

Category II

Physical Science Courses with Physics discipline as one of the Core Disciplines

(B. Sc. Physical Science with Physics as Major discipline)

DISCIPLINE SPECIFIC CORE COURSE – PHYSICS DSC 3: HEAT AND THERMODYNAMICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
HEAT AND THERMODYNAMICS PHYSICS DSC – 3	4	2	0	2	Passed 12 th Class	NIL

LEARNING OBJECTIVES

This course will review the basic concepts of thermodynamics, kinetic theory of gases with a brief introduction to statistical mechanics. The primary goal is to make the student understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through a brief knowledge of statistical mechanics. The lab course deals with providing the knowledge of the concepts of thermodynamics along with Planck's law and Stefan Boltzmann laws related to black body radiation.

LEARNING OUTCOMES

At the end of this course, students will be able to,

- gain an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations along with Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- gain the basic knowledge about quantum statistics: the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of

resistance, study variation of thermo-e.m.f. across two junctions of a thermocouple with temperature etc.

SYLLABUS OF PHYSICS DSC – 3

THEORY COMPONENT

Unit – I - Laws of Thermodynamics (10 Hours)

Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_p and C_v , work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit – II - Thermodynamic Potentials and Maxwell's Relations (5 Hours)

Basic concept of Thermodynamic Potentials, Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, derivation of Maxwell's Thermodynamic Relations and their applications in Clausius Clapeyron Equation, value of $C_p - C_v$, TdS Equations, Energy equations for ideal gases, evaluation of C_p/C_v

Unit – III - Kinetic Theory of Gases and Molecular Collisions (6 Hours)

Maxwell-Boltzmann Law of Distribution of Velocities in an ideal gas and its experimental verification, Mean, Root Mean Square and Most Probable Speeds, Mean Free Path (Zeroth order), Transport Phenomena in ideal gases: Viscosity, Thermal Conductivity and Diffusion (for vertical case)

Unit – IV - Theory of Radiation (5 Hours)

Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law

Unit – V - Statistical Mechanics (4 Hours)

Macrostate and Microstate, phase space, Entropy and thermodynamic probability, Maxwell-Boltzmann law, qualitative description of Quantum statistics – Bose Einstein and Fermi Dirac, comparison of three statistics.

References:

Essential Readings:

- 1) Heat and Thermodynamics: M. W. Zemansky and R. Dittman, Tata McGraw-Hill, 1981
- 2) Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, 2nd Edition, Tata McGraw-Hill.
- 3) Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Sears and Salinger, Narosa, 1988
- 4) Concepts in Thermal Physics: Blundell and Blundell, 2nd Edition, Oxford University Press, 2009
- 5) Thermal Physics, A. Kumar and S. P. Taneja, R. Chand Publications, 2014
- 6) A Text Book of Heat and Thermodynamics for Degree Students, J. B. Rajam, S. Chand, 1981

Additional Readings:

- 1) An Introduction to Thermal Physics: D. Schroeder, Oxford University Press (earlier published by Pearsons), 2021
- 2) Thermal Physics: C. Kittel and H. Kroemer, 2nd Edition, W. H. Freeman, 1980
- 3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company

PRACTICAL COMPONENT**(15 Weeks with 4 hours of laboratory session per week)**

At least six experiments to be done from the following:

- 1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's 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 Charlton's disc method using steam or electrical heating.
- 4) Measurement of Planck's constant using black body radiation.
- 5) To determine the temperature coefficient of resistance by Platinum Resistance Thermometer using Carey Foster's bridge.
- 6) To study the variation of thermo-e.m.f. across two junctions of a thermocouple with temperature.
- 7) To determine Stefan's Constant.
- 8) To determine the Temperature Coefficient of Resistance using Platinum Resistance Thermometer (PRT) by Callender-Griffith Bridge

References for laboratory work:

- 1) Advanced Practical Physics for students: B. L. Flint and H. T. Worsnop, Asia Publishing House, 1971
- 2) A Text Book of Practical Physics: Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal
- 3) Advanced level Practical Physics: Nelkon and Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- 4) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, 1990, New Central Book Agency.
- 5) Practical Physics: G. L. Squires, Cambridge University Press, 1985
- 6) B.Sc. Practical Physics: Harnam Singh, P. S. Hemne, revised edition 2011, S. Chand and Co.
- 7) B. Sc. Practical Physics: C. L. Arora, S. Chand and Co.
- 8) B. Sc. Practical Physics: Geeta Sanon, R. Chand and Co.