



Indian Institute of Technology, Kanpur

Department of Physics

PHY 615: Non-equilibrium Statistical Mechanics

Introduction: Review of Equilibrium SM and Aim of NESM (1 Lecture)

Module 1: Langevin and Fokker-Planck Equations (12 Lectures):

Langevin equation: Application to free Brownian particle;

Fokker-Planck equation: Application to Diffusion; Mapping onto Schroedinger Equation and application to Brownian particle subjected to harmonic potential; Kramers' theory of activated barrier crossing and decay of metastable states- nucleation.

Module 2: Markov Chains and master equation (12 Lectures):

Markov processes, classifications of states; application to Random walk and birth-death processes; master eq for interacting systems, Kinetic Ising model: exact solution in one-dimension and mean-field approximation in higher dimensions, critical slowing down.

Module 3: Paths, Path Integrals and Path-based formulation of NESM (12 Lectures):

Random excursions, backward master equation and distribution of First-passage times; stochastic calculus and calculus of variations; Path Integrals; Info-theoretic and Path-based stochastic thermodynamics, fluctuation theorems.

Module 4: Non-equilibrium Steady-states (6 Lec):

Totally Asymmetric Simple Exclusion Process (TASEP) under periodic boundary conditions, exact flux-density relation; TASEP under open boundary conditions and the phase diagram; applications to traffic flow.

Books:

1. "Simple Brownian Diffusion", by Gillespie and Seitaridou (Oxford University Press, 2013).
2. "A Kinetic View of Statistical Physics", by Krapivsky, Redner and Ben-Naim (Cambridge University Press, 2010).

Instructor : Prof . D. Chowdhury.