Electronic Device Fundamentals
ECE 4570, Fall Semester 2019

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Instructor:
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Course Website:
https://djena.engineering.cornell.edu/2019_ece4570.htm
https://classes.cornell.edu/browse/roster/FA19/class/ECE/4570
Class notes and homework assignments will appear on this website. Please bookmark it.

Class Hours:
Mondays, Wednesdays, and Fridays 9:05 am - 9:55 am.
Location: Phillips Hall 101.
Office hours, Labs, Discussion Sessions: To Be Decided.

Prerequisites:
ECE 3150 or permission of instructor.

Course contents:
Develops an understanding of semiconductor device physics. Starting with a look at carrier statistics, energy band diagrams and transport, the course analyzes the operation of Schottky and p/n diodes and bipolar junction transistors to elucidate operational principles in quasistatic, small-signal and high-frequency conditions. It then spends about two thirds of the time on metal-oxide-semiconductor structures and their transistors with an emphasis on advanced features of modern technology for digital and high frequency operation. The exploration encompasses long to short devices, inversion, strain, gate-stack, silicon-on-insulator, tunneling, hot carriers, instabilities and reliability, and the non-volatile memories. Accurate modeling, manufacturability and applications underlie this exploration. By using computer simulation and experimental data, the course culminates in a design project dealing with technical concerns in current VLSI industry. The goal for this course is to develop an understanding in the student of the working of the devices so that circuits, devices, and semiconductor processes can all be placed in a fulsome context of the modern integrated semiconductor integrated chip.

Textbook(s):
I will hand out notes as and when required. I will post typed notes for the topics I prefer presenting in ways different from the textbook/references. Unless otherwise stated, **the textbook will be the primary source of reference**. The required text for the class is -
Device Electronics for Integrated Circuits, by Richard Muller, Theodore Kamins, and Mansun Chan (**MKC**), John Wiley and Sons, 3rd Edition, ISBN: 0471593982, Excellent treatment of MOSFETs and Bipolar Transistors. Limits itself to Silicon based electronic devices.

Suggested references for extra reading are -
Fundamentals of VLSI Devices, by Taur and Ning (**TN**), Cambridge University Press, Very comprehensive and well written textbook, limits itself to Silicon based electronic devices.
Nanoscale Transistors, by Mark Lundstrom and Jing Guo (**LG**) Springer, 2006, A short book describing MOSFETs from the ballistic transport viewpoint. Discusses scaling and transistor limits.
Physics of Semiconductor Devices, by Simon Sze (**SZE**), Wiley Interscience. A classic. Very encyclopedic; an excellent handbook for practicing device engineers.

Exams and Grades:
10 Assignments, 2 written prelim exams, and 1 written final exam. The approximate breakup of scores that will go towards your final grade is:
50% Assignments [$\sim$10 assignments, each assignment = 5% of final grade!]
10% Prelim 1 [Tuesday, October 1st, 2019]
15% Prelim 2 [Tuesday, November 5th, 2019]
25% Final [Thursday, December 19th, 2019]

Outcomes: (**1**) Obtain a well-grounded understanding of semiconductor device operation and advanced ideas in use in microelectronic industry. (**2**) Learn through simulations, the aspects of physical behavior that analytic solutions are incomplete at and their more complete description of operational physics. (**3**) Apply device fundamentals and simulation techniques to design modern nanoscale device structures.(**4**) Develop comprehensive skills straddling electronics, integration, and devices as used in integrated circuits leading to effective communication of results.

Homeworks:

- Homework assignments are an integral part of learning in this course.
- You are allowed to work with other students in the class on your homeworks. The name(s) of the student(s) you worked with must be included in your homework. But what you turn in must be in your *own* writing, and have your *own* plots and figures. Turning in plots/figures/text that are exact replicas of others *is considered cheating* (see below).
- Assignments must be turned in before class on the due date. The time the assignment is turned in should be written. There will be a 10% penalty each day of delay, and assignments will not be accepted beyond 3 days after the due date. There will be no exceptions to this rule.
- Present your solutions *neatly*. Do not turn in rough unreadable worksheets - learn to **take pride in your presentation**. Show the relevant steps, so that partial points can be awarded. $\boxed{\text{BOX}}$ your final answers where applicable. Draw figures wherever necessary. Please print out the question sheet(s) and staple to the top of your homework. Write your name, email address, and date/time the assignment is turned in on the cover.

Academic Integrity:
Students are expected to abide by the Cornell University Code of Academic Integrity with work submitted for credit representing the student's own work. Discussion and collaboration on homework and laboratory assignments is permitted and encouraged, but final work should represent the student's own understanding. Specific examples of this policy implementation will be distributed in class. Course materials posted on Blackboard or Piazza are intellectual property belonging to the author. Students are not permitted to buy or sell any course materials without the express permission of the instructor. Such unauthorized behavior will constitute academic misconduct. Please read Cornell's policy on cheating here: `http://cuinfo.cornell.edu/aic.cfm`. Let's approach the course in the spirit of adventure & enjoy discovering the secrets of materials and devices that power our world today!