Syllabus for ECEN 3320
Semiconductor Devices
Fall 2012

Purpose

Integrated circuits permeate every aspect of our present day lives. This course introduces the basic concepts of the operation of the semiconductor devices that comprise today’s integrated circuits. Topics to be discussed include semiconductor materials, basic device physics, p-n junctions, metal-semiconductor junctions and transistors, both bipolar and metal-oxide-semiconductor (MOS).

Particulars

Instructor: Alan Mickelson
Office: ECEE 130
Phone: (303)492-7539
email: mickel@schof.colorado.edu
Lecture: MWF 11:00 -11:50 a.m.
Office Hours: W 4:00 p.m. - 5:00 p.m. and Th 2:00 - 3:00 p.m.
Exams: Three midterm exams will be given with the last given during the final exam period (Tuesday December 18, 4:30 p.m. - 7:00 p.m.).
Homeworks: There will be weekly homeworks. Solutions will be posted as well as discussed in class at a rate of a problem per day.
Quizzes: There will be roughly one quizz per week that will be based on one of the homework problems.
Website: http://ecee.colorado.edu/ecn3320/
Prerequisite: Circuits/Electronics 4 (ECEN 3250) or equivalent.
Text: B. Van Zeghbroeck, Principles of Semiconductor Devices (online)
Objectives

The objectives of this course are

1. to understand the operation of the most ubiquitous of semiconductor devices,
2. to use models of semiconductor devices to predict terminal characteristics under diverse operating conditions,
3. to judiciously design circuits that avail themselves of the semiconductor devices chosen for the circuit design.

References

B. Van Zeghbroeck, Principles of Semiconductor Devices
Referred to in subsequent as VZ, sometimes with sections written following as in VZ 2.1. The textbook is attached to the website and can be accessed by simply clicking on the title.


Work Load/Expectations

As is the University requirement, each hour in class requires two hours of outside class preparation. The amount to 6 hours per week of outside of class preparation. Reading assignments should be completed before class and homeworks handed in on time.

Grading

The final grade will be based on a total of 20% quiz grades, 20% homework grades, and 60% (20% each) of midterm grades.
Tentative Schedule

Week 1: August 27, 29 and 31 (VZ Chap. 2.1 – 2.4)
- Overview of course and expectation
- Crystal structure
- Energy band structure
- Density of states

Week 2: September 5 and 7 (VZ Chap. 2.5 – 2.6)
- Equilibrium distribution functions
- Carrier statistics in equilibrium
- Intrinsic and extrinsic semiconductors
- Non-equilibrium statistics

Week 3: September 10, 12 and 14 (VZ Chap. 2.7)
- Drift and diffusion current
- Hall effect

Week 4: September 17, 19 and 21 (VZ Chap. 2.8 – 2.9)
- Generation and recombination of carriers
- Continuity equation 1

Week 5: September 24, 26 and 28 (VZ Chap. 4.1 – 4.3)
- Continuity equation 2
- pn junction
- Electrostatic analysis

Week 6: October 1, 3 and 5 (VZ Chap. 4.4)
- Current in pn junction

Week 7: October 8, 10 and 12 (VZ Chap. 4.5)
- Junction breakdown
Week 8: October 15, 17 and 19 (VZ Chap. 4.6 – 4.10)
  • Optoelectronic devices

Week 9: October 22, 24 and 26 (VZ Chap. 3.1 – 3.3)
  • Schottky diode
  • Electrostatic analysis

Week 10: October 29, 31 and November 2 (VZ Chap. 3.4 – 3.5)
  • Current in Schottky diode
  • Ohmic contact
  • Density of states

Week 11: November 5, 7 and 9 (VZ Chap. 5)
  • Bipolar junction transistor

Week 12: November 12, 14 and 16 (VZ Chap. 6.1 – 6.4)
  • MOS device
  • Operating principle
  • MOS under bias

Week 13: November 19, 21 and 23 (VZ Chap. 6.5 – 6.6)
  • MOS analysis
  • Non-ideal MOS devices

Week 14: November 26, 28 and 30 (Fall Break)
  • Fall Break, Thanksgiving

Week 15: December 3, 5 and 7 (VZ Chap. 7.1 – 7.4)
  • MOSFET operation
  • MOSFET analysis
Week 16: December 10, 12 and 14 (VZ Chap. 7.4 – 7.7)

- Threshold voltage
- MOSFET circuits
- Advanced MOSFET circuits

Final Exam: Tuesday December 18 from 4:30 p.m. - 7:00 p.m.

Disability

If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and http://www.colorado.edu/disabilityservices/

Religious Observance

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, students with religious obligations that may cause conflicts with the course proceeding are requested to talk to the instructor within the first two weeks of the semester. See full details at http://www.colorado.edu/policies/fac_relig.html

Classroom Behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Class rosters are provided to the instructor with the student’s legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code
Honor Code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://www.colorado.edu/academics/honorcode/

Discrimination & Sexual Harrassment

The University of Colorado at Boulder policy on Discrimination Harassment (http://www.colorado.edu/policies/discrimination.html), the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships applies to all students, staff and faculty. Any student, staff or faculty member who believes she/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh.