GOVERNMENT COLLEGE FOR MEN (A),KADAPA

I BSc, SEMESTER- II: PHYSICS -w.e.f. 2025-26

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

SEMESTER-II

COURSE 3: WAVES AND OPTICS (LAB)

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. Dispersive power of a prism.
10. Determination of wavelength of light using diffraction grating-normal incidence method.
11. Determination of wavelength of laser light using diffraction grating.
12. Resolving power of a telescope.
13. Refractive index of a liquid-hallow prism.
14. 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.

MODEL PAPER
GOVERNMENT COLLEGE FOR MEN(A),Kadapa
I BSc, SEMESTER- II: PHYSICS -w.e.f. 2025-26 COURSE 3: WAVES AND OPTICS

Time: 3Hours **Max Marks:60**

SECTION-A

Answer any FIVE of the following. Each question carry 4 Marks (5x4 =20 Marks)

1. Write the Characteristics of SHM.
2. Write Uses of Lissajous figures?
3. The displacement of particle executing SHM is $y = 0.6 \sin(10\pi t + \pi/4)$, then find (1) Amplitude (2) Frequency?
4. Write short notes on formation of colors on thin films.
5. Write differences between Fresnel and Fraunhoffer diffractions.
6. State and explain Malus law.
7. The refractive indices for red and blue colors of thin lens made of glass are 1.540 and 1.575, calculate dispersive power?
8. Derive expression for velocity of Transverse wave in stretched string.

SECTION-B

Answer any FIVE of the following. Each carry 8 Marks (5x8 = 40 Marks)

1. Obtain differential equation of simple harmonic oscillator. Derive general solution.
2. Derive equation of Damped Harmonic Oscillator.
3. Derive expression for velocity of Longitudinal waves in a Bars.
4. Explain formation of Newton rings. Derive expression for wavelength of monochromatic light from Newton rings?
5. Explain diffraction due to single slit?
6. Explain construction and working of Zone plate?
7. Explain construction and working of Nicol prism?

16.Describe Laurentz polarimeter? Explain an experiment to determine the specific rotation of sugar solution using it?

12. Explain the design of FM Radio circuit using LCR series circuit.
13. Explain the DC motor Construction and operating principle.
14. Write the applications of a Resistor in heaters and as a fuse element.
15. Explain the role of a Transformer in a regulated Power supplies
16. Explain A.C Power generator Construction and its working principle.

GOVERNMENT COLLEGE FOR MEN(A), KADAPA

I BSc, SEMESTER- II: PHYSICS -w.e.f. 2025-26

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

MODEL PAPER

GOVT COLLEGE FOR MEN (A) , KADAPA

I. B.Sc.,SEMESTER- II: PHYSICS (Hons) ,2025-26

COURSE-4: HEAT AND THERMODYNAMICS

Time: 3 Hrs Max. Marks :60

Section –A

Answer any *FIVE* of the following. Each carry 4 mark. 5X4 = 20 marks

1. Write postulates of kinetic theory of gases?
2. Write differences between reversible and irreversible process?
3. Write short notes on entropy of the universe?
4. Derive Clausius – Clapeyron latent heat equation using Maxwells equations?
5. Write applications of substances at low temperatures?
6. Write characteristics of black body spectrum?
7. A heat engine draw heat from the source at temperature 1127^0C and reject to the sink at temperature 7^0C. Calculate its efficiency?
8. Explain Raleigh Jeans formula?

Section –B

Answer any *FIVE* of the following. Each carry 8 mark. 5X8 = 40 marks

1. What are transport phenomena? Derive expression for coefficient of viscosity of gas based on the kinetic theory?
2. Derive expression for Maxwells law of distribution of molecular velocities?
3. Explain Carnot engine? Derive expression for its efficiency?
4. What is entropy? Explain change in entropy in reversible and irreversible process?
5. Write thermodynamic potentials? Derive Maxwells equations from thermodynamic potentials?
6. What is Joule Kelvin effect? Explain porous plug experiment? Write its results
7. What is adiabatic demagnetization? Explain experiment how low temperature can be obtained in this method?
8. Explain solar constant? Explain how it is determined experimentally?

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Practical Course on HEAT AND THERMODYNAMICS

Work load: 30 hrs per semester **2 hrs/week**

Objective:

The objectives for practicals 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 OUTCOMRES:

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 six experiments to be done and recorded Experiments

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. Measurement of Stefan’s constant- emissive method

10. Study of variation of resistance with temperature - Thermistor.

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.