Course: Core Paper VI - HPHCR3062T & HPHCR3062P

Semester	III
Paper Number	HPHCR3062T &HPHCR3062P
Paper Title	THERMAL PHYSICS
No. of Credits	06 (Theory – 4, Lab – 2)
Theory/ Composite	Composite
No. of periods assigned	Th:4 periods/week Pr:3 periods/week
Name of Faculty member(s)	
Course description/ objective	The course consists of Kinetic theory of gases which is a classical basis of macroscopic phenomena and a part of thermodynamics. In this course, the students will learn about 1) Maxwell Boltzmann distribution of velocities 2) Degrees of freedom and law of equipartition of energy 3) Molecular collisions 4) Transport phenomena in ideal gases 5) Van der Waal's equation of state 6) Law of corresponding states 7) Low temperature physics 8) Maxwell's thermodynamic relations and its applications 9) The broad objective of the second module is to make students understand the principles of Thermodynamic and to be aware of its application in different areas of science. 10) Zeroth law of thermodynamics and concept of temperature, extensive and intensive variables, concepts of heat and work is introduced. 11) The 1st law of thermodynamics and its applications in various processes 12) Reversible and irreversible processes, Carnot efficiency and refrigerator is introduced. 13) The 2nd law of thermodynamics, the concept of entropy and third law of thermodynamics is discussed. 14) Thermodynamic Potentials and 1st and 2nd order phase transitions is discussed
Syllabus	As enclosed
Texts	As enclosed
Reading/ Reference Lists	As enclosed
Evaluation	Total – 100 (Theory – 60, Practical – 40) Theory – CIA – 10 Semester Examination – 50 Group A (25 marks) Group B (25 marks) One 10 marks qs out of two qs One 10 mark qs out of two qs Three 5 mark qs out of five qs Three 5 mark qs out of five qs

Syllabus:
HPHCR3062T - THERMAL PHYSICS (Credits – Theory – 04, Practicals – 02)

Module A **[26 lectures]**

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient**.** **[7 Lectures]**

Second Law of Thermodynamics:

Reversible and Irreversible process with examples.Conversion of Work into Heat and Heat into Work.Heat Engines.Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **[8 Lectures]**

Entropy:

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas.Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes.Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **[6 Lectures]**

Thermodynamic Potentials:

Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy.Their Definitions, Properties and Applications.Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation**.** **[5 Lectures]**

Module B[26 lectures]

Kinetic Theory of Gases: Distribution of Velocities-Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **[7 lectures]**

Molecular Collisions: Mean Free Path. Collision Probability.Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance. **[4 lectures]**

Real Gases: Behaviour of Real Gases: Deviations from the Ideal Gas Equation. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.Law of Corresponding States.Joule-Thomson Porous Plug Experiment.Joule- Thomson Effect for Real and Van der Waals Gases.Temperature of Inversion.Joule- Thomson Cooling.**[8 lectures]**

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations : (1) ClausiusClapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. **[7 lectures]**

Reference Books

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
3. Thermodynamics and an introduction to thermostatistics, H. B. Callen, 1985, Wiley.
4. A treatise on Heat, Saha&Srivastava, Indian Press Limited.
5. Kinetic theory, Loeb, McGraw-Hill Book Company.

HPHCR320P – Thermal Physics Lab (Credit – 2) (39 periods)

1. To determine mechanical equivalent of heat (J) by Callendar and Barnes' constant flow method.
2. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
3. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Chorlton's disc method.
4. To determine the temperature coefficient of resistance by Platinum Resistance Thermometer (PRT).
5. To study the variation of thermo-emf of a thermocouple with difference of temperature of its two junctions.

Reference Books

1.Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced Practical Physics, B. Ghosh& K.G. Majumder, Sreedhar Publishers.

Paper Structure

(a) Marks for experiment : 30 marks
(i) Class performance on any one expt. – 8
(ii) Lab. Viva on the same experiment as (i) - 7
(iii) LNB for each of the three experiments - 5 x 3 = 15

(b) Grand Viva – 8 marks
(c) Attendance – 2 marks