ANDHRA KESARI UNIVERSITY ::ONGOLE

Model Syllabus for 4-Year UG Honours in B.Sc. (Physics) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Mathematical Physics	3	3
			Introduction to Mathematical Physics-Practical	2	1
		2	Mechanics and Properties of Matter	3	3
			Mechanics and Properties of Matter-Practical	2	1
	II	3	Waves and Optics	3	3
			Waves and Optics-Practical	2	1
		4	Heat and Thermodynamics	3	3
			Heat and Thermodynamics-Practical	2	1
II	III	5	Atomic, Molecular & Nuclear physics	3	3
			Atomic, Molecular & Nuclear physics-Practical	2	1
		6	Basic Electronics	3	3
			Basic Electronics-Practical	2	1
		7	Applied Optics	3	3
			Applied Optics-Practical	2	1
	IV	8	Electricity, Magnetism and Electromagnetic Theory	3	3
			Electricity, Magnetism and Electromagnetic Theory-Practical	2	1
		9	Analog Electronics	3	3
			Analog Electronics-Practical	2	1
		10	Advances in Physics	3	3
			Advances in Physics-Practical	2	1
III	V	11	Introduction to Solid State Physics	3	3
			Introduction to Solid State Physics-Practical	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
		12 A	Electronic Instrumentation	3	3
			Electronic Instrumentation-Practical	2	1
		OR			
		12 B	Solar Energy and Applications	3	3
			Solar Energy and Applications-Practical	2	1
		OR			
		12 C	Fundamentals of Nano Science	3	3
			Fundamentals of Nano Science-Practical	2	1
		OR			
		12 D	Solar, Thermal and Photovoltaic Conversion	3	3
			Solar, Thermal and Photovoltaic Conversion-Practical	2	1
		OR			
		12 E	Fundamentals of Python and Numerical Methods	3	3
			Fundamentals of Python and Numerical Methods-Practical	2	1
		13 A	Electronic Devices and Circuits	3	3
			Electronic Devices and Circuits-Practical	2	1
		OR			
		13 B	Low Temperature Physics and Refrigeration	3	3
			Low Temperature Physics and Refrigeration-Practical	2	1
		OR			
		13 C	Synthesis of Nano Materials	3	3
			Synthesis of Nano Materials-Practical	2	1
		OR			
		13 D	Wind, Hydro, Ocean & Geo-thermal Energy	3	3
			Wind, Hydro, Ocean & Geo-thermal Energy-Practical	2	1
		OR			
		13 E	Computations in Mechanics, Waves and Oscillations	3	3
			Computations in Mechanics, Waves and Oscillations-Practical	2	1

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
	VI	14 A	Analog and Digital Electronics	3	3
			Analog and Digital Electronics-Practical	2	1
		OR			
		14 B	Vacuum Technology	3	3
			Vacuum Technology-Practical	2	1
		OR			
		14 C	Characterization of Nano Materials	3	3
			Characterization of Nano Materials-Practical	2	1
		OR			
		14 D	Energy Storage and Conversion Systems	3	3
			Energy Storage and Conversion Systems-Practical	2	1
		OR			
		14 E	Computations in Optics, Heat and Thermodynamics	3	3
			Computations in Optics, Heat and Thermodynamics-Practical	2	1
		15 A	Electronic Communication Systems	3	3
			Electronic Communication Systems-Practical	2	1
		OR			
		15 B	Materials for Industrial Applications	3	3
			Materials for Industrial Applications-Practical	2	1
		OR			
		15 C	Applications of Nanomaterials	3	3
			Applications of Nanomaterials-Practical	2	1
		OR			
		15 D	Biomass and Hydrogen Energy	3	3
			Biomass and Hydrogen Energy-Practical	2	1
		OR			
		15 E	Computations in Electricity, Magnetism, Electromagnetic Theory and Modern Physics	3	3
			Computations in Electricity, Magnetism, Electromagnetic Theory and Modern Physics-Practical	2	1

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the **FIVE** specified domains. **For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A.** To ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters.

SEMESTER-I

COURSE 1: INTRODUCTION TO MATHEMATICAL PHYSICS

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

COURSE OBJECTIVE:

To equip students with foundational mathematical techniques—such as vector calculus, linear algebra, complex numbers, probability, and Fourier analysis—essential for understanding and solving problems in physics.

LEARNING OUTCOMES:

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

1. Apply concepts of vector differentiation and integration to analyze physical fields and prove integral theorems.
2. Use matrix operations and eigenvalue techniques to solve linear systems in physics.
3. Represent and manipulate complex numbers in various forms for solving AC circuit problems.
4. Interpret and apply basic probability concepts and distributions to model physical phenomena.
5. Analyze periodic signals using Fourier series and evaluate Fourier coefficients for common waveforms.

UNIT-I - VECTOR ANALYSIS **(9. Hrs.)**

Distinction between Ordinary and partial derivatives, Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field with derivations and physical interpretation. Vector integration (line, surface and volume), Statement and proof of Gauss and Stokes theorems.

UNIT-II – LINEAR ALGEBRA **(9. Hrs.)**

Vector and Scalar quantities in Physics, Matrices and Operations: Types, Addition and Multiplication, Identity and Inverse, Determinant (2x2 and 3x3), Trace, Transpose, Eigenvalues and Eigen Vectors, Calculation of Eigen values using characteristic equations. System of Linear Equations: Solving 2-variable system using matrices, Simple examples from physics (Current, forces)

UNIT – III COMPLEX NUMBERS **(9. Hrs.)**

Basic Complex numbers: Real and imaginary parts, Conjugate of complex numbers, Modulus and argument (magnitude and phase), Polar and Exponential (Euler) form of complex numbers. Addition and subtraction of complex numbers, Multiplication and division of complex numbers. Phasor representation: representation of voltage and current as phasors, Derivation of Impedance of a series LCR circuit.

UNIT – IV PROBABILITY **(9. Hrs.)**

Probability Theory Basics, Sample space, events, conditional probability, and Bayes' theorem. Independence and mutual exclusivity. Random Variables and Probability Distributions, Concept of random variables (discrete and continuous). Common distributions and their applications: Binomial, Poisson, and Gaussian.

UNIT V FOURIER ANALYSIS **(9. Hrs.)**

Introduction to periodic functions: Concept of periodicity (waves, oscillations, AC current), Graphical understanding of Sine and Cosine functions, Need for Fourier analysis, Real world signals (heartbeat, electrical signal, musical tones), Fourier theorem ad evaluation of Fourier coefficients, Analysis of periodic wave functions – Square wave, saw tooth wave and triangular wave.

Reference books

1. Mathematical methods for physics sciences (3^{rd} edition) - Mary. L. Boas
2. First Chapter (Vector analysis) in Introduction to Electrodynamics (3^{rd} edition) – David. J. Griffiths
3. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier

Student Activities:

- Problem-solving sessions using real-life physics applications (e.g., using vector calculus in electromagnetism).
- Group projects on solving physical systems using matrix methods and linear algebra tools.
- Mini-lab activity on phasor diagrams and impedance using circuit simulation software (like LTspice or Tinkercad Circuits).
- Data collection and analysis task: Record physical measurements (e.g., decay times, counts) and apply statistical models (Poisson/Gaussian).

SEMESTER-I

COURSE 1: INTRODUCTION TO MATHEMATICAL PHYSICS

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

COURSE OBJECTIVE:

To develop foundational computational and analytical skills through hands-on exercises that prepare students for understanding and solving problems in various realms of physics.

LEARNING OUTCOMES:

1. Graphing and Visualization:
   Students will be able to plot mathematical functions and visualize physical phenomena using Excel, Python, or MATLAB.
2. Vector and Matrix Computations:
   Students will perform operations on vectors and matrices and represent them both analytically and graphically.
3. Numerical Methods:
   Students will apply numerical techniques like Newton-Raphson, Bisection, and Euler's method to solve equations and differential equations.
4. Data Analysis and Fitting:
   Students will analyze experimental data using tools like least squares fitting and compute statistical quantities such as mean, standard deviation, and error.
5. Fourier and Complex Number Representation:
   Students will approximate functions using Fourier series and graphically represent complex numbers.

List of Practical

Minimum of 6 experiments to be conducted and recorded

1. Graphing standard functions: sin(x), cos(x), e^x, ln(x), x^2, $\sqrt{x}$ etc. using Excel/Python/Graph paper
2. Experimental determination and vector diagram verification of vector addition and scalar product using graphical methods.
3. Using MATLAB/Python to visualize vector fields and compute gradient, divergence, and curl.
4. Solve simple non-linear equations (e.g., x3−x−1=0) using graphical methods and bisection/newton-raphson method (Python or Excel).
5. Fit experimental data (e.g., Hooke's law) to a straight line using least squares method in Excel or Python.
6. Linear equation Solution and System of linear equation solution using MATLAB/OCTAVE
7. Fourier approximation of a square wave up to 5 terms using Python/MATLAB and plotting the result.

8. Numerical solution of dy/dx=x+y, given initial condition using Euler's method.
9. Single coin tossing and four coin tossing using MATLAB/OCTAVE and verification of statistical laws
10. Use Python/Excel to perform addition, multiplication, and finding inverse of 2x2 and 3x3 matrices.
11. Simulate and plot s-t, v-t graphs using s=ut+0.5gt2s = ut + 0.5gt^2 using Excel or Python.
12. Calculate mean, standard deviation, and percentage error for a given data set using Excel/Python/Manual calculations
13. Represent the given complex numbers on graph paper
14. Determine the Eigen Values of the given matrix using characteristic equation

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SEMESTER-I

COURSE 2: MECHANICS AND PROPERTIES OF MATTER

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

COURSE OBJECTIVE:

To provide students with a foundational understanding of classical mechanics and the physical properties of matter, including particle dynamics, central forces, elasticity, fluid behavior, and the basic principles of special relativity.

LEARNING OUTCOMES: After successful completion of the course, students will be able to:

1. Apply Newton's laws to variable mass systems and analyze particle collisions using conservation laws and scattering theory.
2. Describe motion under central forces and derive orbital dynamics including Kepler's laws and satellite motion.
3. Explain elastic behavior of materials using stress-strain relations, and analyze the bending of beams and torsional motion.
4. Interpret fluid dynamics concepts such as streamline flow, Bernoulli's principle, and viscosity with practical applications.
5. Understand the key postulates of special relativity and apply Lorentz transformations to problems involving time dilation, length contraction, and mass-energy equivalence.

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 ,11th 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-I

COURSE 2: 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. **Demonstrate a practical understanding of classical mechanics** by performing experiments on momentum, collisions, and motion under force.
2. **Analyze physical systems involving elasticity, fluid flow, and torsion** through hands-on measurements and data interpretation.
3. **Apply fundamental physics principles** to explain satellite motion, scattering phenomena, and beam bending using experiments and simulations.
4. **Use scientific simulations and digital tools** to visualize and investigate abstract concepts such as rocket motion, central forces, and relativity.
5. **Develop experimental, observational, and analytical skills** including data recording, graph plotting, and error estimation in real and virtual environments.

Minimum of 6 experiments to be conducted and recorded

1. Young's modulus by uniform bending
2. Young's modulus by non-uniform bending
3. Rigidity modulus using torsional pendulum
4. Surface tension by capillary rise method
5. Flywheel – Determination of moment of inertia
6. Bifilar suspension – moment of inertia of a rectangular body
7. Radius of capillary tube by Hg thread method
8. Simulation of rocket motion using water rocket or computer simulation.
9. Verification of Kepler's third law using orbit simulation.
10. Simulation-based study of Rutherford scattering.
11. Determination of modulus of rigidity using Maxwell's needle.
12. Measurement of Poisson's ratio of a rubber tube.
13. Verification of Bernoulli's theorem using a horizontal tube setup.
14. Demonstration of lift on an airfoil using airflow setup.
15. Simulation of Michelson-Morley experiment.
16. Visualization of time dilation and length contraction using 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: Lagrangian Mechanics

Activity: Apply Lagrangian mechanics to various physical systems

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

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SEMESTER-II

COURSE 3: WAVES AND OPTICS

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

COURSE OBJECTIVE:

The course aims to develop a foundational understanding of oscillatory motion, wave behavior in strings and bars, and optical phenomena like interference, diffraction, and polarization. Students will learn to mathematically analyze vibrations and light behavior through theoretical and experimental approaches.

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. Distinguish between Longitudinal and Transverse waves.
3. Understand the phenomenon of interference of light and its formation in Thin films and Newton's rings.
4. Distinguish between Fresnel's diffraction and Fraunhoffer diffraction and observe the diffraction patterns in the case of single slit and the diffraction grating and to describe the construction and working of zone plate and make the comparison of zone plate with convex lens
5. Explain the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.

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

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 VIBRATING STRINGS AND BARS (9 Hrs.)

Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones and harmonics. Energy transport and transverse impedance. Longitudinal vibrations in bars- wave equation and its general solution. Special cases (i) bar fixed at both ends (ii) bar fixed at the midpoint (iii) bar fixed at one end. Tuning fork.

UNIT-III: INTERFERENCE **(9 hrs)**

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) –colors of thin films- Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film). Determination of diameter of wire, Newton's rings in reflected light. Determination of wavelength of monochromatic light using Newton's rings.

UNIT-IV: DIFFRACTION **(9 hrs.)**

Introduction, distinction between Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction – Diffraction due to single slit, Fraunhofer diffraction pattern with N slits (diffraction grating), Resolving power of grating, Determination of wavelength of light in normal incidence using diffraction grating. Fresnel's half period zones-area of the half period zones-zone plate, Difference between interference and diffraction.

UNIT-V: POLARIZATION **(9 hrs.)**

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

REFERENCE BOOKS:

1. BSc Physics Vol.1, Telugu Academy, Hyderabad.
2. BSc Physics Vol.2, Telugu Akademy, Hyderabad
3. Fundamentals of Physics. Halliday/Resnick/Walker, Wiley India Edition 2007.
4. Waves & Oscillations. S. Badami, V. Balasubramanian and K.R. Reddy, Orient Longman.
5. College Physics-I. T. Bhimasankaram and G. Prasad. Himalaya Publishing House.
6. Optics – Ajoy Ghatak, Tata McGraw Hill
7. Fundamentals of Optics – Jenkins and White, McGraw Hill
8. Wave Optics and Vibrations – N. Subrahmanyam & Brijlal, S. Chand & Co.
9. Vibrations and Waves – H. J. Pain, Wiley

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SEMESTER-II

COURSE 3: WAVES AND OPTICS

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. Determine fundamental mechanical quantities like acceleration due to gravity and spring constant using compound pendulum and spring-based experiments, applying principles of oscillatory motion.
2. Apply statistical methods to analyze experimental data, estimate errors, and understand the importance of precision in repeated time-period measurements using a simple pendulum.
3. Explore wave phenomena through sonometer experiments, verifying laws of vibrations in stretched strings, and understand the relationship between frequency, tension, and length.
4. Analyze interference patterns in Newton's rings and wedge method to determine lens curvature and wire thickness, demonstrating coherence and phase concepts in light.
5. Examine diffraction effects using grating and prisms to determine wavelength and dispersive power, and assess optical resolving capabilities of telescopes and gratings.
6. Investigate polarization phenomena through polarimetry and understand optical activity by determining specific rotation of optically active substances.

Minimum of 6 experiments to be conducted 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.
3. Solving equation of motion for DHO & FHO using MATLAB/OCTAVE/Python
4. Determination of the force constant of a spring by static and dynamic method.
5. Verification of laws of vibrations of stretched string –sonometer.
6. Determination of radius of curvature of a given convex lens-Newton's rings.
7. Resolving power of grating.
8. Study of optical rotation – polarimeter.
9. Fourier transform simulation of single slit diffraction
10. Fourier transform simulation of diffraction at circular,rectangular aperture,edge
11. Dispersive power of a prism.

12. Determination of wavelength of light using diffraction grating-normal incidence method.
13. Determination of wavelength of laser light using diffraction grating.
14. Resolving power of a telescope.
15. Refractive index of a liquid-hallow prism.
16. Determination of thickness of a thin wire by wedge method.

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.

UNIT-II VIBRATING STRINGS AND BARS

Activity: Measuring the speed of sound in a metal rod and comparing it with the theoretical value. Students can use a microphone and an oscilloscope to measure the time delay between two reflections of a sound pulse in the rod. They can then use the formula for the speed of sound in a solid to calculate the speed and compare it with the theoretical value

UNIT-III: INTERFERENCE

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

UNIT-IV: DIFFRACTION

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-V: 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.

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SEMESTER-II

COURSE 4: 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-II

COURSE 4: 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.