral, written, and graphical formats.
