PH 436: Introduction to Condensed Matter Physics

Instructor

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

Meeting

Wednesday and Friday, 11:05 am — 12:30 pm at LC 101

Office hours

Wednesday 5:30 pm by appointment (send me an email beforehand)

Teaching assistant

Sagnik Banerjee (Email: 200260044@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; see this paper for a derivation if you are interested]
    - 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)
    - Topology of what? [GY]
    - Calculation and implication [GY]
- What is missing? What lies ahead? [Lecture]

Grading #

- Endsem exam: 50%
- 3 quizzes: 30% (3×10%)
- In-class problem solving: 10% (5×2%)
- Group presentation: 10%

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.