

EEE 731 Advanced MOS Devices

3 Credit Hours

Time: Tuesday and Thursday, 10:40 – 11:55
Location: TBA

Instructor: Hugh Barnaby

Course Introduction:

This course is a continuation of Semiconductor Device Theory I (EEE 531), which is a pre-requisite for attendance. The focus of the course is exclusively silicon MOS devices, which are the dominant semiconductor structures in integrated circuit technologies today. EEE 731 is designed for graduate students focusing on either circuit design or device physics, to deepen their understanding of MOS physics and expose them to the use of Technology Computer Aided Design (TCAD) for device analysis and engineering. The first part of the course will briefly review basic concepts of device physics from carrier statistics and transport in silicon to the basic equations of device operation. Students should already have a strong grasp of these concepts coming into this course. A detailed analytical treatment of the physics of pn junctions and MOS capacitors will follow. This material should also be mostly review for students, however in some cases the course will delve somewhat deeper. For example, the concepts of surface potential, threshold voltage, and defects will be covered extensively. Once this review has been completed, we will begin to examine the fundamental physics of silicon MOS transistors. Derivations of the current-voltage characteristics in strong inversion and subthreshold will be presented for both long and short channel devices. Processes related to non-standard behavior including the body effects, scaling and small geometry effects, hot electrons, impact ionization, and leakage current mechanisms will be introduced and analyzed. The last part of the course will focus on the alternative structures that are beginning to be utilized in modern front-end CMOS technologies. These include high K dielectrics and silicon on insulator devices. The course will introduce students to modeling devices with TCAD device simulation software. As assigned projects will require device simulation to support and validate physical analysis and design, TCAD will be an important aspect of the course.

Pre-requisites: EEE 531

Textbooks:

Required Y Taur, T. H. Ning, *Fundamentals of Modern VLSI Devices*, Cambridge University Press, 1998.

Optional Y. P. Tsividis, *Operation and Modeling of the MOS Transistor*, McGraw-Hill, 1987.
Robert F. Pierret, *Semiconductor Device Fundamentals*, Addison-Wesley, 1996.