

Semiconductor Devices

Prof. Eric Polizzi

ECE 609- Spring06

University of Massachusetts, Amherst

Syllabus

- **Instructor:** Prof. Eric Polizzi
- **Office:** Marcus 201C
- **Day and Time:** M-W-F 10:10-11:00
- **Place:** Marston 220
- **Office Hours:** M-W-F, Time 2-3pm ?
- **E-mail:** polizzi@ecs.umass.edu
 - Homework and important information will be sent by e-mail
- <http://www.ecs.umass.edu/ece/polizzi>
 - Go under Teaching and find also homework, and handouts. Website updated time to time

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).
- **Suggested Reading:**
 - 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)
 - On-line ECE-609 spring05 lectures notes of Prof. Max Fischetti

Outline

I. Physics of Semiconductors:

- Review of quantum mechanics
- Energy band theory
- Theory of electrical conduction

II. Two-Terminal devices

- P-N junctions
- Metal-semiconductors contacts
- MOS capacitors

III. Three-Terminal devices

- Bipolar junction transistor
- MOSFET

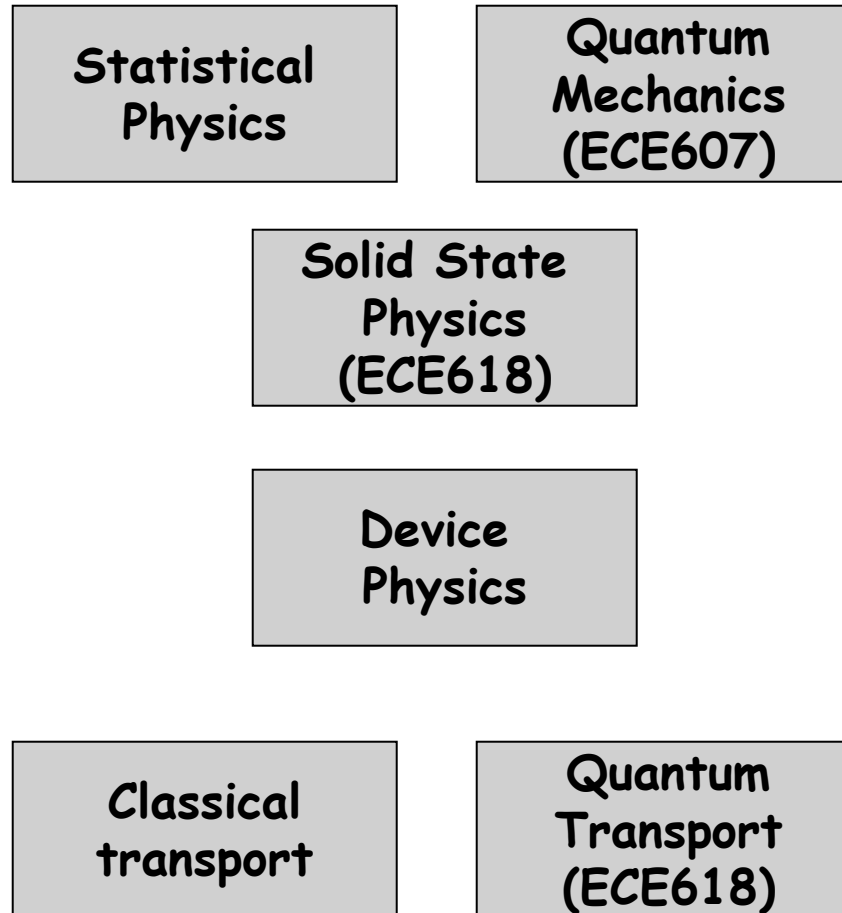
IV. Nanoscale semiconductor devices

- Quantum effects in semiconductors
- Introduction to quantum transport

Grading

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

ECE609 Overview



Numerical Modeling and Simulation: ECE614, and ECE special topics

ECE609 Overview

● Purpose of the Course:

- Provide the foundations to understand what is a semiconductors
- Provide the foundations to understand the electronic properties and the physics of charge transport in semiconductors
- Explain the operating principles 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, Nanowire, FinFET, SET, Spintronics, etc...**