PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Course Code				23PHMAL232			
Title of the Course				**HEAT & THERMODYNAMICS**			
Offered to: (Programme/s)				**B. Sc Hons Physics**			
L	**4**	**T**	**0**	**P**	**0**	**C**	**3**
Year of Introduction:		**2024-25**		**Semester:**			**3**
Course Category:		**MAJOR**		**Course Relates to:**		**GLOBAL**	
Year of Revision:		**NA**		**Percentage:**		**NA**	
Type of the Course:				EMPLOYABILITY			
Crosscutting Issues of the Course:				ENVIRONMENT AND SUSTAINABILITY			
Pre-requisites, if any				BASIC KNOWLEDGE			

Course Description:

The course "Heat and Thermodynamics" makes the students able to understand the basic physics of heat and temperature and their relation with energy, work, radiation and matter. The students also learn how laws of thermodynamics are used in a heat engine to transform heat into work. The course contains the study of laws of thermodynamics, thermodynamic description of systems, thermodynamic potentials, and kinetic theory of gases.

Course Aims and Objectives:

S. NO	COURSE OBJECTIVES
1	Understand the kinetic theory of gases and transport phenomena, including viscosity, thermal conductivity, and diffusion.
2	Explore thermodynamic principles, including entropy, thermodynamic potentials, and their applications in various processes.
3	Learn the fundamentals of low-temperature physics and radiation laws, with a focus on blackbody radiation and methods of measuring radiation.

COURSE OUTCOMES

Upon successful completion of this course, students should have the knowledge and skills to:

CO NO	COURSE OUTCOME	BTL	PO	PSO
CO1	Understand the microscopic behaviour of molecules, interactions, and use kinetic theory of gases to derive expressions for the pressure of an ideal gas, the concepts of transport phenomena of heat transfer, mass transfer, and momentum transfer.	K2	2	PSO 2
CO2	Gain knowledge on the basic concepts of thermodynamics, define heat, work, thermal efficiency, and the difference between various forms of energy and describe energy exchange processes, reversible and irreversible processes.	K1	1	PSO 1
CO3	Develop critical understanding of concept of Thermodynamic potentials, the formulation of Maxwell's equations and its applications.	K2	2	PSO 2
CO4	Understand very low temperatures like the concept of Joule Thomson effect, Liquefaction of gases, and the properties at very low temperatures.	K2	4	PSO 2
CO5	Examine the nature of black body radiations and the basic theories.	K5	1	PSO 2

For BTL: K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

CO-PO MATRIX									
CO NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1		2							3
CO2	2								2
CO3		2							3
CO4	2			1					2
CO5	3								3

Use the codes 3, 2, 1 for High, Moderate and Low correlation Between CO-PO-PSO respectively

COURSE STRUCTURE:

Unit	Learning Units	Lecture Hours
I	**Kinetic Theory of gases**: **1.1 Kinetic Theory of gases**-Introduction, Maxwell's law of distribution of molecular velocities, Mean free path, Degrees of freedom, Principle of equipartition of energy (Qualitative ideas only), **1.2 Transport phenomenon in ideal gases**: Viscosity, Thermal conductivity and Diffusion of gases.	12
II	T**hermodynamics**: **2.1 Introduction to Thermodynamics** Introduction- Isothermal and Adiabatic processes - Work done in these processes, Heat engines - Reversible and irreversible processes, Carnot's engine and its efficiency, Second law of thermodynamics, Carnot's theorem, Thermodynamic scale of temperature **2.2 Entropy** Entropy and its Physical significance, change in entropy in reversible and irreversible processes; Entropy and disorder-Entropy of Universe; Temperature-Entropy (T-S) diagram and its uses	12
III	**Thermodynamic Potentials and Maxwell's equations**: **(NO PROBLEM)** **3.1 Thermodynamic potentials** - Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy and their significance, Derivation of Maxwell's thermodynamic relations from thermodynamic potentials, **3.2 Applications of Maxwell's thermodynamic relations**: (i) Clausius-Clayperon's equation (ii) Value of C_P- C_V (iii) Value of C_P/C_V (iv) Joule-Kelvin coefficient for ideal and Van der Waals' gases	12
IV	**Low temperature Physics**: **4.1 Methods for producing very low temperatures**: Joule Kelvin effect - porous plug experiment, Joule expansion, Distinction between adiabatic and Joule Thomson expansion, Expression for Joule Thomson cooling	12

	4.2 Production of low temperature: Adiabatic demagnetization **(Qualitative),** Principle of Refrigeration, effects of chloro and fluoro carbons on ozone layer.	
V	**5.1 Radiation Laws**: Blackbody and its spectral energy distribution of black body radiation, Kirchoff's law, Wein's displacement law, Stefan-Boltzmann's 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. **5.2 Measurement of Radiation** Pyrometers: Angstrom pyrheliometer and determination Solar constant, Estimation of the surface temperature of Sun.	12

TEXT BOOKS

1. BSc Physics, Vol.2, Telugu Akademy, Hyderabad
2. Unified Physics Vol.2, Optics & Thermodynamics, Jai Prakash Nath & Co.Ltd., Meerut

REFERENCE BOOKS

1. Thermodynamics, R.C. Srivastava, S.K. Saha & Abhay K. Jain, Eastern Economy Edition.
2. Fundamentals of Physics. Halliday/Resnick/Walker. C. Wiley India Edition 2007
3. Heat and Thermodynamics -N Brij Lal, P Subrahmanyam, S. Chand& Co.,2012
4. Heat and Thermodynamics- MS Yadav, Anmol Publications Pvt. Ltd, 2000
5. University Physics, HD Young, MW Zemansky, FW Sears, Narosa Publishers, New Delhi

ACTIVITY: UNIT-1

Assignment: 1. Derive expression for Maxwell's law of distribution of molecular velocities.

2. Derive expression for the co-efficient of viscosity, thermal conductivity and diffusion of gases.

ACTIVITY: UNIT-2

Assignment: 1. Derive the working of Carnot's engine and derive an expression for its Efficiency

2. State and prove Carnot's theorem

3. Problems

ACTIVITY: UNIT-3

Assignment: 1. Obtain Maxwell's thermodynamic equations using thermodynamic Potentials

2. Derive Clausius-Clapeyron's equation.

3. Problem on Inversion temperature

ACTIVITY: UNIT-4

Assignment: 1. How the principle of Adiabatic demagnetization used in producing very low Temperatures

Seminar: 1. Different methods for producing low temperatures.

2. Principle of refrigeration

3. Effects of chloro and fluoro carbon on ozone layer

ACTIVITY: UNIT-5

Assignment: 1. Derive Planck's law of black body radiation. Deduce Wein's law and Rayleigh- Jean's law from Planck's law.

2. Define solar constant. Explain with necessary theory how the solar constant is determined

Seminar: Black body. Energy distribution in black body radiation.

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SEMESTER -END MODEL QUESTION PAPER

Course Code & Title of the Course:	23PHMAL232
Title:	**HEAT & THERMODYNAMICS**
Offered to:	**B.Sc. Honours Physics**
Category: Major	**SEMESTER: 3**
Max. Marks	**70**
Max.Time	**3 Hrs**

SECTION-A

Answer All questions.

5X4=20M

1. (A) Write a note mean free path. (CO1, K1)

(OR)

(B) Explain the second law of thermodynamics in terms of entropy. (CO2, K2)

2. (A) Prove $C_p - C_v = R$ (CO3, K3)

(OR)

(B) Write the principle of refrigeration. (CO4, K3)

3. (A) How did you find the solar constant? (CO5, K2)

(OR)

(B) Explain the distribution of energy in black body radiation. (CO5, K2)

4. (A) Calculate the efficiency of a reversible engine that operates between the temperatures 200^0 C and 120^0 C? (CO2, K3)

(B) Calculate the temperature inversion of helium gas. Given a=3.44 $x10^{-3}$ ntm^4/mol^2 and b = 0.023 $x10^{-3}$ m^3 /mol. (CO4, K3)

5. (A) Find the wavelength at which maximum energy is radiated by a black body at a temperature of 227^0 C and Wien's constant is $2.877x10^{-3}$ mk. (CO5, K3)

(OR)

(B) Calculate the temperature of the sun from the following data S= 1.34 kW/m^2, radius of the sun = $7.92X10^5$ km. Distance of the sun from the earth = $1.5X10^5$km and Stefan's constant =$5.7X10^{-8}$ $Wm^{-2}K^{-4}$ (CO5, K3)

SECTION-B

Answer All questions. 5X10=50M

6. (A) Derive an expression for Maxwell's law of distribution of molecular speeds in a gas. (CO1, K1)

(OR)

(B) Define coefficient of viscosity. On the basis of kinetic theory of gases, derive an expression for the coefficient of viscosity. (CO1, K1)

7. (A) Describe the working of Carnot's reversible engine and derive an expression for its efficiency. (CO2, K2)

(OR)

(B) What are reversible and irreversible processes? How does the entropy change in each of these processes? (CO2, K2)

8. (A) Define the four thermodynamic potentials. Obtain Maxwell's thermodynamic equations using these potentials. (CO3, K3)

(OR)

(B) State and explain the Joule-kelvin effect. Obtain an expression for Joule-kelvin coefficient. (CO3, K3)

9. (A) What is adiabatic demagnetization? How is this principle used in producing low temperatures? (CO4, K2)

(OR)

(B) Explain Joule-kelvin effect. Derive an expression for Joule-Thompson cooling. (CO4, K2)

10. (A) Derive the Planck's formula for the distribution of energy in black body radiation. (CO5, K2)

(OR)

(B) What is a pyrometer? Describe the construction and working of Angstrom pyrheliometer (CO5, K2)