PHYS 141A - SOLID STATE PHYSICS (4 UNITS)

COURSE OVERVIEW

SUMMARY

Physics 141A is the first course in the solid state physics sequence. Assuming prior knowledge of what an atomic orbital is and how a Hamiltonian operator acts, this class derives many models and formulas to describe various properties of solid-state compounds. Note that this class is taught by a physics professor, not a chemist, so the lectures and homework are heavily bent towards mathematical derivations, and pictures and visual representations are less common than in chemistry classes. Depending on the professor teaching the class, the topics may vary, but are generally the same.

PREREQUISITES

Chemistry 120A (chem120a.html) or Physics 137A (phys137a.html) (Recommended; online it says required, but this rule is not enforced)

TOPICS COVERED

- Crystal binding and structure
  - Basic crystal systems, Miller indices
- Reciprocal lattice and diffraction
  - Scattering amplitude, atomic form factor, structure factor
  - Ewald sphere, Wigner Seitz cell
- Phonons

    - Harmonic approximation, spring model dispersion
    - Allowed modes: longitudinal, transverse, optical, acoustic
    - Phonon scattering, scattering amplitude, G-vectors, quantization
    - Bose-Einstein distribution function, phonon heat capacity, phonon density of states, thermal conductivity, Umklapps scattering
- Electronic structure
    - Free electron gas, density of states in k-space
    - Electron transport: conductivity, Hall effect, thermal conductivity
    - Band structure diagrams, central theorem, crystal orbitals, Bloch's theorem, nearly free electron model
- Semiconductors
    - Bandgaps, crystal momentum conservation, group velocity, semiclassical electron motion, effective mass, holes, cyclotron resonance, doping
    - P-n junction, band bending, depletion region, tight binding, screening
- Magnetic properties of materials
    - Magnetic induction, ferromagnetism, paramagnetism, diamagnetism, magnetic interaction mechanisms

WORKLOAD

COURSEWORK

- 11 problem sets
- 1 midterm, 1 final

TIME COMMITMENT

3 hours of lecture per week, 5 hours per problem set.

CHOOSING THE COURSE

WHEN TO TAKE

The class is predominantly juniors and seniors, as this is an upper-division elective. This class is not overly time-intensive.

WHAT NEXT?

- Physics 141B: Solid State Physics (phys141b.html)
- MSE 102: Crystallography (mse102.html)
- MSE 104: Materials Characterization (mse104.html)

ADDITIONAL COMMENTS AND TIPS

This class will be an unusual transition for the chemistry student, as many formulas are derived in class while real-life models and examples will scarcely be given. The math isn't difficult though. It's a class more bent on formulas than on applications.

This class counts as allied subject credit for the chemistry major, or can count towards the optional materials chemistry concentration as well.

Many topics will be repeated from Chem C150, although in significantly greater depth. C150 is a survey class covering many more topics than 141A but in less depth, while 141A hones in on several particular topics covered in C150.

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