PHYDSC202T

THERMAL PHYSICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective*: This course aims at reviewing the basic concepts of thermodynamics, kinetic theory of gases, phenomena related to real gases with a brief introduction to Maxwell's thermodynamical equations. The primary goal is to understand the applications of fundamental laws of thermodynamics to various systems and processes.*

Unit 1: Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Zeroth Law of Thermodynamics & Concept of Temperature, First Law of Thermodynamics and its differential form, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes.

Second Law of Thermodynamics: Heat Engines & its efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **(12 Lectures)**

Unit 2:

Entropy: Concept of Entropy, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy and Entropy of the Universe. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. **(13 Lectures)**

Unit 3:

Maxwell's Thermodynamic Relations: Derivations of Maxwell's Relations. Application of Maxwell's Relations to:(1) Clausius Clapeyron equation, (2) Values of $C_P - C_V$ 3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Change of Temperature during Adiabatic Process etc.

Phase Transition: First and second order Phase Transitions with examples, Clausius Clapeyron Equation. **(10 Lectures)**

Unit 4: Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy. Specific heats of Gases.

Molecular Collisions: Basic idea of Mean Free Path. Collision Probability. Transport

Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Einstein's theory of translational Brownian Motion. **(12 Lectures)**

Unit 5:

Real Gases: Behaviour of Real Gases: Deviations from the Ideal Gas Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State, Vapour and Gas. Van der Waal's Equation of State for Real Gases. Values of Critical constants. Comparison with Experimental Curves. P-V Diagrams. Law of Corresponding States. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. Regenerative cooling. **(13 Lectures)**

Expected learning outcomes: *At the end of this course, the students will get an essence of the basic concepts of thermodynamics - the first and the second law of thermodynamics, the concept of entropy and the associated theorems along with the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations, the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, transport phenomena including Brownian motion.*

Reference Books:

1. A Treatise on Heat, Meghnad Saha and B.N.Srivastava, 1958, Indian Press
2. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
3. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
4. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.
5. Thermal Physics, A. Kumar and S.P. Taneja, 2014, S. Chand Publications.
6. Thermal physics, A. B. Gupta and H. P. Roy, Books and Allied Publisher.