

# **PHY632 (Transport in Mesoscopic Systems) 2023-24-I**

**Instructor:** Anjan K. Gupta, Physics Department, IIT Kanpur

**Schedule:** MTh 10:00- 11:00, T12:00-13:00

## **Course Content:**

This is a first course in Mesoscopic Physics. The students should have a background in quantum mechanics at least at the level of PSO201 or Phy431. Some basic understanding of condensed matter physics is also desirable.

Tentatively, we plan to discuss the following topics in this course:

- 1) Introduction, basic length and the corresponding energy and time scales in metals.
- 2) Drudé model; Diffusion equation and Einstein relation; classical size effects.
- 3) Quantum diffusive transport, weak localization, phase coherence and interference effects in non-superconductive systems
- 4) Classical and quantum ballistic transport, conductance quantization, multi-terminal devices and Landauer-Büttiker formalism.
- 5) Landau levels, edge states, quantum Hall effect (integer and fractional) in 2D electron gas
- 6) Charging effects, Coulomb blockade and quantum dots
- 7) Mesoscopic Superconductivity: Josephson effect, RCSJ model, Bloch oscillations, approach to flux and charge Q-bits.

## **Reference Books:**

- 1) Mesoscopic Physics: An introduction, by Harmans (available online).
- 2) Introduction to mesoscopic physics, by Y. Imry
- 3) Electronic Transport in Mesoscopic Systems, by Supriyo Datta
- 4) "Quantum Transport", Lecture Notes by Yuri M. Galperin (available at <http://folk.uio.no/yurig/quTpdf.pdf>)
- 5) "Quantum Transport in semiconductor nanostructures", C. W. J. Beenakker and H. van Houton in "Solid State Physics", vol.44, ed. by Frederick Seitz and David Turnbull, Academic Press (1991).
- 6) "Electron Transport in nanostructures and mesoscopic devices", T. Ouisse, Wiley 2008.  
Other references for specific topics may be suggested during the course.

## **Evaluation:** Out of 240 marks

Home-works: 40 marks

Mid-Sem: 40 marks (1 hr)

Term Paper: 40 marks (presentations in the last week of Oct)

End Sem: 120 marks

Attendance: Compulsory (the final marks will be scaled by attendance with above 90% getting scale 1 and zero at or below 40%)