Semiconductor Devices

Prof. Eric Polizzi

ECE 609- Spring07

University of Massachusetts, Amherst

Syllabus

- **Instructor:** Prof. Eric Polizzi
- **Office:** Marcus 201C
- **Day and Time:** M-W-F 10:10-11:00am
- **Place:** Marston 220
- **Office Hours:** M-W-F, 11:00-12:00am
- **E-mail:** polizzi@ecs.umass.edu
  - Homework and important information will be sent by e-mail
- http://www.ecs.umass.edu/ece/polizzi

Syllabus

- **Prerequisite:** A solid state or quantum mechanics undergraduate course is recommended
- **Textbook:**
  - J.P. Colinge and C. A. Colinge, "*Physics of Semiconductor Devices*", (Kluwer Academic, Boston, 2002).
  - On-line ECE-609 spring06 draft lectures notes
- **Suggested Reading:**
  - C. Cohen-Tannoudji, B. Diu, and F. Laloe, "Quantum mechanics"
  - C. Kittel, "*Introduction to Solid State Physics*", Fourth Edition (John Wiley and Sons, New York, 1971).
  - S. M. Sze, "*Semiconductor Devices: Physics and Technology*", (John Wiley and Sons, 1985).
  - Y. Taur and T. H. Ning, "*Fundamentals of Modern VLSI Devices*", (Cambridge University Press, New York, 1998)

Outline

I. **Physics of Semiconductors:**
   - Review of quantum mechanics
   - Energy band theory
   - Semiconductors Fundamentals
   - Theory of electrical conduction

II. **Two-Terminal devices**
   - P-N junctions
   - Metal-semiconductors contacts
   - MOS capacitors
   - Heterojunctions

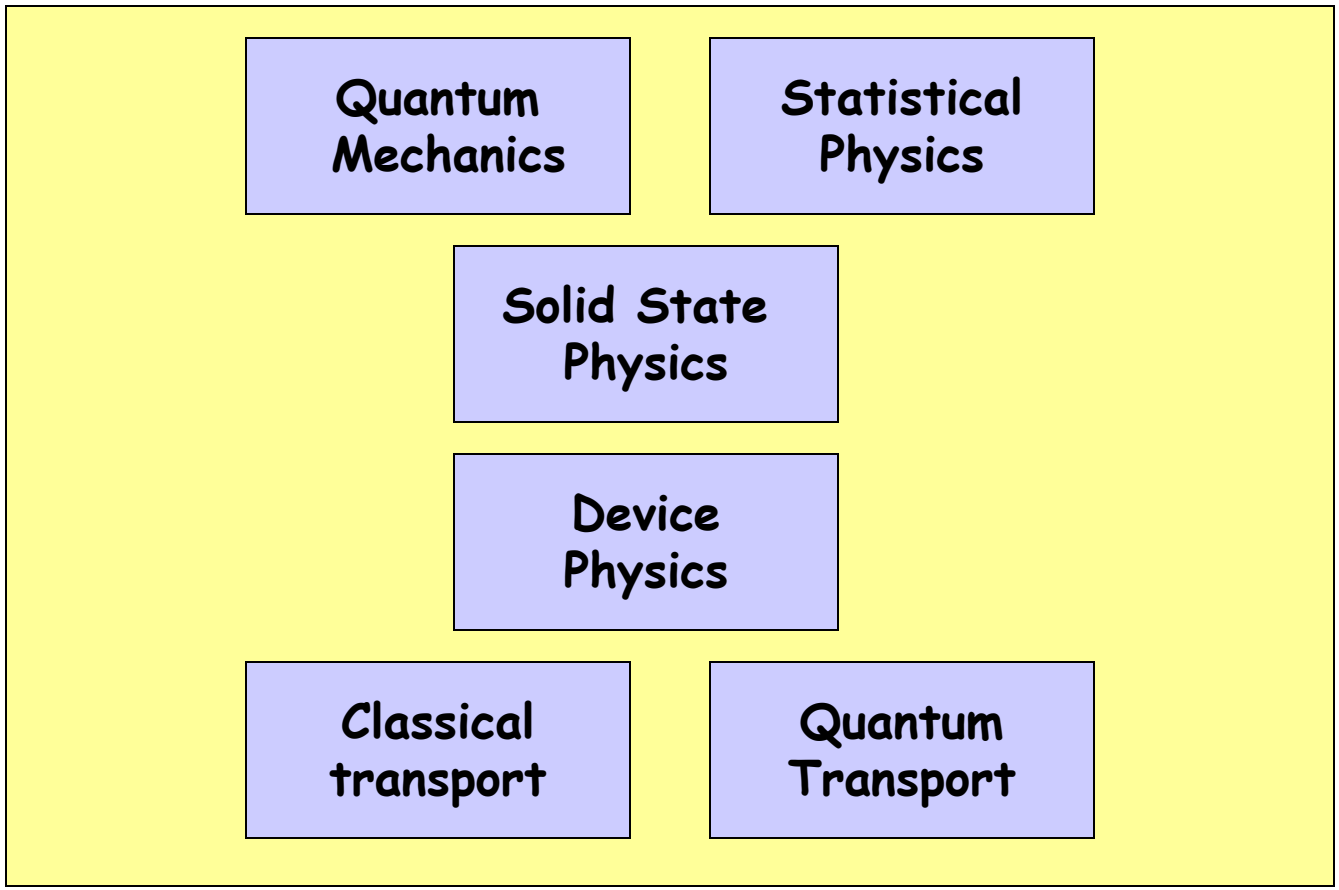
III. **Three-Terminal devices**
   - MOSFET
   - Bipolar junction transistor

IV. **Nanoscale semiconductor devices**
   - Quantum effects in semiconductors
   - Introduction to quantum transport

Grading

- Homework 30% (~6 homework)
- Midterm 30% (on chapters 1-2)
- Final 40% (all chapters)

ECE609 Overview



ECE609 Overview

- **Purpose of the Course:**
  - Provide the foundations to understand what is a semiconductor
  - Provide the foundations to understand the electronic properties and the physics of charge transport in semiconductors
  - Explain the operating principles in semiconductor devices
  - Perspectives of emerging device technology

History of semiconductor transistors

- **1947: Bipolar Junction Transistors (BJT)**
  - high current drive capability, widely used as an amplifier, key component in oscillators, high-speed integrated circuits and switching circuits.
  - Device parameters are hard to control, power consumption is extremely high limiting its integration density
- **1960: Planar Process NMOS technology**
  - Easier control over processing, high circuit integration density, low cost, lesser power dissipation than BJT, NMOS preferred over PMOS due to higher speed
  - NMOS integrated circuits have large static power consumption
- **1963: *CMOS* technology** (1971: Microprocessor, 1993: Pentium)
  - Low power consumption
  - Due to technology scaling, device parameters will eventually reach their physical limitations, majors barriers in further advancement of CMOS technology
- **20??: Emerging Nanoelectronics devices**: CNT, Si or III-V Nanowire, Molecular devices, SET, Spintronics, etc…