

# **Advanced Statistical Mechanics (JT308)**

**Instructor: Prof. Subir K Das**

**4 credit course; LTP structure 3-0-1**

On Certain Theoretical Developments in the Domain of Phase Transitions, targeted at Advanced Masters and Ph.D. Students.

Preliminaries: Concept of Equilibrium; Laws of Thermodynamics; Free Energies and Interpretation; Liouville's Theorem; Statistical Ensembles – Fluctuations, Equivalence and Choices.

(Descriptions of) Phase Transitions: Phase Boundaries; Order Parameter; Types of Phase Transitions; Nucleation; Wetting; Nonequilibrium Processes; Critical Phenomena -- Static and Dynamic Aspects.

Static Critical Phenomena: Critical Exponents; Exponent (In)Equalities; Universality; Range of Interaction; Ising and Related Models; Symmetry Properties; Spontaneous Symmetry Breaking; Mermin-Wagner-Hohenberg Theorem; Finite Systems and Impossibility of Phase Transitions; Weiss Molecular Field Theory; Bethe Approximation; Landau Theory; Exact Solutions in Simple Situations; Critical Fluctuations and Correlations -- Ornstein-Zernike Theory and Corrections; Ginzburg Criterion; Widom's Scaling Picture and Exponent Equalities; Fisher's Scaling for Finite Systems and Estimation of Exponent Values; Renormalization Group -- Kadanoff Blocking, Wilson's decimation, Flows and Fixed Points, Relevant, Irrelevant and Marginal Pictures; Wilson-Fisher Epsilon Expansion, Evaluation of Exponents.