

ECE 441
Physics and Modeling of Semiconductor Devices

Professor Wenjuan Zhu

Spring Semester 2018

Course Overview

This course focuses on the derivation of models for the terminal currents of the semiconductor devices used in integrated circuits, specifically, the MOSFET and bipolar junction transistor. Our objective will be to represent the device's steady-state response; however, we will also discuss how to extend the models to the transient case. On an as-needed basis throughout the semester, we will study semiconductor physics, focusing on topics such as drift and diffusion, generation and recombination, and avalanche multiplication. In the latter part of the semester, we will explore the motivations behind recent modifications to the basic transistor structures, such as the adoption of high-k gate dielectrics for MOSFETs.

Lectures

MWF 10:00–10:50 AM, 3081 ECE Building

Important Dates

Midterm 1: F 02/23

Midterm 2: W 4/4 (tentative)

Final Exam: W 5/09 (tentative)

Grading

Weekly Homework 20%

TCAD Assignments 10%

Midterm Exams 30% (15% each)

Final Exam 40%

Instructor Office Hours*

Wednesday 4:00 pm – 5:00pm, MNTL 3258

**I occasionally need to shift my office hours to accommodate prelim exams, travel, etc., so always check the class webpage before coming to office hour on any given day. Any changes to my office hours will be listed under "Announcements."*

Teaching Assistant

Jialun Liu (liu126@illinois.edu)

Office hours: Thursday 2:00 pm – 3:00pm, at ECEB 5034

Textbook

R. Muller and T. Kamins, *Device Electronics for Integrated Circuits*, 3rd edition, John Wiley & Sons, 2003.

Homework Policy

Homework is due in class each Friday before the lecture begins. If you will not be able to attend class due to a job interview, conference trip, etc., you may turn in your homework early by giving it to the TA or the instructor, either in person or as an email attachment. Late homework will not be accepted. Each student's lowest homework grade of the semester will be dropped before the semester total score is calculated. A student who is seriously ill for more than 7 consecutive days should contact the instructor so

that s/he is not unduly penalized for missing multiple homework. Homework is to be the student's own work, not a collaborative or plagiarized work. However, students are permitted and encouraged to help one another by engaging in discussion of the course material and approaches to solving the homework problems.

Course Policy on Absences

If you miss an exam, or homework assignment the following procedures apply:

- 1) Absences for job interviews or for specific university-sponsored events must be pre-arranged with the course instructor. Upon verification that the excuse is valid and complies with the UIUC Student Code, the course coordinator will issue an excused absence in the event a quiz is given. Pre-arranged excused absences will not be given for exams except in the case of specific university-related events as described in the UIUC Student Code.
- 2) Excused absences are not given for missed homework assignments for any reason, as only the top 9 of the 11 assigned homework assignments count towards the course grade.
- 3) In the event of illness, you must receive an Excused Absence Form from the Undergraduate College Office, Room 207 Engineering Hall, indicating what work you have missed and the reason for the absence. This form must be signed by a physician or medical official for a medical excuse, or by the Office of the Dean of Students (Emergency Dean) for a personal excuse due to personal illness, family emergencies, or other uncontrollable circumstances. The office may be reached at 333-0050. **Note that Excused Absence Forms in the case of illness are now only given out by the office for the case of serious illness lasting more than 3 days. Excused absences are not granted for minor illness.**

For missed classes or hour exams, present the completed form in person to the course instructor as possible after you return.

Scores on hour exams missed due to excused absences **will not be made up**. Your grade will be determined based on the average of the grades that you have completed. Specifically, the average of your completed scores will be used to determine the total, homework or hour exam score and the final total score.

Class Website and Web-board

<http://courses.engr.illinois.edu/ece441>. Homework and exam solutions will be posted on the class website, as will copies of any slides shown in class. If you have a question regarding a homework assignment or an exam, post the question on the class web-board; you may link to the ECE 441 web-board from the class homepage. The web-board is the **primary** means for student-staff communication outside class and office hours. Email should be used only for matters of a personal nature. The web-board will be checked on a daily basis.

List of Topics

We will cover the following topics. Relevant sections of the textbook are noted in parentheses. Exact reading assignments will be given on the weekly homework sheets.

- Semiconductor Physics (1.1, 1.2)
- Metal-Semiconductor Contacts (3.1-3.6)
- PN junctions (4.1-4.5, 5.1-5.4)
- MOS Capacitor (8.1-8.7)

- MOSFET (9.1-9.4, 10.2, 10.5)
- Bipolar Transistor (6.1-6.4, 7.1-7.2)

Some of the lectures will cover material that is not in the textbook, so attendance is expected. Smart-phones and other communication devices must be turned off while you are in my classroom.