SRI VENKATESHWARA GOVERNMENT ARTS & SCIENCE COLLEGE, PALEM

DEPARTMENT OF PHYSICS

Learning Outcomes for undergraduate Education in Physics

1. 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.
- **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 reskilling in all areas of Physics.

The graduates should be able to:

- Demonstrate

  (i) a fundamental/systematic or coherent understanding of the academic field of Physics, its different learning areas like Astrophysics, Material science, Nuclear and Particle Physics, Condensed matter Physics, Atomic and Molecular Physics, Mathematical Physics, Analytical dynamics, Space science and applications, 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 different areas of study in Physics outlined above, including research and development, teaching and government and public service;

(iii) skills in areas related to specialization area relating the subfields and current developments in the academic field of Physics.

- Use knowledge, understanding and skills required for identifying problems and issues relating to Physics, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources from various Physics laboratories of the world, and their application, analysis and evaluation using methodologies as appropriate to Physics for formulating new theories and concepts.
- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of Physics. Develop communication abilities to present these results in technical as well as popular science meetings organized in various universities and other private organizations.
- Ability to meet one's own learning needs, drawing on a range of current research and development work and professional materials, and interaction with other physicists around the world.
- Apply one's knowledge of Physics and theoretical and laboratory skills to new/unfamiliar contexts to identify and analyse problems and issues and solve complex problems in Physics and related areas with well-defined solutions.
- Demonstrate Physics-related technological skills that are relevant to Physics-related job trades and employment opportunities.

2. Program learning outcomes relating to B.Sc. Courses in Physics:

The student graduating with the Degree B.Sc. with physics 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.

MECHANICS, WAVES AND OSCILLATIONS (I PAPER)

(i) Course learning outcome:

After going through the course, the student should be able to

- Understand laws of motion and their application to various dynamical situations, notion of inertial frames and concept of Galilean invariance. He / she will learn the concept of conservation of energy, momentum, angular momentum and apply them to basic problems.
- Understand the analogy between translational and rotational dynamics, and application of both motions simultaneously in analyzing rolling with slipping.
- Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.
- Understand the phenomena of collisions and idea about center of mass and laboratory frames and their correlation.
- Understand the principles of elasticity through the study of Young Modulus and modulus of rigidity.
- Understand simple principles of fluid flow and the equations governing fluid dynamics.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit, through the study of law of Gravitation.

- Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting in a merry-go-round experiences an outward pull.
- Describe special relativistic effects and their effects on the mass and energy of a moving object.
- appreciate the nuances of Special Theory of Relativity (STR)

- 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) and fluid dynamics (verification of Stokes law, Searle method) etc.

- Understand the concepts of mechanics, acoustics and the properties of matter
- Understand physical characteristics of SHM and obtaining solution of the oscillator using differential equations
- Calculate logarithmic decrement relaxation factor and quality factor of a harmonic oscillator
- Use Lissajous figures to understand simple harmonic vibrations of same frequency and different frequencies
- Solve wave equation and understand significance of transverse waves
- Solve wave equation of a longitudinal vibration in bars free at one end and also fixed at both the ends.

(ii) Broad contents of the course:

- Fundamental of Dynamics
- Work and Energy
- Collisions
- Rotational Dynamics
- Elasticity
- Fluid Motion
- Gravitation and cathode force Motion
- Oscillation
- Non-inertial Systems

- Special Theory of Relativity

(iii) Skills to be learned:

- Learn basics of the kinematics and dynamics linear and rotational motion.
- Learn the concepts of elastic in constant of solids and viscosity of fluids.
- Develop skills to understand and solve the equations of Newtonian Gravity and central force problem.
- Acquire basic knowledge of oscillation.
- Learn about inertial and non-inertial systems and essentials of special theory of relativity.

THERMODYNAMICS & OPTICS (II PAPER)

(i) Course learning outcome:

- Comprehend 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.
- Learn about Maxwell's thermodynamic relations.
- Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Learn about the real gas equations, Van der Waal equation of state, the Joule- Thompson effect.
- In the laboratory course, the students are expected to do some basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistant, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.
- Gain knowledge on various theories of light.
- Acquire skills to identify and apply formulas of optics and wave physics.
- Understand the properties of light like reflection, refraction, interference, diffraction.

- Understand the applications of diffraction and polarization.
- Understand the applications of interference in design and working of interferometers.
- Understand the resolving power of different optical instruments.
- Gain knowledge on working of holography and their applications in various fields.
- Gain knowledge in optical fiber and their applications in communication.

(ii) Broad contents of the course:

- Zeroth and First Law of Thermodynamics
- Second Law of Thermodynamics
- Entropy
- Thermodynamic Potentials
- Maxwell's Thermodynamic Relations
- Kinetic Theory of Gases: Distribution of Velocities Molecular Collisions Real Gases

(iii) Skills to be learned:

- This basic course in thermodynamics will enable the student to understand various thermo dynamical concepts, principles.

ELECTRICITY, MAGNETISM & ELECTRONICS

(III PAPER)

(i) Course learning outcome:

- Define the various fields in electrostatics, magnetostatics and electrodynamics, and to understand how they are related

- Explain propagation of electromagnetic waves in various environments;
- Apply Maxwell's Equations to selected problems;
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations;
- Integrate several components of the course in the context of a new situation.

(ii) Broad contents of the course:

- Review of Maxwell's equations
- EM wave propagation in unbounded media of various types
- EM wave propagation in bounded media separated by two types of media
- Polarization of electromagnetic waves
- Wave guides
- Optical fibers

(iii) Skills to be learned:

- Comprehend the role of Maxwell's equation in unifying electricity and magnetism.
- Derive expression for

  (i) Energy density
  (ii) Momentum density
  (iii) Angular momentum density of the electromagnetic field

- Learn the implications of Gauge invariance in EM theory in solving the wave equations and develop the skills to actually solve the wave equation in various media like

  (i) Vacuum
  (ii) Dielectric medium
  (iii) Conducting medium
  (iv) Dilute plasma

- Derive and understand associated with the properties, EM wave passing through the interface between two media like

  (i) Reflection

(ii) Refraction

(iii) Transmission

(iv) EM waves

- Learn the basic physics associated with the polarization of electromagnetic waves by doing various experiments for:

(i) Plane polarized light

(ii) Circularly polarized light

(iii) Circularly polarized light

MODERN PHYSICS & ELECTRONICS (IV PAPER)

(i) Course learning outcome:

- Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter.
- Understand the theory of quantum measurements, wave packets and uncertainty principle.
- Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g., one dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier.
- Understanding 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.
- Ability to calculate the decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrinos and its properties and role in theory of beta decay.
- Understand fission and fusion well as nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.
- Understand various interactions of electromagnetic radiation with matter. Electron positron pair creation.

- In the laboratory course, the students will get opportunity to perform the following experiments
- Measurement of Planck's constant by more than one method.
- Verification of the photoelectric effect and determination of the work Function of a metal.
- Determination of the charge of electron and e/m of electron.
- Determination of the ionization potential of atoms.
- Determine the wavelength of the emission lines in the spectrum of Hydrogen atom.
- Determine the absorption lines in the rotational spectrum of molecules.
- Verification of the law of the Radioactive decay and determine the mean life time of a Radioactive Source, Study the absorption of the electrons from Beta decay. Study of the electron spectrum in Radioactive Beta decays of nuclei.
- Plan and Execute 2-3 group projects in the field of Atomic, Molecular and Nuclear Physics in collaboration with other institutions, if, possible where advanced facilities are available.
- Understand the concept of sequential logic circuits and study of different sequential circuit with reference to storage.
- Understand different counting circuits and their applications. 4. Understand different digital storage devices, memory, and their classification with expansion.
- Understand the concepts and ideas of designing circuit using computers.
- Understand circuit maker software
- Analyze different parameters of simple circuit and setting of different parameters using circuit maker
- Understand the concept of virtual instrumentation and advance virtual instrumentation
- Describe OPAMP as different types of RC, AC ASCILLATORS
- Understand OP AMP as multi vibrators
- Design and explain A to D and D to A convertors.
- Describe the positive and negative feedback and advantages of positive feedback.

(ii) Broad contents of the course:

- Failure of classical physics and need for quantum physics.
- Various experiments establishing quantum physics and their interpretation.
- Wave-particle duality, uncertainty relation and their implications.
- Schrodinger equation and its simple applications in one dimensional potential problem of bound states and scattering.
- Elementary introduction of Nuclear Physics with emphasis on

  (i) Nuclear Structure
  (ii) Nuclear Forces
  (iii) Nuclear Decays
  (iv) Fission and Fusion

(iii) Skills to be learned:

- Comprehend the failure of classical physics and need for quantum physics.
- Grasp the basic foundation of various experiments establishing the quantum physics by doing the experiments in laboratory and interpreting them.
- Formulate the basic theoretical problems in one-, two- and three-dimensional physics and solve them.
- Learning to apply the basic skills developed in quantum physics to various problems in

  (i) Nuclear Physics
  (ii) Atomic Physics

- Identify the different electronics components used in electronic circuits.
- Understand the working of solid-state semiconductor devices used in the circuit
- Understand different concepts of electronics and network theorem.
- Understand different concepts of semiconductor materials and devices.
- Determine various parameters and V-I characteristics of diodes and transistors.
- Understand the concepts of digital electronics
- Understand the basic working of different logic gates and laws of Boolean algebra, De Morgan theorem, NOR & NAND logic for simplification of circuits.

- Understand the concepts of K-maps and designing of logic circuits.
- Understand and design different controlling circuits us ed in digital electronics
- Describe working, characteristics and applications of semiconductor devices. Understand and describe special high-power semiconductor.
- Analyze different parameters and relation between the different terms related to amplifier.
- Classification of different amplifier and analyze the concepts of different types of amplifiers.
- Understand the concepts of different logic family and comparison of different parameters of logic family.
- Convert different type of codes and number systems which are used in digital communication and computer systems.
- Employ the codes and number systems converting circuits and compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.
- Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
- Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints.
- Apply the fundamental knowledge of analog and digital electronics to get different types analog to digitalized signal and vice-versa converters in real world with different changing circumstances.
- Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.