

# **PH 436: Introduction to Condensed Matter Physics**

## **Instructor**

Hridis Pal (Email: hridis.pal[at]iitb.ac.in, Office: Physics 217)

## **Meeting**

Mon: 11:35-12:30, Tue: 08:30-9:25, and Thu: 09:30-10:25 hrs. at CL 111 ESE

## **Office hours**

By appointment—send an email to fix the time

## **Teaching assistant**

Devansh Satra (Email: devanshsatra[at]iitb.ac.in)

## **References**

### Primary

- Solid State Physics, N. W. Ashcroft and N. D. Mermin, Thomson Asia Pte Ltd. Singapore (2003). Hereafter, it is referred to as “AM”.

### Supporting

- The Oxford Solid State Basics, S. H. Simon, Oxford University Press—Indian Edition (2013). Hereafter, it is referred to as “S”.
- Modern Condensed Matter Physics, S. M. Girvin and K. Yang, Cambridge University Press, UK (2019). Hereafter, it is referred to as “GY”.

## **Topics [with source reference]**

- Introduction
  - What is condensed matter physics? [Lecture + S Ch.1 (general reading)]
  - The goal of this course: Properties of quantum crystalline solids [Lecture + S Ch.1 (general reading)]
- Solid as an electron gas

- Drude theory [AM Ch. 1]
- Sommerfeld theory [AM Ch. 2]
- What is missing? [Lecture + AM Ch. 3 (general reading)]
- Solid as an electron gas + lattice
  - Crystal lattices
    - Real space [AM Ch. 4]
    - Reciprocal space [AM Ch. 5]
    - Experimental probe(s) [AM Ch. 6 + S 14.1, 14.2]
  - Electron gas in a lattice
    - Bloch's theorem [AM Ch. 8]
    - Weak periodic potential [S Ch. 15]
    - Tight-binding method [AM Ch. 10 + S Ch. 11]
    - Metals, insulators, semiconductors (and ...) [AM Ch. 8, S 16.1-16.3]
    - Experimental probe(s) [AM Ch. 14 (general reading)]
  - Electron (semiclassical) dynamics and consequences
    - Semiclassical equations of motion and consequences [AM Ch. 12, excluding the section on high-field Hall effect and magnetoresistance]
  - Lattice vibrations
    - Classical theory [AM Ch. 22]
    - Quantum theory–Phonons [AM Ch. 23]
    - Thermodynamic consequences [AM Chs. 22+23]
    - Experimental probe(s) [AM Ch. 24 (general reading)]
  - What is missing? [Lecture]
- Topology in solids (a cursory look)
  - Berry physics [GY 13.1, 13.3]
  - An example: SSH model [[Pedagogical notes](#)]
- What is missing? What lies ahead? [Lecture]

### Grading #

- 1 quiz: 10%
- Midsem exam: 30%
- Endsem exam: 45%
- Presentation: 15%
  - Choice 1: Paper presentation at the end of the semester
  - Choice 2: Presentation of 1 tutorial set in class + submission of any 3 tutorial sets from the remaining

# Audit: A grade of DD or above is required at the end of the semester. All other requirements remain the same as those required for credit.