Thermodynamics and Statistical Mechanics

Programme: M.Sc.	Year: 1st	Semester: 2^{nd} semester
Course: Science	Credits: 4	Hours (LTP): 40+12+0

Course Context and Overview (100 words):
The course is designed mainly for second semester M.Sc. physics students. This course reviews basic concepts of the thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics, and theories of various ensembles (microcanonical, canonical and grand canonical ensembles). The course finally provides a flavor of how thermodynamics and statistical mechanics can be used to understand complex systems and related phenomena.

Prerequisites Courses:
Classical mechanics, elementary thermodynamics, basic quantum mechanics, and mathematical physics.

Course Outcomes (COs):
On completion of this course, students will have the ability to do:
CO1: Use the basic concept of thermodynamics to selected problems of physics and related field.
CO2: Acquire the knowledge of statistics and physical principles to describe kinetic theory of gases. Learn Boltzmann transport equation and its applications.
CO3: Use mathematical and physical principles to understand the classical statistical mechanics and learn about the statistical basis of thermodynamics.
CO4: Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.

Course Topics:

Topics	**Contact Hours (Including Tutorials)**
Unit 1: Basic concepts of thermodynamics Extensive and intensive variables, Laws of thermodynamics (includes Thermodynamic potentials, Entropy, the Maxwell relations, chemical potential), Applications of the thermodynamics to (a) ideal gas, (b) magnetic material, (c) dielectric material	**10(L) + 4(T)**
Unit 2: Kinetic theory of gases Key ideas of the kinetic theory, the mean free path, distribution of molecular velocities in an ideal gas, Maxwell-Boltzmann distribution law, experimental verification of the Maxwell's distribution law, Boltzmann Transport equation	**8(L) + 2(T)**

Unit 3: Formulation of the classical statistical mechanics **Part A:** Probability theory, Phase space and quantum states, macroscopic states and microscopic states, Liouville's theorem, the statistical basis of thermodynamics, classical ideal gas, entropy of mixing and the Gibbs paradox, equipartition theorem	**7(L) + 15(L) + 6(T)**
Part B: Elements of ensemble theory: Microcanonical ensemble, canonical ensemble, and grand canonical ensemble	

REFERENCES

This course does not follow a particular text book. The following are useful reference books:

1. K. Huang, *Statistical Mechanics* (John Wiley & Sons, 2003).
2. R. K. Pathria and P.D. Beale, *Statistical Mechanics* (Elsevier, Third edition, 2011).
3. D. Chowdhury and D. Stauffer, *Principles of Equilibrium Statistical Mechanics*, (Wiley-VCH, 2000).
4. L. D. Landau and E. M. Lifshitz, *Statistical Physics* (Part 1. 3rd ed. Pergamon Press, 1980)
5. Frederick Reif, ed. *Fundamentals of Statistical and Thermal Physics* (McGraw-Hill, 1965)
6. Richard Phillips Feynman, *Statistical Mechanics: A set of Lectures* (Westview Press, 1998)
7. M. W. Zemansky, *Heat and Thermodynamics* (McGraw-Hill Book Company Inc. 1968)
8. M. N. Saha and B. N. Srivastava *A treatise on Heat*: (Science Book Agency, 1967)
9. Carl S. Helrich *Modern Thermodynamics with Statistical Mechanics*, 2009, Springer.
10. , S. J. Blundell and K. M. Blundell, *Concepts in Thermal Physics*, 2^{nd} Ed., 2012, Oxford University Press.

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.)