SRI VENKATESHWARA GOVERNMENT ARTS AND SCIENCE COLLEGE, PALEM

Till 2016

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-Boltzman 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 fibres

(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 wavesby 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 problems 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.

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2016-19

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linkages with related disciplinary areas/subjects like Chemistry, Mathematics, Life sciences, Environmental sciences, Atmospheric Physics, Computer science, Information Technology;

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- 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 (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.

(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.

WAVES & OSCILLATIONS (II PAPER)

(i) Course learning outcome:

On successful completion of this course students will:

- 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.

THERMODYNAMICS (III 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-Boltzman 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.

(ii) Broad contents of the course:

α. Zeroth and First Law of Thermodynamics

β. Second Law of Thermodynamics

χ. Entropy

δ. Thermodynamic Potentials

ε. Maxwell's Thermodynamic Relations

ϕ. 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.

OPTICS (IV PAPER)

(i) Course learning outcome:

On successful completion of this course students will:

- 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.

ELECTROMAGNETIC THEORY (V PAPER)

(ii) 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.

(iii) 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 fibres

(iv) 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 wavesby doing various experiments for:

(i) Plane polarized light

(ii) Circularly polarized light

(iii) Circularly polarized light

SOLID STATE PHYSICS (VI PAPER)

(i) Course learning outcome:

On completion of the course, the student should have the following learning outcomes:

The student is able to

- Explain mechanical properties of solid matter, and connect these to bond type.
- Explain how diffraction of electromagnetic waves on solid matter can be used to obtain lattice structure.

- Know the concept of phonons, and how the dispersion relationship appears for different lattice structures.
- Explain how a lattice vibrates at finite temperature, and how these vibrations determine the heat capacity and conduction.
- Know the concept density of states in one, two and three dimensions.
- Explain simple theories for conduction of heat and electrical current in metals.
- Classify solid state matter according to their band gaps.
- Understand how electrons and holes behave in semiconductors, and explain how they conduct current.
- Explain and give simple models for Schottky and PN-junctions.
- Explain how light emitting diodes and solar cells work.
- Know the basic physics behind dia, para and ferromagnetism.
- Differentiate between local (Curie) and band (Stoner) contributions to ferromagnetism.
- Know what superconductivity is and qualitatively relate it to lattice vibrations and the density of state.

(ii) Skills to be learned:

The student is able to

- Build models to understand the physical properties of solid matter.
- Critically evaluate the approximations needed to build models to understand the solid state.
    - Write a short scientific paper on a published research work in solid state physics.

MODERN PHYSICS (VII 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.

(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 problems 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

BASIC ELECTRONICS (VIII PAPER)

(i) Course learning Outcome:

By the end of this course, the students will be able to:

- Identify the different electronics components used in electronic circuits.
- Understand the working of solidstate 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.
- 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) Skills to be learned:

At the end of the course, a student will be able to:

1. Convert different type of codes and number systems which are used in digital communication and computer systems.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

BASICS OF RENEWABLE ENERGY

(SEC)

(i) Course learning outcome:

- The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible. Some of the renewable sources of energy which should be studied here are: (i) off-shore wind energy, (ii) tidal energy, (iii) solar energy, (iv) biogas energy and

(v) hydroelectricity.

All these energy sources should be studied in detail.

- Learn about piezoelectricity, carbon- captured technologies like cells, batteries.
- The students should observe practical demonstrations of
- (i) training modules of solar energy, wind energy etc.,
- (ii) Conversion of vibration into voltage using piezoelectric materials,
- (iii) Conversion of thermal energy into voltage using thermoelectric modules.

(ii) Broad contents of the course:

- Fossil fuels and Alternate Sources of Energy
- Solar energy
- Wind Energy harvesting
- Ocean Energy
- Geothermal Energy
- Hydro Energy
- Piezoelectric Energy Harvesting
- Electromagnetic Energy Harvesting

(iii) Skills to be learned:

- In this course student will study non –conventional energy sources and their practical applications.

SRI VENKATESHWARA GOVERNMENT ARTS AND SCIENCE COLLEGE, PALEM

From 2019

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 & 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.

(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.

THERMAL PHYSICS (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-Boltzman 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.

(ii) Broad contents of the course:

α. Zeroth and First Law of Thermodynamics

β. Second Law of Thermodynamics

χ. Entropy

δ. Thermodynamic Potentials

ε. Maxwell's Thermodynamic Relations

ϕ. Kinetic Theory of Gases : Distribution of Velocities Molecular Collisions

Real Gases

(iii) Skills to be learned:

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

ELECTROMAGNETIC THEORY (III PAPER)

(i) Course learning outcome:

- Achieve an understanding of the Maxwell's equations, role of displacement current, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, boundary conditions at the interface between different media.
- Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
- Analyse the phenomena of wave propagation in the unbounded, bounded, vacuum, dielectric, guided and unguided media.
- Understand the laws of reflection and refraction and to calculate the reflection and transmission coefficients at plane interface in bounded media.
- Understand the linear, circular and elliptical polarisations of EM waves. Production as well as detection of waves in laboratory.
- Understand propagation of EM waves in anisotropic media, uni-axial and biaxial crystals phase retardation plates and their uses.
- Understand the concept of optical rotation, theories of optical rotation and their experimental rotation, calculation of angle rotation and specific rotation.
- Understand the features of planar optical wave guide and obtain the Electric field components, Eigen value equations, phase and group velocities in a dielectric wave guide.
- Understand the fundamentals of propagation of electromagnetic waves through optical fibres and calculate numerical apertures for step and graded indices and transmission losses.
- In the laboratory course, the student gets an opportunity to perform experiments

Demonstrating principles of

- Interference, Refraction and diffraction of light using monochromatic sources of light. Demonstrate interference, Refraction and Diffraction using microwaves.
- Determine the refractive index of glass and liquid using total internal reflection of light.
- Verify the laws of Polarisation for plane polarised light.

- Determine Polarisation of light by Reflection and determine the polarization angle off or air-glass surface
- Determine the wavelength and velocity of Ultrasonic waves in liquids using diffraction.
- Study specific rotation of sugar using Polarimeter.
- Analyze experimentally the Elliptically Polarised light using Babinet's Compensator
- Study Experimentally the angle dependence of radiation for a simple dipole antenna
- Plan and Execute 2-3 group projects for designing new experiments based on the Syllabi.

(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 fibres

(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 wavesby doing various experiments for:

(i) Plane polarized light

(ii) Circularly polarized light

(iii) Circularly polarized light

- Learn the application of EM theory to

(i) Wave guides of various types

(ii) Optical fibers in theory and experiment

WAVES & OPTICS (IV PAPER)

(i) Course learning outcome:

This course will enable the student to

- Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.
- Apply basic knowledge of principles and theories about the behaviour of light

and the physical environment to conduct experiments.

- Understand the principle of superposition of waves, so thus describe the formation of standing waves.
- Explain several phenomena we can observe in everyday life that can be explained as wave phenomena.
- Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.
- Understand the working of selected optical instruments like biprism, interferometer, diffraction grating, and holograms.
- 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 firsthand.
- The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse, longitudinal waves can be learnt in this laboratory course.

(ii) Broad contents of the course:

- Superposition of Two Collinear Harmonic Oscillations
- Superposition of Two Perpendicular Harmonic Oscillations
- Waves Motion – General
- Velocity of Waves
- Superposition of Two Harmonics Waves

MODERN PHYSICS (V-A 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.

(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 problems 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

COMPUTATIONAL PHYSICS (V-B PAPER)

(i) Course learning outcome:

- Learn the importance of computers in solving problems in Physics.
- Learn how to plan for writing the algorithm for solving a problem by drawing the flowchart of simple problems like roots of quadratic equations etc.
- Have a working knowledge about the Linux system, for example, the necessary commands.
- Learn, write and run FORTRAN programs in the Linux system. In particular,

they should attempt the following exercises:

(i) Exercises on syntax on usage of FORTRAN.

(ii) Usage of GUI windows, Linux commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.

(iii) To print out all natural even/ odd numbers between given limits.

(iv) To find maximum, minimum and range of a given set of numbers.

- The students should also learn "Scientific Word Processing", particularly, how to use the LaTeX software in writing articles and papers which include mathematical equations and diagrams. Similarly, students should learn the basics of Gnuplot.
- To have hands-on experience on computational tools, students are expected to do the following exercises:

(i) to compile a frequency distribution and evaluate mean, standard deviation etc,

(ii) to evaluate sum of finite series and the area under a curve,

(iii) to find the product of two matrices

(iv) to find a set of prime numbers and Fibonacci series,

(v) to write program to open a file and generate data for plotting using Gnuplot,

(vi) plotting trajectory of a projectile projected horizontally,

(vii) plotting trajectory of a projectile projected making an angle with the horizontal direction,

(viii) creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen, saving it as an eps file and as a pdf file,

(ix) to find the roots of a quadratic equation,

(x) numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization,

(xi) Simulate the motion of a particle in a central force field and plot the output for visualization.

(ii) Broad contents of the course:

- Introduction

- Scientific Programming
- Control Statements
- Scientific word processing: Introduction to LATEX
- Visualization

(iii) Skills to be learned:

- The students should learn the skills for writing a flow chart and then writing the corresponding program for a specific problem using the C/ C^{++}/FORTRAN language.
- The student should also acquire the proficiency in effectively using the GUI Windows, the LINUX operating system and also in using the LaTeX software for wring a text file.

ELECTRONICS (VI-A PAPER)

(i) Course learning Outcome:

By the end of this course, the students will be able to: 1. Identify the different electronics components used in electronic circuits.

- Understand the working of solidstate 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.
- 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) Skills to be learned:

At the end of the course, a student will be able to:

1. Convert different type of codes and number systems which are used in digital communication and computer systems.

2. 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 ofeconomy, performance and efficiency.

3. 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.

4. 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.

5. 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.

6. 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.

APPLIED OPTICS (VI-B PAPER)

(i) Course learning outcome:

This course will enable the student to get

- Familiar with optical phenomena and technology.
- Qualitative understanding of basic lasing mechanism, types of Lasers, characteristics of Laser Light, types of Lasers, and its applications in developing LED, Holography.
- The idea of propagation of electromagnetic wave in a nonlinear media – Fibre optics as an example will enable the student to practice thinking in a logical process, which is essential in science.
- Experiments in this course will allow the students to discuss in peer groups to develop their cooperative skills and reinforce their understanding of concepts.

(ii) Broad contents of the course:

- Sources and Detectors
- Fourier Optics
- Holography
- Photonics: Fibre Optics

(iii) Skills to be learned:

This course will help in understanding about the lasers and detectors, Holography, Optical fibre and their applications.

RENEWABLE ENERGY AND ENERGY HARVESTING (GENERAL ELECTIVE)

(i) Course learning outcome:

- The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible. Some of the renewable sources of energy which should be studied here are: (i) off-shore wind energy, (ii) tidal energy, (iii) solar energy, (iv) biogas energy and (v) hydroelectricity.

  All these energy sources should be studied in detail.

- Learn about piezoelectricity, carbon- captured technologies like cells, batteries.
- The students should observe practical demonstrations of
- (i) training modules of solar energy, wind energy etc.,
- (ii) Conversion of vibration into voltage using piezoelectric materials,
- (iii) Conversion of thermal energy into voltage using thermoelectric modules.

(ii) Broad contents of the course:

- Fossil fuels and Alternate Sources of Energy
- Solar energy
- Wind Energy harvesting
- Ocean Energy
- Geothermal Energy

- Hydro Energy
- Piezoelectric Energy Harvesting
- Electromagnetic Energy Harvesting

(iii) Skills to be learned:

- In this course student will study non –conventional energy sources and their practical applications.

1. EXPERIMENTAL METHODS AND ERRORS ANALYSIS (SEC-1)

(i) Course learning outcome:

The students are expected to learn the art and science of carrying out experimental research. At the end of the course a student should be able to design and carry out an experiment on his/her own. This is an important skill which anybody wanting to do experimental research is expected to possess.

- Describe and explain the working principles of the various techniques
- Identify the strength and limitation of each technique, therefore, choose the right technique for characterization of properties
- Know the operational details and interpret the data obtained by the techniques

2. ELECTRICAL CIRCUITS AND NETWORKING (SEC-2)

(i) Course learning outcome:

After the completion of the course the student will acquire necessary skills/ hands on experience /working knowledge on multimeters, voltmeters, ammeters, electric circuit elements, dc power sources, ac/dc generators, inductors, capacitors, transformers, single phase and three phase motors, interfacing dc/ac motors to control and measure, relays and basics of electrical wiring.

(ii) Broad contents of the course:

a. Basic principles of electricity, electrical circuits and electrical drawings.
b. Physics of generators, transformers, electric motors.
c. Solid state devices and their uses.
d. Electrical wiring and measures for electrical protection.

(iv) Skills to be learned:

a. Skills to understand various types of DC and AC circuits and making electrical drawings with symbols for various systems.
b. Skills to understand and operate generators, transformers and electric motors.
c. Develop knowledge of solid-state devices and their uses.
d. Skills to do electrical wiring with assured electrical protection devices.

3. BASIC INSTRUMENTATION (SEC-3)

(i) Course learning outcome:

- Explain basic concepts and definitions in measurement.
- Describe the bridge configurations and their applications.
- Elaborate discussion about the importance of signal generators and analyzers in Measurements.
- Recognize the evolution and history of units and standards in Measurements.
- Identify the various parameters that are measurable in electronic instrumentation.
- Employ appropriate instruments to measure given sets of parameters.
- Practice the construction of testing and measuring set up for electronic systems.
- To have a deep understanding about instrumentation concepts which can be applied to Control systems.
- Relate the usage of various instrumentation standards.

4. BIOMEDICAL INSTRUMENTATION (SEC-4)

(i) Course learning outcome:

- Explain the different medical imaging systems, compare advantages and disadvantages, understand the limitations and find the best suitable method for different pathological diagnoses.
- Explain and describe different diagnostic measurement methods for identification of human biopotentials and their necessary instrumentation.
- Explain and describe different diagnostic measurement methods for different humane variables and their necessary instrumentation.
- Explain and describe different therapeutic methods of treatment where electrical medical equipment are a vital part of the method and their necessary instrumentation.
- Analyse and evaluate the effect of different diagnostic and therapeutic methods, their risk potential, physical principles, opportunities and possibilities for different medical procedures.
- Have a basic understanding of medical terminology, relevant for biomedical instrumentation.
- Understand and describe the physical and medical principles used as a basis for biomedical instrumentation.
- Understand the elements of risk for different instrumentation methods and basic electrical safety.
- Understand the position of biomedical instrumentation in modern hospital care.

5. DIGITAL ELECTRONICS (SEC-5)

(i) Course learning outcome:

- After studying this course, the students would gain enough knowledge
- Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
- To understand and examine the structure of various number systems and its application in digital design.
- The ability to understand, analyze and design various combinational and sequential circuits.
- Ability to identify basic requirements for a design application and propose a cost-effective solution.
- The ability to identify and prevent various hazards and timing problems in a digital design.
- To develop skill to build, and troubleshoot digital circuits.