

Department of Physics

Indian Institute of Technology Kanpur

Course Title: Condensed Matter Phenomena in Low-Dimensional Materials

Course Number: PHY642

Course Units: 3-0-0-0 (9)

Course Instructor: Adhip Agarwala

Course Timings: Mon/Wed (5pm-6.30pm)

Prerequisites: Master's level of Condensed Matter Physics

First Lecture: 6th Jan, 2027 (Venue: TBA)

Total Lectures: 26 (75 mins each) [Extra Tutorial Sessions may be taken]

Course Objective:

Low dimensional systems display a rich set of phenomena which are fundamentally distinct from the three dimensional solid state physics we are familiar with. This requires us to include ideas of quantum confinement, topology and band-geometry to understand them. The course will introduce you to a host of such phenomena, physical systems in which they are realized and theoretical framework which is required to understand them. The course will be heavy on assignments and is recommended only for advanced graduate students who have a requisite background on standard solid state physics.

Syllabus:

Lectures	Topics
2	Brief overview of three dimensional solid state phenomena, transport and magnetism
8	Two dimensional continuum systems: 2DEG, Quantum Hall, Landau levels (2), Overview of Fractional quantum of Hall effect (2), Semiclassical Boltzmann transport (3), Success and limitations (1)
10	Two dimensional Lattice systems: Graphene, Bilayer Graphene (2), Twisted Graphene and heterostructures (4), Transition metal dichalcogenides (2), Band-Geometry, Low-dimensional magnetism and role of lattice symmetries (2)
6	One dimensional systems: Ballistic transport, Scattering Matrices, NEGF. Role of Interactions: Luttinger liquids and their transport signatures

References:

There is no standard textbook. Reference material will be shared as per lectures.

Grading scheme:

Quiz (20%), Mid-Sem Examination (20%),
Final Examination (30%), Assignments (20%),
Readings and discussions (10%).
Grading will be relative.

Assignment Submission Policy:

Will be in hard-copy. Please respect deadlines.

Assignment/Exam Policy:

In Assignments: Participants are welcome to discuss among each other and refer to literature. Due credit should be provided in terms of references/people discussed with, when submitting the assignment.

Copying an assignment from a colleague – will be penalized. Students may be asked to present their answers to assignment questions to the rest of the class, therefore please ensure you stand by your submitted scripts.

In exams, any kind of mal-practice will be severely penalized. Present examiner's discretion will be final in such instances.

Attendance policy:

An attendance record will be maintained. Exams/surprise quizzes (if any) will not be repeated for absentees. Frequent casual absences/vegetative participation may be penalized, and/or sustained attendance with active participation may be rewarded. Instructor discretion will be final.

Absence due to medical/emergencies will be duly considered, even for re-examination, if informed with necessary documents and in time.