Condensed Matter Phenomena in Low-dimensional Systems (Phy642)

Instructor: T. K. Ghosh

Objectives: This course is divided into 28 lectures and systematically developed from basic principles to an advanced level. We will introduce the essential theoretical formalism at an accessible level with illustrations of experimental results. This course will be useful for PG as well as advanced UG students

Course Contents:

1) **Semiconductor Heterojunctions**: Two-dimensional and one-dimensional charged systems, quantum Hall effect, Shubnikov de-Haas (sDH) and dHvA oscillations, role of Berry phase in transport coefficients, transport and optical properties of quantum dots and wires.

2) **Spin-Orbit Coupled Systems**: Low-dimensional electron/hole with spin-orbit interaction, beating pattern in magnetotransport measurements, spin-field effect transistor, spin Hall effect, spin Hanle effect.

3) **Two-Dimensional Dirac Materials**: Graphene monolayer and bilayer, charge and optical conductivity, anomalous quantum Hall effect, existance and role of zero-energy states, graphene nano ribbons, graphene based quantum dots, scattering properties of Dirac electrons, basic properties of silicene, molybdenum dishulphide and phosphorous.

References:

1) Properties of Spin-orbit coupled low-dimensional systems, lecture note by T. K. Ghosh
2) Graphene: Carbon in Two -Dimension by M. I. Katsnelson
3) Semiconductor Spintronics (Tutorial Review) by J. Fabian, A. Matos-Abiague, C. Ertler, P. Stano, and I. Zutic, arXiv:0711.1461