PHY632 (Transport in Mesoscopic Systems) 2017-18-I

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

Schedule: To be announced

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 in 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) Mesoscopic Superconductivity: Josephson effect, RCSJ model, Bloch oscillations, approach to flux and charge Q-bits.
7) Charging effects, Coulomb blockade and quantum dots

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).

Other references for specific topics may be suggested during the course.