

B. Sc. II Year		BPH-C301			Semester-III	
DSC 3		THERMAL PHYSICS AND STATISTICAL MECHANICS				
Total Lectures	Time Allotted for End Semester Examination	Marks Allotted for Continuous Assessment	Marks Allotted for End Semester Examination (ESE)	Maximum Marks (MM)	Total Credits	
60	3 Hrs	30	70	100	04	

NOTE: The question paper shall consist of TWO sections (Sec.-A, Sec.-B). Sec.-A shall contain 10 short answer type questions of Five mark each and student shall be required to attempt any Five questions. Sec.-B shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

Thermodynamic Description of System:

Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_p & C_v , Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **(22 Lectures)**

Thermodynamic Potentials:

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_p - C_v)$, C_p/C_v , TdS equations. **(10 Lectures)**

Kinetic Theory of Gases:

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. **(10 Lectures)**

Theory of Radiation:

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. **(6 Lectures)**

Statistical Mechanics:

Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Phase space - Fermi-Dirac distribution law - Bose-Einstein distribution law - comparison of three statistics. **(12 Lectures)**

Reference Books

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Suggested Reading

1. S. Loknathan : Thermodynamics, Heat and Statistical Physics
2. Sharma and K.K. Sarkar : Thermodynamics, and Statistical Physics
3. Brijlal and Subrahmanyam : Heat and Thermodynamics
4. Garg, Bansal and Ghose : Thermal Physics, McGraw Hill, 2012.
5. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997.
6. Enrico Fermi, "Thermodynamics", Dover Publications, 1956.
7. MeghnadSaha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973
8. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998.
9. Singhal and Prakash: Heat and Thermodynamics, Pragati Prakashan

Suggested Online Link:

1. MIT Open Learning - Massachusetts Institute of Technology, <https://openlearning.mit.edu/>
2. National Programme on Technology Enhanced Learning (NPTEL), <https://www.youtube.com/user/nptelhrd>
3. SwayamPrabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8

(i) Course learning outcome:

- Learn 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. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Have a knowledge of the real gas equations, Van der Waal equation of state, the Joule- Thompson effect.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics.
- In the laboratory, the students are expected to perform the following experiments:
 - (i) Measurement of Planck's constant using black body radiation,
 - (ii) To determine Stefan's Constant,
 - (iii) To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method,
 - (iv) To determine the temperature co-efficient of resistance by Platinum resistance thermometer,
 - (v) To study the variation of thermo emf across two junctions of a thermocouple with temperature,
 - (vi) To determine the coefficient of linear expansion by optical lever method.
 - (vii) To determine the pressure coefficient of air by constant volume method,
 - (viii) To determine the coefficient of linear expansion by travelling microscope,
 - (ix) To determine the coefficient of thermal conductivity of a bad conductor by Searle's method.

(ii) Broad contents of the course:

- Laws of Thermodynamics
- Thermodynamic Potentials
- Kinetic Theory of Gases
- Theory of Radiation
- Introduction to Statistical Mechanics

(iii) Skills to be learned

- In this course the students should be skilled in doing calculations in thermodynamics and in statistical mechanics.
- They should also be proficient in doing calculations with the kinetic theory of ideal and real gases.
- In the laboratory course, the students should acquire the skills of doing basic experiments in thermal physics with the right theoretical explanations of results there from.