Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NPHD519	ADVANCED STATISTICAL MECHANICS	3	0	0	3

Prerequisites: Statistical Mechanics, Mathematical Physics, Quantum Mechanics

Course Objective
Systems, made up of large number of constituent particles are characteristic by many emergent properties which are understood by the laws of statistical mechanics. The course is meant to introduce these laws to the students.
Learning Outcomes
Students will be conversant with the general notions of Statistical Mechanics viz. ensemble theory. Using this approach they should be able to calculate properties of systems with many particles. They will also have the idea of the statistical basis of phase transitions and critical phenomena.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Phase Transitions :** Thermodynamics of phase transitions, order parameter, first order and continuous phase transitions metastable states, coexistence of phases.	4	Students will know about the classification of phase transitions and their characterizing parameters
2.	**Critical Phenamena:** Fluid- magnet analogy; Spatial and temporal fluctuations, Critical point exponents and their inter-relationship, scaling hypothesis, universality classes, Peierls argument for phase transitions. Spontaneous breakdown of symmetry, Landau theory of phase transitions. Role of fluctuations, lower and upper critical dimensions. Introduction to the elements of the renormalization group approach to continuous phase transitions:	10	Students will learn about the behaviour of physical properties near critical point.
3.	**Statistical mechanical models:** Ising, lattice gas, Heisenberg, XY and Potts models. Transfer matrix method. illustration using the one-dimensional Ising model, renormalization in one dimension.	8	Students will learn some statistical model systems to apply the rules and to calculate the properties
4.	**Nonequilibrium Statistical Mechanics:** Systems out of equilibrium, kinetic theory of a gas, approach to equilibrium and the H-theorem, Boltzmann equation and its application to transport problems, master equation and irreversibility, simple examples, ergodic theorem.	8	Students will learn the mechanics to deal with the statistical systems which are out of equilibrium
5	Brownian motion, Langevin equation, fluctuation-dissipation theorem, Einstein relation, Fokker-Planck equation.	6	The students will learn about the Brownian motion and its theory.
6	**Correlation Functions:** Time correlation functions, linear response theory, Kubo formula, Onsager relations.	6	Students will learn about various correlations instrumental in bringing a system into equilibrium.
	Total	**42**	

Text Books:

1. Statistical Mechanics: R. K. Pathria; Elsevier; 2002.
2. Statistical Mechanics, K. Huang, Wiley, 1987.

Reference Books:

1. Statistical Mechanics: Landau and Lifshitz; Butterworth-Heinemann; 1976.
2. Modern Theory of Critical Phenomena: Shang Keng Ma; Levant Books; 2007.
3. Introduction to Phase Transitions and Critical Phenomena; H. Eugene Stanley; Oxford University Press; 1987.