ECE215B/Materials206B Spring 2008

Fundamentals of Solids for Electronics II

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Lecture Hours: Monday/Wednesday, 4:00 - 5:50pm; 1437 Phelps
Office Hours: Tuesday, 4:00 - 5:50pm
First lecture: Wednesday 2 April 2008
No lecture: Monday 31 March (make-up lecture to be announced)
Last lecture: Wednesday 4 June 2008
Six Homeworks: Assigned periodically
Grading: Best of two quizzes: 50%; Final exam: 50%
Quiz#1: Monday 5 May 2008, 5:00 - 5:50pm (tentative)
Quiz#2: Monday 2 June 2008, 5:00 - 5:50pm
Final Exam: Friday 13 June 2008, 4:00-7:00 PM, 1437 Phelps
Lecture style: One 10-minute break at ~4:55 PM.
Exam style: Closed book, closed notes, but lots of clues. Calculators required.


**Syllabus**

- **Electrical Properties (Macroscopic + Microscopic Viewpoint)**
  - Classical Electrostatics
  - Microscopic Dipoles and Relation to the Macroscopic
  - Electrostatic Feedback Loop and Ferroelectricity
  - Piezoelectricity and Ultrasonic Transducers
  - Pyroelectricity and “Uncooled” Infrared Detectors
- **Magnetic Properties (Macroscopic + Microscopic Viewpoint)**
  - Classical Magnetostatics
  - Microscopic Dipoles and Relation to the Macroscopic
  - Magnetostatic Feedback Loop and Ferromagnetism
- (Optional) **Quantum Theory of Ferromagnetism**
  - Heisenberg Hamiltonian
  - Spin waves and their Quantization (magnons)
- **Transport theory I: Kinetic Theory of charge-carrier transport in E and B fields**
  - Equations of motion and scattering.
  - dc and ac electrical conductivity; Drude-Lorentz model.
  - Drift and diffusion of electrons.
  - Transport of phonons (heat transport).
- **Transport theory II: Boltzmann Transport Formalism**
  - Statistical description of a population of carriers.
  - Inclusion of scattering in relaxation-time approximation.
  - Transport conductivities.
  - Drift and diffusion.
- **Transport theory III: Semi-classical Transport Theory**
  - Transport of carriers within a band; hole theorem.
  - Inclusion of scattering: relaxation time and quantum-mechanical derivations.
  - Bipolar behavior and recombination mechanisms.
  - Development of the semiclassical drift-diffusion equations.
- **Transport theory IV: Elementary Quantum Transport Theory**
  - Tunneling theory: stationary state and transfer-Hamiltonian approaches.
    - Resonant tunneling in envelope function approximation.
    - Interband tunneling in \( \mathbf{k} \cdot \mathbf{p} \) model
  - Quantum conductance: Landauer’s formula.
  - Quantum Boltzmann transport.