	ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for Physics (Minor) in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
II	III	1	Mechanics and Properties of Matter	3	3
			Mechanics and Properties of Matter-Practical	2	1
	IV	2	Waves and Optics	3	3
			Waves and Optics-Practical	2	1
III	V	3	Heat and Thermodynamics	3	3
			Heat and Thermodynamics-Practical	2	1
		4	Atomic, Molecular & Nuclear-Practical	3	3
			Atomic, Molecular & Nuclear Physics-Practical	2	1
	VI	5	Electricity, Magnetism and Electromagnetic Theory	3	3
			Electricity, Magnetism and Electromagnetic Theory-Practical	2	1
		6	Electronic Devices and Digital Electronics	3	3
			Electronic Devices and Digital Electronics-Practical	2	1

SEMESTER-III

COURSE 1: MECHANICS AND PROPERTIES OF MATTER

Theory **Credits: 3** **3 hrs/week**

COURSE OBJECTIVE:

The course on Mechanics and Properties of Matter aims to provide students with a fundamental understanding of the behavior of physical systems, both in terms of mechanical motion and in terms of the properties of matter.

LEARNING OUTCOMES:

1. Students will be able to apply the laws of motion, solve equations of motion for variable mass systems.
2. Students will be able to define central forces and provide examples, understand the characteristics and conservative nature of central forces, to derive equations of motion under central forces.
3. Students will be able to define and relate elastic constants, interpret stress-strain relationships, and analyze bending in beams.
4. Students will be able to apply the basic principles of fluid dynamics including Bernoulli's theorem, viscosity, and surface tension in practical contexts.
5. Students will be able to differentiate between Galilean relativity and the concept of absolute frames, comprehend the postulates of the special theory of relativity, apply Lorentz transformations, understand and solve problems.

UNIT-I MECHANICS OF PARTICLES **(9 hrs)**

Newton's Laws of motion, motion of variable mass system, Equation of motion of a rocket. Conservation of energy and momentum, collisions in two and three dimensions, concept of impact parameter, scattering cross-section, Rutherford scattering-derivation

UNIT-II CENTRAL FORCES **(9 hrs)**

Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, conservative force as a negative gradient of potential energy, equations of motion under a central force, derivation of Kepler's laws, motion of satellites, Geo-stationary satellites

UNIT III: ELASTICITY AND BENDING OF BEAMS (9 hrs)

Stress and strain, Hooke's Law, Elastic moduli – Young's, bulk, and shear modulus, Poisson's ratio – Physical meaning, bending of beams – Types, point and distributed load, Cantilever and uniform bending – Qualitative treatment, Torsional pendulum – working principle and uses.

UNIT IV: FLUID MECHANICS (9 hrs)

Fluids: Properties and classification, Streamline vs. turbulent flow, Reynolds number, Bernoulli's theorem – Statement, simple derivation and applications (Venturimeter, airplane lift), Equation of continuity – Concept, Viscosity – Poiseuille's law (statement and qualitative explanation), Surface tension – Examples and qualitative ideas

UNIT V: SPECIAL THEORY OF RELATIVITY (9 hrs)

Galilean relativity, absolute frames, Michelson-Morley experiment, negative result, postulates of special theory of relativity, Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation

REFERENCE BOOKS:

1. BSc Physics -Telugu Akademy, Hyderabad
2. Mechanics - D.S. Mathur, Sulthan Chand & Co, New Delhi
3. Mechanics - J.C. Upadhyaya, Ramprasad & Co., Agra
4. Properties of Matter - D.S. Mathur, S. Chand & Co, New Delhi ,11^{th} Edn., 2000
5. Physics Vol. I - Resnick-Halliday-Krane ,Wiley, 2001
6. Properties of Matter – Brijlal & Subrmanyam, S. Chand & Co. 1982
7. Mechanics-EM Purcell, Mc Graw Hill
8. University Physics-FW Sears, MW Zemansky & HD Young, Narosa Publications, Delhi
9. College Physics-I. T. Bhima sankaram and G. Prasad. Himalaya Publishing House.
10. Mechanics, S. G. Venkata chalapathy, Margham Publication, 2003.
11. Fluid Mechanics – Frank M. White, McGraw Hill.
12. Textbook of Fluid Dynamics – M. D. Raisinghania, S. Chand & Co.

SEMESTER-III

COURSE 1: MECHANICS AND PROPERTIES OF MATTER

Practical **Credits: 1** **2 hrs/week**

COURSE OBJECTIVE:

To develop practical skills in the use of laboratory equipment and experimental techniques for measuring properties of matter and analyzing mechanical systems.

LEARNING OUTCOMES:

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques to measure properties of matter and analyze mechanical systems.
2. Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.
3. Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.
4. Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis.
5. Understanding of physical principles: Students should develop an understanding of the physical principles governing mechanical systems and the properties of matter, including elasticity, viscosity, and thermal expansion.

Minimum of 6 experiments to be done and recorded

1. Young's modulus by uniform bending
2. Young's modulus by non-uniform bending
3. Rigidity modulus using torsional pendulum
4. Viscosity of liquid by Poiseuille's method
5. Surface tension by capillary rise method
6. Flywheel – Determination of moment of inertia
7. Viscosity of liquid by Searle's viscometer method
8. Bifilar suspension – moment of inertia of a rectangular body
9. Radius of capillary tube by Hg thread method
10. Optional Simulation-based activity: Time dilation or projectile simulation.

STUDENT ACTIVITIES

Unit I: Mechanics of Particles

Activity: Collision Experiments

Students can set up simple collision experiments using marbles, carts, or other objects. They can measure the initial and final velocities, masses, and analyze the momentum conservation. By varying the conditions (e.g., masses, initial velocities), they can observe the effects on the collision outcomes.

Unit II: Central Forces

Activity: Pendulum Motion Students can investigate the motion of a simple pendulum by varying its length and measuring the time period. They can analyze the relationship between the period and the length, and discuss the concept of centripetal force and its role in circular motion.

Unit III: Elasticity and Bending of Beams

Activity: Beam Bending Experiment

Use rulers or meter sticks on supports to apply loads and measure deflection. This hands-on demo helps visualize how elasticity and loading affect real-world structures.

Unit IV: Fluid Mechanics

Activity: Water Jet Speed Measurement

Students can measure the range and height of a water jet to relate fluid velocity with pressure (Bernoulli principle). They can also explore streamlines using ink in water.

Unit V: Special Theory of Relativity

Activity: Time Measurement Students can perform a time measurement experiment using simple devices like water clocks or sand timers. They can compare the measured time between two events at different relative speeds and discuss the concept of time dilation

SEMESTER-IV

COURSE 2: WAVES AND APPLIED OPTICS

Theory **Credits: 3** **3 hrs/week**

COURSE OBJECTIVE:

This course introduces the physical principles of oscillatory motion, interference, and polarization of light, and explores modern optical phenomena including lasers, optical fibers, and holography. The objective is to build a deep conceptual understanding of wave behavior in mechanical and optical systems and their technological applications.

LEARNING OUTCOMES:

On successful completion of this course, the students will be able to:

1. Describe the basic characteristics of waves such as frequency, wavelength, amplitude, period, and speed and utilize mathematical relationships related to wave characteristics.
2. Understand the phenomenon of interference of light and its formation in Thin films and Newton's rings and Distinguish between Fresnel's diffraction and Fraunhoffer diffraction and observe the diffraction patterns in the case of single slit.
3. Explain the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.
4. Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields.
5. Understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.

UNIT-I: SIMPLE HARMONIC, DAMPED & FORCED OSCILLATIONS (9hrs)

Simple Harmonic Oscillator: Solution of differential equation, and physical characteristics, Principle of superposition, Combination of two mutually perpendicular SHMs (1:1 and 1:2 frequencies), Lissajous figures. Damping, Damped Harmonic Oscillator: Solution of differential equation, Energy considerations, Logarithmic decrement, relaxation time, quality factor, Forced Oscillations: Solution of differential equation.

UNIT-II: INTERFERENCE AND DIFFRACTION (9 hrs)

Interference: Principle of superposition – coherence Conditions for interference of light. Fresnel's biprism determination of wavelength of light, change of phase on reflection, Oblique incidence of a plane wave on a thin film due to reflected light (cosine law) –Newton's rings in reflected light. Determination of wavelength of monochromatic light using Newton's rings.

Diffraction: Introduction, distinction between Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction – Diffraction due to single slit, Difference between interference and diffraction.

UNIT-III: POLARIZATION (9 hrs)

Polarized light: methods of polarization by reflection, refraction, double refraction, Brewster's law, Mauls law, Nicol prism polarizer and analyser, Quarter wave plate, Half wave plate, optical activity - Determination of specific rotation by Laurent's half shade Polarimeter. Idea of elliptical and circular polarization

UNIT-IV: LASERS (9 hrs)

Lasers: Introduction, Spontaneous emission, Stimulated emission, Population Inversion, Laser principle, Einstein coefficients, Types of lasers: He-Ne laser, Ruby laser, Semiconductor laser, Applications of laser.

UNIT-V: OPTICAL FIBERS AND HOLOGRAPHY (9 hrs)

Principle of Optical fibers, Acceptance angle, Acceptance cone, Numerical aperture, Types of optical fibers - Graded and Stepped index, Types Signal attenuation mechanisms in optical fibers, Applications of Optical fibers - Sensors, Imaging, Communication.

Holography: Basic principle of holography-Gabor hologram and its limitations, Applications of holography.

REFERENCE BOOKS:

1. BSc Physics Vol.1, Telugu Academy, Hyderabad.
2. Fundamentals of Physics. Halliday/Resnick/Walker, Wiley India Edition 2007.
3. Waves & Oscillations. S. Badami, V. Balasubramanian and K.R. Reddy, Orient Longman
4. BSc Physics, Vol .2, Telugu Academy, Hyderabad
5. A Text Book of Optics-N Subramanyam, L Brijlal, S. Chand& Co.
6. Unified Physics Vol. II Optics & Thermodynamics – Jai Prakash Nath & Co. Ltd., Meerut
7. Optics, F.A. Jenkins and H.G. White, Mc Graw-Hill 5. Optics, Ajay Ghatak, Tata Mc Graw-Hill. Introduction of Lasers – Avadhanulu, S. Chand & Co.
8. Principles of Optics- BK Mathur, Gopala Printing Press, 1995

SEMESTER-IV

COURSE 2: WAVES AND APPLIED OPTICS

Practical **Credits: 1** **2 hrs/week**

COURSE OBJECTIVE:

This course provides students with a broad understanding of the physical principles of the oscillations, to help them develop critical thinking and aims to provide students with a fundamental understanding of the behavior and properties of light and its interaction with matter.

LEARNING OUTCOMES:

1. Perform experiments to analyze oscillatory systems and visualize resonance and damping.
2. Use optical instruments to study interference and polarization.
3. Measure the wavelength of light using Newton's rings and biprism methods.
4. Understand laser characteristics and fiber optic transmission through practical demonstration.
5. Record, analyze, and interpret experimental data with precision.

Minimum of 6 experiments to be done and recorded

1. Determination of 'g' by compound/bar pendulum
2. Simple pendulum normal distribution of errors-estimation of time period and the error of the mean by statistical analysis Verification of inverse square law of light using photovoltaic cell.
3. Determination of radius of curvature of a given convex lens-Newton's rings.
4. Resolving power of grating.
5. Study of optical rotation – polarimeter.
6. Dispersive power of a prism.
7. Determination of wavelength of light using diffraction grating-minimum deviation method.
8. Determination of wavelength of light using diffraction grating-normal incidence method.
9. Determination of thickness of a thin wire by wedge method
10. Refractive index of liquid using laser and rectangular container
11. Optical fiber - Numerical Aperture.

STUDENT ACTIVITIES

UNIT-I: Simple harmonic, damped & forced oscillations

Activity: Measuring the period of a simple pendulum and verifying the relationship between the period and the length of the pendulum. Students can use a stopwatch and a ruler to measure the time for a fixed number of oscillations and calculate the period.

Activity: Measuring the damping coefficient of a mass-spring system and calculating the quality factor. Students can measure the amplitude of the system as it undergoes damped oscillations and use the logarithmic decrement formula to calculate the damping coefficient. They can then use the formula for the quality factor to evaluate the quality of the system.

UNIT-II: Interference and Diffraction

Ask students to measure the diameter of the central bright spot and the diameter of the nth ring for different values of n, and then calculate the wavelength of light.

Build a simple diffraction grating using a piece of cardboard and some sewing needles. Ask students to measure the distance between the needles, count the number of lines per unit length, and then calculate the grating spacing and the wavelength of light.

UNIT-III: Polarization

Ask students to measure the angle of rotation of the polarized light before and after passing through the sample, and then calculate the specific rotation of the sample.

Unit-IV: Lasers

Activity: Laser Communication Demo – Group project to transmit voice using a laser beam and photodiode.

Unit-V: Optical fibers and Holography

Demonstrate the principle of holography using a laser beam, a beam splitter, and a photographic plate. Ask students to record a hologram of a simple object and then reconstruct the image using a laser beam.

SEMESTER-V

COURSE 3: HEAT AND THERMODYNAMICS

Theory **Credits: 3** **3 hrs/week**

COURSE OBJECTIVE:

The course on Heat and Thermodynamics aims to provide students with a fundamental understanding of the principles of heat and energy transfer and their applications in various fields

LEARNING OUTCOMES:

On successful completion of this course, the student will be able to:

1. Understand the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions and the transport phenomenon in ideal gases
2. Gain knowledge on the basic concepts of thermodynamics, the first and the second law of thermodynamics, the basic principles of refrigeration, the concept of entropy, the thermodynamic potentials and their physical interpretations. Understand the working of Carnot's ideal heat engine, Carnot cycle and its efficiency
3. Develop critical understanding of concept of Thermodynamic potentials, the formulation of Maxwell's equations and its applications.
4. Differentiate between principles and methods to produce low temperature, liquefy air, and understand the practical applications of substances at low temperatures.
5. Examine the nature of black body radiations and the basic theories.

UNIT-I: KINETIC THEORY OF GASES **(9 hrs)**

Kinetic Theory of gases- Introduction, Maxwell's law of distribution of molecular velocities, Lammert's toothed wheel method; Mean free path, Principle of equipartition of energy, Transport phenomenon in ideal gases: viscosity and Thermal conductivity.

UNIT-II: THERMODYNAMICS **(9 hrs)**

Introduction- Reversible and irreversible processes, Carnot's engine and its efficiency, Carnot's theorem, Thermodynamic scale of temperature, Second law of thermodynamics Entropy: Physical significance, Change in entropy in reversible and irreversible processes; Change of entropy when ice changes into steam. Temperature- Entropy (T-S) diagram and its uses.

UNIT-III: THERMODYNAMIC POTENTIALS AND MAXWELL'S EQUATIONS (9 hrs)

Thermodynamic Potentials-Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy and their significance, Derivation of Maxwell's thermodynamic relations from thermodynamic potentials, Clausius-Clayperon's equation, Joule-Kelvin coefficient for ideal and Van der Waals' gases.

UNIT-IV: LOW TEMPERATURE PHYSICS (9 hrs)

Methods for producing very low temperatures, Critical temperature, Inversion temperature, Joule Kelvin effect, Porous plug experiment, Joule expansion, Distinction between adiabatic and Joule Thomson expansion, Expression for Joule Thomson cooling, Production of low temperatures by adiabatic demagnetization (qualitative), Refrigeration – Vapour compression machine.

UNIT-V: QUANTUM THEORY OF RADIATION (9 hrs)

Black body, Ferry's black body, Spectral energy distribution of black body radiation, Wein's displacement law and Rayleigh- Jean's law (No derivations), Planck's law of black body radiation-Derivation, Deduction of Wein's law and Rayleigh- Jean's law from Planck's law, Solar constant and its determination using Angstrom pyro heliometer, Estimation of surface temperature of Sun.

REFERENCE BOOKS

1. BSc Physics, Vol.2, Telugu Akademy, Hyderabad
2. Thermodynamics, R.C. Srivastava, S.K. Saha & Abhay K. Jain, Eastern Economy Edition.
3. Unified Physics Vol.2, Optics & Thermodynamics, Jai Prakash Nath & Co. Ltd., Meerut
4. Fundamentals of Physics. Halliday/Resnick/Walker. C. Wiley India Edition, 2007
5. Heat and Thermodynamics - N BrijLal, P. Subrahmanyam, S. Chand & Co., 2012
6. Heat and Thermodynamics - MS Yadav, Anmol Publications Pvt. Ltd, 2000
7. University Physics, HD Young, MW Zemansky, FW Sears, Narosa Publishers, New Delhi

SEMESTER-V

COURSE 3: HEAT AND THERMODYNAMICS

Practical **Credits: 1** **2 hrs/week**

COURSE OBJECTIVE:

The objectives for practical's in Heat and Thermodynamics can vary depending on the specific course or program, but here are some general objectives that may apply, to develop practical skills in the use of laboratory equipment and experimental techniques for studying heat and thermodynamics.

LEARNING OUTCOMES:

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques for studying heat and thermodynamics.
2. Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.
3. Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.
4. Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis.
5. Understanding of physical principles: Students should develop an understanding of the physical principles governing heat and thermodynamics, including the laws of thermodynamics, heat transfer, and thermodynamic cycles.

Minimum of 6 experiments to be done and recorded

1. Specific heat of a liquid – Joule's calorimeter –Barton's radiation correction
2. Thermal conductivity of bad conductor - Lee's method
3. Thermal conductivity of rubber.
4. Measurement of Stefan's constant.
5. Specific heat of a liquid by applying Newton's law of cooling correction.
6. Heating efficiency of electrical kettle with varying voltages.
7. Thermo emf- thermo couple - Potentiometer

8. Thermal behavior of an electric bulb (filament/torch light bulb)
9. Study of variation of resistance with temperature - Thermistor.
10. Thermal expansion of solids using metal ball and a ring.

STUDENT ACTIVITIES

Unit I: Kinetic Theory of Gases

Activity: Speed Distribution Analysis

Students can conduct a simple experiment using gas molecules (e.g., small balls) in a container. They can measure the speeds of the molecules using a motion sensor or stopwatch and analyze the distribution of molecular velocities. They can compare the observed distribution with the expected Maxwell's law of distribution.

Unit II: Thermodynamics

Activity: Heat Engine Efficiency Calculation

Students can work in groups to design a simple heat engine (e.g., using a syringe and a small turbine). They can measure the temperature changes and calculate the efficiency of their engine. They can compare their calculated efficiency with the theoretical Carnot efficiency to understand the limitations of real heat engines.

Unit III: Thermodynamic Potentials and Maxwell's Equations

Activity: Thermodynamic Relations Verification

Students can solve numerical problems involving different thermodynamic potentials (internal energy, enthalpy, Helmholtz free energy, and Gibbs free energy) and verify the Maxwell's thermodynamic relations. They can compare the calculated values using different relations to ensure consistency.

Unit IV: Low Temperature Physics

Activity: Adiabatic Demagnetization Experiment

They can discuss the distinction between adiabatic and Joule-Thomson expansions.

Unit V: Quantum Theory of Radiation

Activity: Black Body Radiation Spectrum Analysis

They can estimate the surface temperature of the Sun using the solar constant and Angstrom pyro heliometer data.

SEMESTER-V

COURSE 4: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Theory **Credits: 3** **3 hrs/week**

COURSE OBJECTIVE:

The course aims to introduce students to the principles of atomic structure, molecular spectroscopy, and fundamental nuclear physics. It covers key experimental methods and theoretical models, helping students understand how microscopic interactions lead to observable physical phenomena in atoms, molecules, and nuclei.

LEARNING OUTCOMES:

On successful completion of this course, the students will be able to:

1. Understand the principles of atomic structure and spectroscopy.
2. Understand the principles of molecular spectroscopy.
3. Develop critical understanding of concept of Matter waves and Uncertainty principle.
4. Describe nuclear properties, binding energy, and nuclear models such as the liquid drop and shell model.
5. Explain the working of nuclear detectors and accelerators and classify elementary particles and their interactions.

UNIT-I: INTRODUCTION TO ATOMIC STRUCTURE AND SPECTROSCOPY (9 hrs)

Introduction to Bohr's model of the hydrogen atom, Vector atom model and Quantum numbers associated with it, Stern and Gerlach experiment, Coupling Schemes (LS & JJ), Spectral terms and spectral notations, Selection rules, Zeeman effect, Experimental arrangement to study Zeeman effect and expression for Zeeman shift.

UNIT-II: MOLECULAR SPECTROSCOPY (9 hrs)

Molecular rotational and vibrational spectra, electronic energy levels and electronic transitions, Raman effect, Characteristics of Raman effect, Experimental arrangement to study Raman effect, Quantum theory of Raman effect, Applications of Raman effect. Spectroscopic techniques: IR and UV-Visible.

UNIT-III: MATTER WAVES & UNCERTAINTY PRINCIPLE (9 hrs)

Matter waves, de Broglie's hypothesis, Properties of matter waves, Davisson and Germer's experiment, Heisenberg's uncertainty principle for position and momentum & energy and time, Illustration of uncertainty principle using diffraction of beam of electrons (Diffraction by a single slit) and photons (Gamma ray microscope).

UNIT-IV: INTRODUCTION TO NUCLEAR PHYSICS (9 hrs)

Nucleus: Properties of nucleus, Mass defect, Binding energy – binding energy curve; Nuclear forces: Characteristics of nuclear forces, Yukawa's meson theory; Nuclear Models- Liquid drop model- Semi empirical mass formula, Shell model, magic numbers.

UNIT-V: NUCLEAR DETECTORS AND NUCLEAR ACCELERATORS (9 hrs)

Nuclear detectors: Geiger- Muller counter, Cloud chamber (expansion type), Scintillation counter. Nuclear Accelerators: Cyclotron-construction, working and applications; Synchrocyclotron-construction, working and applications. Classification of elementary particles, Types of interactions- strong, electromagnetic and weak interactions;

REFERENCE BOOKS:

1. BSc Physics, Vol.4, Telugu Akademy, Hyderabad
2. Atomic Physics by J.B. Rajam; S. Chand & Co.,
3. Modern Physics by R. Murugeshan and Kiruthiga Siva Prasath. S. Chand & Co.
4. Concepts of Modern Physics by Arthur Beiser. Tata McGraw-Hill Edition.
5. Nuclear Physics, Irving Kaplan, Narosa Pub. (1998).
6. Nuclear Physics, Theory and experiment – P.R. Roy and B.P. Nigam, New Age Int.1997.
7. Atomic and Nuclear Physics (Vol.2), S.N. Ghoshal, S. Chand & Co. (1994).
8. Nuclear Physics, D.C. Tayal, Himalaya Pub. (1997).

SEMESTER-V

COURSE 4: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Practical **Credits: 1** **2 hrs/week**

COURSE OBJECTIVE:

To develop practical skills and experimental understanding in atomic and nuclear physics, including spectral line measurements, particle detection, and verification of quantum and nuclear models.

LEARNING OUTCOMES:

1. Demonstrate a deep understanding of the principles and theories of modern physics through hands-on experimentation and data analysis.
2. Analyze and interpret experimental data using statistical methods and error analysis, drawing meaningful conclusions and relating them to theoretical concepts.
3. Design and conduct independent experiments or investigations related to modern physics, demonstrating the ability to plan, execute, and analyze experimental procedures and results.
4. Gain a solid understanding of fundamental concepts in nuclear physics.
5. Understand the principles and operation of laboratory equipment and instruments specific to nuclear physics experiments.
6. Develop proficiency in conducting experiments related to nuclear physics.

Minimum of 6 experiments to be done and recorded

1. e/m of an electron by Thomson method.
2. Determination of Planck 's constant (photocell).
3. Verification of inverse square law of light using photovoltaic cell.
4. Determination of the Planck's constant using LEDs of at least 4 different colours.
5. Determination of work function of material of filament of directly heated vacuum diode.
6. GM counter – Determination of dead time
7. Study of characteristic curve of GM counter and estimation of its operating voltage
8. Estimation of efficiency for a gamma source of the GM counter
9. To verify inverse square law using GM counter
10. Production and attenuation of Bremsstrahlung
11. Estimation of efficiency for a beta source of the GM counter
12. Study of back scattering of beta particles

STUDENT ACTIVITIES

UNIT-I: Introduction to Atomic Structure and Spectroscopy

Spectroscopy Experiment

Divide the students into small groups and provide each group with a spectrometer or spectroscope, a light source, and different samples or elements for analysis.

Instruct the students to carefully observe the spectra produced by the samples using the spectrometer.

Data Collection

Have the students record their observations in their lab notebooks or worksheets. They should note the wavelengths or colors of the observed spectral lines and any patterns they observe.

Analysis and Discussion: Guide a class discussion on the observed spectra and their significance. Discuss how the observed spectral lines correspond to specific energy transitions in the atoms. Ask students to compare the spectra of different samples or elements and identify any similarities or differences.

UNIT-II: Molecular Spectroscopy

Begin the activity with a brief introduction to molecular structure, discussing concepts such as chemical bonds, molecular geometry, and the importance of molecular structure in determining the properties and behavior of substances. Explain the principles of spectroscopy, focusing on vibrational and rotational spectra and how they relate to molecular vibrations and rotations.

UNIT-III: Matter waves & Uncertainty Principle

Begin the activity by introducing the concept of matter waves and the uncertainty principle. Discuss how the wave-particle duality of matter is a fundamental principle in quantum mechanics. Provide a brief overview of the historical development of the uncertainty principle and its implications for our understanding of the behavior of particles on a microscopic scale.

UNIT-IV: Introduction to Nuclear Physics

Provide students with a computer simulation or interactive app that allows them to explore radioactive decay processes. Ask students to observe and analyze the decay patterns of different isotopes, including the concept of half-life. Guide students to make connections between the simulation results and the fundamental principles of nuclear physics

UNIT-V: Nuclear Detectors and Nuclear Accelerators

Activity: Detector Comparison Chart – Students create a comparative table of detector types, operation principles, advantages, and use-cases.

SEMESTER-VI

COURSE 5: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Theory **Credits: 3** **3 hrs/week**

COURSE OBJECTIVE:

The course on Electricity, Magnetism and Electromagnetic theory aims to provide students with a fundamental understanding of the principles of electricity, magnetism, and electromagnetic theory.

LEARNING OUTCOMES:

On successful completion of this course, the students will be able to:

1. Understand the Gauss law and its application to obtain electric field in different cases and formulate the relationship between electric displacement vector, electric polarization, Susceptibility, Permittivity and Dielectric constant.
2. To learn the methods used to solve problems using loop analysis, Nodal analysis, Thvenin's theorem, Norton's theorem, and the Superposition theorem
3. Distinguish between the magnetic effect of electric current and electromagnetic induction and apply the related laws in appropriate circumstances.
4. Understand Biot and Savart’s law and Ampere’s circuital law to describe and explain the generation of magnetic fields by electrical currents.
5. Develop an understanding on the unification of electric, and magnetic fields and Maxwell’s equations governing electromagnetic waves.
6. Phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q- factor, Power factor and the comparative study of series and parallel resonant circuits

UNIT-I: ELECTROSTATICS AND DIELECTRICS (9 hrs)

Gauss’s law - Statement and its proof, Electric field intensity due to uniformly charged solid sphere, Electrical potential–Equipotential surfaces, Potential due to a uniformly charged sphere. Dielectrics-Polar and Non-polar dielectrics - Effect of electric field on dielectrics, Dielectric strength, Electric displacement D, electric polarization Relation between D, E and P, Dielectric constant and electric susceptibility.

UNIT-II: CURRENT ELECTRICITY (9 hrs)

Electrical conduction - drift velocity-current density, equation of continuity, ohms law and limitations, Kirchhoff’s Law’s, Branch current method, Nodal Analysis, Star to Delta & Delta to Star conversions. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem.

UNIT-III:MAGNETOSTATICS AND ELECTROMAGNETIC INDUCTION (9hrs)

Magnetostatics

Biot-Savart's law and its applications: (i) long straight wire and (ii) circular loop, Hall Effect, determination of Hall coefficient and applications, magnetic charge, concept of vector potential.

Electromagnetic Induction

Faraday's laws of electromagnetic induction, Lenz's law, Self-induction and Mutual induction, Self- inductance of a long solenoid, Magnetic Energy density, mutual inductance of a pair of coils, coefficient of Coupling.

UNIT-IV ELECTROMAGNETIC WAVES-MAXWELL'S EQUATIONS (9hrs)

Maxwell's equations: integral and differential forms (No derivation), Continuity equation, Concept of displacement current. Plane electromagnetic wave equation, Hertz experiment - Transverse nature of electromagnetic waves, Electromagnetic wave equation in conducting media, Skin depth, Poynting theorem-Pointing vector, Wave equations for E & B, Maxwell's equations in matter.

UNIT-V VARYING AND ALTERNATING CURRENTS (9 hrs)

Growth and decay of currents in LR, CR, LCR circuits-Critical damping, alternating current - A.C. fundamentals, and A.C through pure R, L and C, Relation between current and voltage in LR and CR circuits, Phasor and Vector diagrams, LCR series and parallel resonant circuit, Q - factor, Power in ac circuits, Power factor.

REFERENCE BOOKS:

1. BSc Physics, Vol.3, Telugu Akademy, Hyderabad.
2. Electricity and Magnetism, D.N. Vasudeva. S. Chand & Co.
3. Electricity, Magnetism with Electronics, K.K. Tewari, R. Chand & Co.,
4. "Electricity and Magnetism" by Brijlal and Subramanyam Ratan Prakashan Mandir, 1966
5. "Electricity and Magnetism: Fundamentals, Theory, and Applications" by
6. Murugeshan, Kiruthiga Siva prasath, and M. Saravanapandian
7. "Electricity and Magnetism: Theory and Applications" by Ajoy Ghatak and Lokanathan
8. Electricity and Magnetism: Problems and Solutions" by Ashok Kumar and Rajesh Kumar
9. Electricity and Magnetism, R.Murugeshan, S. Chand & Co.

SEMESTER-VI

COURSE 5: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Practical	**Credits: 1**	**2 hrs/week**

COURSE OBJECTIVE:

The course objective for a practical course in electricity and magnetism may include to develop practical skills in handling electrical and electronic components, such as resistors, capacitors, inductors, transformers, and oscillators.

LEARNING OUTCOMES:

1. Demonstrate a thorough understanding of the fundamental concepts and principles of electricity and magnetism.
2. Apply the laws and principles of electricity and magnetism to analyze and solve electrical and magnetic problems.
3. Design, construct, and test electrical circuits using various components and measuring instruments.
4. Measure and analyze electrical quantities such as voltage, current, resistance, capacitance, and inductance using appropriate instruments.
5. Apply the principles of electromagnetism to understand and analyze the behavior of magnetic fields and their interactions with electric currents

Minimum of 6 experiments to be done and recorded

1. LCR circuit series resonance, Q factor.
2. LCR circuit parallel resonance, Q factor.
3. Determination of AC-frequency –Sonometer.
4. Verification of Kirchhoff’s laws and Maximum Power Transfer theorem.
5. Verification of Thevenin’s and Norton’s theorem
6. Field along the axis of a circular coil carrying current-Stewart & Gee’s apparatus.
7. Charging and discharging of CR circuit-Determination of time constant
8. A.C Impedance and Power factor
9. Determination of specific resistance of wire by using Carey Foster’s bridge.
10. Determination of M & H

STUDENT ACTIVITIES

UNIT-I Electrostatics and Dielectrics

Conduct a simulation to visualize equipotential surfaces for a given charge distribution.

Conduct a group discussion on the significance of electric field lines and how they can be used to predict the motion of charged particles in electric fields.

UNIT-II Current electricity

Conduct a Wheatstone bridge experiment in class and discuss the balancing condition and sensitivity. Conduct a group activity where students are divided into groups and assigned a different circuit analysis method (nodal analysis, mesh analysis, superposition theorem, etc.) and asked to present their findings to the class.

UNIT-III Magneto statics and Electromagnetic Induction

Conduct a demonstration to show the Hall Effect and measure the Hall coefficient of a given material. Conduct a group activity where students are divided into groups, and assigned a different application of Faraday's law (electromagnetic induction, transformers, etc.) and asked to present their findings to the class.

UNIT-IV Electromagnetic waves

Conduct a group activity where students are asked to research the history of the development of Maxwell's equations and present their findings to the class.

Conduct a simulation to visualize the propagation of electromagnetic waves in different media (vacuum, air, water, etc.) and discuss the differences in the behaviour of waves in different media.

UNIT-V Varying and alternating currents

Conduct a demonstration to show the resonance in an LCR circuit and measure the Q-factor.

Conduct a group activity where students are divided into groups and assigned a different power factor correction method (capacitor banks, synchronous condensers, etc.) and asked to present their findings to the class.

SEMESTER-VI

COURSE 6: ELECTRONIC DEVICES AND DIGITAL ELECTRONICS

Theory	**Credits: 3**	**3 hrs/week**

COURSE OBJECTIVE:

This course aims to provide foundational knowledge in solid state physics and basic electronics, enabling students to understand the structure of solids, the behaviour of semiconductors, and the functionality of key electronic devices and circuits.

LEARNING OUTCOMES:

On successful completion of this course, the students will be able to:

1. Understand the structure and classification of solids and determine crystal structures using lattice parameters and Miller indices.
2. Analyse the electrical properties of intrinsic and extrinsic semiconductors and apply knowledge of P-N junction diodes.
3. Analyse and compare the characteristics and operation of different BJT configurations (CB,
   CE, and CC) and demonstrate proficiency in biasing techniques.
4. Comprehend the operation and characteristics of FETs, including JFETs and MOSFETs, and
   explain the working principles and characteristics of UJTs.
5. Understand and perform number system conversions and logical operations with digital logic gates.

UNIT I: Crystal Structure and Bonding

Types of solids: Crystalline and amorphous, Unit cell, lattice, basis – 1D, 2D, and 3D lattices, Bravais lattices (3D) and seven crystal systems, Miller indices – Planes and directions in crystals, common crystal structures: Simple cubic, BCC, FCC, packing fraction, Types of bonding in solids: Ionic, covalent, metallic, and molecular

UNIT II: Semiconductors

Introduction to Conductors, Insulators, Semiconductors – Intrinsic and Extrinsic semiconductors, P-N junction Diode, Formation of depletion region, Forward and Reverse bias, V-I characteristics and Applications, Zener diode – V I characteristics, Applications, Half and full wave rectifiers - Expression for efficiency.

UNIT –III: BIPOLAR JUNCTION TRANSISTOR AND ITS BIASING

Transistor construction, working of PNP and NPN Transistors, Active, Cutoff and Saturation conditions, Configurations of Transistor - CB, CE, and CC, Input and Output Characteristics of CB and CE configurations. Hybrid parameters of a Transistor and equivalent circuit, Transistor as an amplifier

UNIT-IV: FIELD EFFECT TRANSISTORS & POWER ELECTRONIC DEVICES

Differences between JFET and BJT, Construction and working of JFET, Drain and Transfer Characteristics, MOSFET - Depletion-type, and Enhancement- FET Biasing: Voltage Divider Biasing. UJT- Construction, working, V-I characteristics.

UNIT V: DIGITAL ELECTRONICS

Digital Numbers representation. Number Systems and Codes: Decimal, Binary, Octal and Hexadecimal number systems, conversions, Binary addition, Binary subtraction using 1's and 2's complement methods. Introduction to Digital logic gates, Logic gates symbol and their truth tables OR, AND, NOT gates, Universal gates, De Morgan's Laws

REFERENCE BOOKS:

1. BSc Physics Vol. 3, Telugu Akademy, Hyderabad
2. Solid State Physics - S.O. Pillai, New Age International
3. Principles of Electronics - V.K. Mehta, S. Chand & Co.
4. Solid State Physics - R.K. Puri and V.K. Babbar, S. Chand & Co.
5. Electronic Principles - A.P. Malvino, McGraw-Hill
6. Solid State Electronic Devices - Ben G. Streetman, Pearson
7. Digital Principles and Applications - Leach & Malvino, McGraw-Hill

SEMESTER-VI

COURSE 6: ELECTRONIC DEVICES AND DIGITAL ELECTRONICS

Practical **Credits: 1** **2 hrs/week**

COURSE OBJECTIVE:

To impart hands-on experience in verifying theoretical principles related to crystal structure, semiconductors, diodes, transistors, FETs, and digital circuits.

LEARNING OUTCOMES:

On successful completion of this practical course, students will be able to:

1. Visualize and analyze common crystal structures such as SC, BCC, FCC, and HCP using software tools like VESTA.
2. Understand and measure the characteristics of P-N junction diodes, Zener diodes, and rectifiers.
3. Demonstrate the functioning and biasing of BJT and FET configurations through practical experiments.
4. Verify the performance and characteristics of UJTs and MOSFETs in circuit applications.
5. Perform and interpret logic gate operations using digital ICs and understand number system conversions.

Minimum of 6 experiments to be done and recorded

1. Visualization of Crystal Structures (SC, BCC, FCC, HCP) using VESTA Software
2. V-I Characteristics of junction diode
3. V-I Characteristics of Zener diode
4. Transistor characteristics – CB configuration
5. Transistor characteristics – CE configuration
6. FET input and output characteristics
7. UJT characteristics
8. Logic Gates- OR, AND, NOT and NAND gates. Verification of Truth Tables.
9. Verification of De Morgan’s Theorems.

STUDENT ACTIVITIES

Unit I: Crystal Structure and Bonding

Activity: Build 3D models of unit cells using balls and sticks for SC, BCC, and FCC lattices. Discussion: Types of bonding and how they affect properties like conductivity and melting point.

UNIT II: Semiconductors

Activity: V-I Characteristic Analysis Students can analyse the V-I characteristics of a PN junction diode by using a simple circuit setup. They can measure the voltage across the diode for different values of forward and reverse bias currents and plot the corresponding current-voltage graph. They can discuss the behaviour of the diode in different bias conditions

UNIT –III: BIPOLAR JUNCTION TRANSISTOR AND ITS BIASING:

Activity: Transistor Configuration Analysis Students can analyze the characteristics of different transistor configurations (CB, CE, CC) using a transistor tester or a circuit setup. They can measure and compare the input/output characteristics, gain, and voltage levels for each configuration. They can discuss the advantages and disadvantages of each configuration

UNIT-IV: FIELD EFFECT TRANSISTORS & POWER ELECTRONIC DEVICES

Activity: FET Transfer Characteristic Analysis Students can analyze the transfer characteristics of a FET by measuring the drain current (ID) for different gate-source voltages (VGS). They can plot the transfer characteristic curve and observe the variations in ID with VGS. They can discuss the operation modes of FETs based on the transfer characteristics.

UNIT V: DIGITAL ELECTRONICS:

Convert numbers between different bases: Students can be asked to convert numbers between binary, decimal, and hexadecimal bases. They can practice converting both integer and fractional numbers, and verify their results using online conversion tools or calculators.

Design a binary adder circuit: Students can be asked to design and build a binary adder circuit using logic gates such as XOR, AND, and OR gates. They can then test the circuit by adding two binary numbers and comparing the result with the expected value.