ECE335F: Introduction to Electronic Devices (2017)
Course website: https://portal.utoronto.ca/

Overview

This course provides an introduction to semiconductor electronic devices. We will begin by discussing the basic principles of semiconductor materials, electronic carriers, and carrier transport. Then we will study the operation, design and performance of devices including PN diodes, Schottky diodes, MOS field effect transistors, bipolar junction transistors, and optoelectronic components. Projects will provide an opportunity to design devices using an industry-standard TCAD tool.

Lectures and Tutorials

Tuesday: 9:00 - 10:00 am, BA1170
Thursday: 9:00 - 10:00 am, BA1170
Friday: 9:00 - 10:00 am, BA1170
TUT0101: Monday, 10:00 am - 12:00 pm, BA2155 (starts on Sept. 18, 2017)
TUT0102: Tuesday, 10:00 am - 12:00 pm, BA2175 (starts on Sept. 19, 2017)

Instructor

Prof. Joyce Poon, joyce.poon@utoronto.ca
Office Hours: Thurs. 10:00-11:00 am, Fri. 10:00-11:00 am, or by appointment, GB444A

Teaching Assistants

Arash Riazi, arash.riazi@mail.utoronto.ca
Torrey Thiessen, torrey.thiessen@mail.utoronto.ca
Tianyuan (Jack) Xue, xuetiany@mail.utoronto.ca
Office Hours: By appointment. Please contact the TA who covered a particular topic.

Grading

Quizzes (top 6 out of 8): 10%
Tests (2): 25% (closed book, equation sheets provided)
TCAD projects (2): 25%
Final exam: 40% (Type: D, Calculator: Type 2)

Textbook


Supplementary References

Course Outline

Time line is approximate.

1. Electrons in semiconductors, Ch. 1.1-1.4 (1.5 week)
   - Crystal lattices
   - Energy bands
   - Semiconductors, insulators, and metals

2. Equilibrium carrier statistics, Ch.1.5-1.10 (1 week)
   - Electrons and holes
   - Density and occupation of states
   - Fermi statistics
   - Carrier concentration

3. Carrier transport, Ch. 2 (1 week)
   - Drift and diffusion
   - Continuity equations

4. PN junction diodes, Ch. 4.1-4.15 (3.5 weeks)
   - Equilibrium, forward bias, reverse bias
   - I-V characteristics
   - Small-signal and transient response
   - Optoelectronics: LEDs, solar cells, photodetectors

5. Metal-semiconductor junctions, Ch. 4.16-4.22 (0.5 week)
   - Schottky diodes
   - Ohmic contacts

6. MOSFET, Ch. 5-6 (3.5 weeks)
   - MOS capacitor
   - Principle of operation
   - Small-signal and transient response
   - Scaling

7. Bipolar junction transistor, Ch. 8 (1 week)
   - Principle of operation
   - Small-signal and transient response

8. “Bonus” topics (interspersed throughout)
   - Micro- and nano- fabrication, Ch. 3
   - Heterojunctions
   - Beyond CMOS
**Tutorials, Quizzes, and Homework**

Every week, homework problems will be assigned for you to practice course concepts. The homework is not graded, but it is strongly recommended that you attempt the homework.

Each tutorial will have two parts. In the first 60 to 75 minutes, the TA will answer your questions and solve some example problems. During the second hour, the TA will give you a short quiz to complete. This quiz will consist of a couple of questions that will be closely based on the homework problems. You can start working on the quiz independently or in a small group. You can ask TA questions if you get stuck. In the final 20-30 minutes of the tutorial, each of you will independently write up your solution to the quiz and submit it for grading.

The tutorial quizzes will be given weekly, with the exception of Oct. 10, 16 and Nov. 13, 14 due to the term tests.

There are no tutorials on Oct. 9 (Thanksgiving holiday) and Oct. 17 (term test 1).

Your top 6 quizzes will constitute 10% of your final grade. In each quiz, half of the marks will be awarded for the method and half for the final answer.

The quizzes in the two sections will be similar, and the time allotted to each quiz will be identical in the two sections. Since each quiz is only worth 1.67%, we will not be accepting petitions.

Please attend your registered tutorial section. If you must switch sections due to extenuating circumstances, please inform the TA of the week or Prof. Poon.

The quizzes are meant to help you stay on top of the course material. They are not meant to be stressful!

**TCAD Projects**

TCAD stands for “technology computer-aided design”, and it refers to the design and simulation of the fabrication process and operation of semiconductor devices.

You will complete two TCAD projects using the industry-standard tool, Synopsys Sentaurus. This software is available on the Linux workstations in the ECE computer labs (GB243, GB251E, SF2102, SF2204).

We will be setting up your access to this software in the coming weeks and will be required to give your UtorIDs. Please make sure you are on Blackboard.

You will complete each project with a partner. Both you and your partner will receive the same mark. You do not have to work with the same partner for the two projects. Each project will constitute 12.5% of your final grade.

The TA for the TCAD projects is Jack Xue (xuetiany@mail.utoronto.ca). Tentative due dates for the projects are Oct. 31 and Nov. 28. Details about the projects will be given later.

**Have fun in the course!**
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**Q = Tutorial quiz during the week**

The initials of the TA responsible for the week are indicated (TX = Jack, TT = Torrey, AR = Arash).