

SYLLABUS

Introduction to Condensed Matter Physics

PHY 251 - PHY 420 - ECE 224 - ECE 424 - MSC 420

(26 lectures of 1h 15m)

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| 1 | Free-Electron Models | <i>(4 lectures)</i> |
| 1.1 | The Drude Theory of Metals | |
| 1.2 | The Sommerfeld Theory of Metals | |
| 1.3 | Failures of the Free-electron Model | |
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| 2 | Structure of Solid Matter | <i>(2 lectures)</i> |
| 2.1 | Crystal Lattice | |
| 2.2 | Reciprocal Lattice | |
| 2.3 | Elements of Crystal Diffraction | |
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| 3 | Harmonic Crystal | <i>(3 lectures)</i> |
| 3.1 | Classical Theory of the Harmonic Crystal | |
| 3.2 | Quantum Theory of the Harmonic Crystal | |
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| 4 | Electronic Band Structures | <i>(6 lectures)</i> |
| 4.1 | Bloch's Theorem | |
| 4.2 | The Nearly Free-Electrons Approximation | |
| 4.3 | The Tight Binding Approximation | |
| 4.4 | Elements of Electron Dynamics: Wave Packets of Bloch Electrons | |
| 4.5* | Quantum Transport in Nanostructures | |
| 4.6* | Graphene | |
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| 5 | Optical Properties | <i>(4 lectures)</i> |
| 5.1 | The Dielectric Function | |
| 5.2 | Optical Properties of Metals and Insulators | |
| 5.3* | Novel Optical Materials: Negative Refractive Index and Metamaterials | |

6 Semiconductors (4 lectures)

- 6.1 Homogeneous Semiconductors
- 6.2 Inhomogeneous Semiconductors
- 6.3 Semiconductor Heterostructures
- 6.4* Semiconductor Epitaxy and Nanofabrication

7 Magnetism (3 lectures)

- 7.1 Diamagnetism and Paramagnetism
- 7.2 The Exchange Interaction
- 7.3* Magnetism in Thin-Films and Giant Magneto-Resistance
- 7.4* Quantum Hall Effect

Main Book

N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Brooks Cole, 1st ed. (1976).

Additional References

C. Kittel, *Introduction to Solid State Physics*, Wiley; 8th ed. (2004).

G. Grosso and G. Pastori Parravicini, *Solid State Physics*, Academic Press, 1st ed. (2000).

H. Ibach and H. Luth, *Solid-State Physics: An Introduction to Principles of Materials Science*, Springer; 4th ed. (2009).