EEO314: MOS Transistor Modeling

Summer 2014

2013-2014 Catalog Description:

An overview of the metal-oxide semiconductor field effect transistor (MOSFET) and its models for circuit analysis. First, short review of the necessary semiconductor physics is given. Second, CMOS fabrication, device structure and operation are introduced. Analytical models of increasing complexity and their SPICE implementations are presented. Peculiarities of the contemporary nanoscale devices are discussed. The course involves project. (3 credits)

Course Designation: Elective

Text Book: Yannis Tsividis, "Operation and modeling of the MOS transistor", Oxford University Press, 3rd Edition, 2011.

Prerequisites:

Instructor: **Leon Shterengas**

Goals:

To understand the physical principles of MOSFET operation and the limitations of the corresponding compact models.

Objectives: In this course, we seek to help engineering/science/technical students:

- understand the MOSFET capabilities and limitations;
- appreciate the current trends in MOSFET technology;
- recognize the fundamental limits of the widely used models;

Topics Covered:

Week 1.	Introduction to solid state physics.
Week 2.	Carrier transport in semiconductors.
Week 3.	Pn and Schottky junctions.
Week 4.	Metal Oxide Semiconductor capacitor.
Week 5.	MOSFET IV characteristics. Body effect.
Week 6.	Complete charge sheet model.
Week 7.	Simplified models.
Week 8.	Midterm.
Week 9.	MOSFETs with ion implanted channels.

Week 10.	Small dimension effects. Velocity saturation. Hot carrier effects.
Week 11.	Transients. Frequency response.
Week 12.	Scaling.
Week 13.	Noise.
Week 14	Project reports.

Class/laboratory Schedule: 3 lecture hours per week.

Program Outcomes and Assessment	**% contribution**
✓ (a) an ability to apply knowledge of mathematics, science and engineering	50
❑ (b1) an ability to design and conduct experiments	
❑ (b2) an ability to analyze and interpret data	
❑ (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	
❑ (d) an ability to function on multi-disciplinary teams	
✓ (e) an ability to identify, formulate, and solve engineering problems	10
❑ (f) an understanding of professional and ethical responsibility	
❑ (g) an ability to communicate effectively	
✓ (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	10
✓ (i) a recognition of the need for, and an ability to engage in life-long learning	10
✓ (j) a knowledge of contemporary issues	10
❑ (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	
❑ Any other outcomes and assessments?	
✓ (l)) an ability to communicate and/or collaborate effectively online	10

Document Prepared by: Leon Shterengas on 2/18/2014