

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
Department of Physics

PHY 615A: Non-equilibrium Statistical Mechanics

Instructor: Prof. Debashish Chowdhury (E-mail id of instructor: debch@iitk.ac.in)

Course Contents:

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 Integral and Path-based formulations (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.

1. **Text Book:** "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).

Lecture & Discussion: As announced by DOAA (please check OARS/Pingala).

Evaluation Components & Policies:

Mid-semester Examination (weightage: 50%).

Term Paper report, presentation, answering questions (weightage: 50%)

(Additional Information given on the next page)

- (i) All official e-mail communication during this online semester will be sent from my official e-mail ID at IIT-K (debch@iitk.ac.in). Students must also send their e-mails to me from their IIT-K e-mail ID; mails sent from gmail/yahoo, or any other such e-mails, will not be recognized as official communication.
- (ii) Since IIT-K has created licensed ZOOM accounts for all the online courses, including PHY615A, and since, in my past experience, meetings run quite smoothly on the ZOOM platform, the meeting of the instructor with the students during the discussion hour, scheduled by the DOAA office, will be conducted on ZOOM.
- (iii) The **video camera must be kept switched ON, with real background, during the entire period of the examination and term paper presentation.**
- (iv) The term paper presentation will be made by the students through ZOOM; **all the term paper presentation sessions will be recorded live.**
- (v) The video files of the online lectures are strictly **for your personal use** only. **These are all protected by copyright law. Therefore, you are advised not to share any of these with anyone else now or ever in future. Sharing these files may lead to violation of copyright law and, consequently, attract penalty.**
- (vi) As you might know, in my in-person lectures I always enter the lecture hall before the second bell and expect the students to do the same. During this online semester please join the ZOOM session at least a minute before the discussion/examination hour begins; I'll not accept request for joining the session after the discussion/examination begins. **There are some typos in the recorded video files; in case of any confusion arising from the typos, it may be brought to the attention of the instructor by the student(s) in the beginning of the discussion hour.**

Prof. D. Chowdhury