האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

INTRO. TO CONDENSED MATTER PHYS. FOR ENGINEERING - 83320

Last update 28-10-2024

HU Credits: *5*

Degree/Cycle: *1st degree (Bachelor)*

Responsible Department: *Applied Physics*

Academic year: *0*

Semester: *1st Semester*

Teaching Languages: *Hebrew*

Campus: *E. Safra*

Course/Module Coordinator: *Jonah Waissman*

Coordinator Email: *jonah.waissman@mail.huji.ac.il*

Coordinator Office Hours: *TBD*

Teaching Staff:
Dr. Jonah Waissman,
Mr. Roy Maman

Course/Module description:
In this introduction to solid state physics, we will learn about periodic atomic structure, its mathematical representation, its dynamics and how this impacts thermodynamic quantities like the specific heat, and how quantum mechanics impacts this picture. We will then see how periodic structure impacts electrons in solids. Time allowing, we will tie the two together to understand the origins of electrical resistance, and how electron interactions can give rise to magnetism.

Course/Module aims:
Introduction to solid state physics. Fundamentals and basic structure of the theory.

Learning outcomes - On successful completion of this module, students should be able to:
Basic understanding of the fundamental concepts of solid-state physics: mathematical representation of lattice structure, reciprocal space, phonon spectra, electronic spectra.

Attendance requirements(%):
0

Teaching arrangement and method of instruction: Lectures + recitations

Course/Module Content:
Periodic structure. Lattices and crystals. Single cells, Wigner - Seitz cell. Crystallographic systems, Bravais lattices. Bragg scattering. Crystallographic directions and planes. Structure factor. Reciprocal lattice. Brillouin zone.

Review of specific heat, Dulong-Petit, equipartition. Solid state specific heat. Lattice vibrations, phonons, classical models. Quantum models, Debye model. Two-atom basis and optical phonons.

Electrons in a periodic structure. Bloch theorem, Bloch functions, conservation laws in the lattice. Nearly-free model, bands and band gaps. Tight-binding models. Free electrons: Fermi gas and Fermi wave vector, Fermi levels, Fermi surface. Heat

capacity in metals.

As time allows: Drude model, origins of electrical resistance. Origins of magnetism, varieties of magnetism. Other optional topics.

Required Reading:
Introduction to Solid State Physics, Charles Kittel

The Oxford Solid State Basics,
Steven H. Simon

Additional Reading Material:
Solid State Physics,
Neil Ashcroft and N. David Mermin

Grading Scheme:
Written Exam % 65
Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 15 %
Mid-terms exams 20 %

Additional information:
None.