

FALL 2000 NEW COURSE OFFERING!

ELEC 7970 Special Topics:

SEMICONDUCTOR DEVICE ELECTRONICS FOR WIRELESS COMMUNICATIONS

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Where and when: 102 Broun Hall, Monday and Wednesday, 1:00-2:15pm

Prerequisites: ELEC 571 or COI

Wireless communication systems continue to explode in importance in both the commercial and the military domains. Telephones have gotten much more complicated than they used to be, so have semiconductor devices. Modern digital wireless communication systems have the most challenging requirements of all the aspects of the electrical performance of semiconductor devices, including high operation frequency, very low noise, high linearity, high gain, high power output, and high power efficiency. While data rates are increasing to accommodate video and data as well as voice traffic, there is a conflicting need to reduce power consumption and extend battery life. As the industry moves toward higher integration and lower cost, wireless design requires designers to have sufficient knowledge of the RF characteristics of semiconductor devices, as well as the interaction between transistor level parameters and circuit performance.

This course provides a self-contained description of the device concepts and design considerations in the context of RF circuits. It covers in detail topics that are crucial to device analysis/design for RF circuits, but are often not included in conventional device physics or circuit design courses. These include high-frequency characteristics, noise, linearity, and large-signal power amplifiers. Both CAD tools and design equations that are developed from the basic laws of physics and engineering circuit analysis will be used for quantitative understanding.

COURSE OUTLINE:

1. Review of essential semiconductor physics
2. HBT/MESFET/CMOS device physics
3. RF small-signal properties: Y-z-h parameters and s-parameters; Equivalent circuit model; Cut-off frequency (f_T) and maximum oscillation frequency (f_{max}); Small-signal power amplifier; Device design for high f_T , high f_{max} , and impedance matching.
4. Noise: Noise parameters and linear noisy two-port theory; Y-parameter based noise modeling; Profile design tradeoffs in SiGe HBT's for lowest noise; Low frequency noise and phase noise.
5. Large signal properties: Large-signal equivalent circuit and its parameter extraction; High injection, knee voltage, offset voltage, and breakdown.
6. Linearity analysis and prediction: Physical nonlinearities in bipolar and field effect transistors; Volterra series circuit analysis for harmonics and intermodulation; device models for distortion analysis; Linearity of transistor amplifiers and differential pairs.
7. RF power amplifiers: Class A amplifiers and linear amplifiers, load-pull theory; Output termination and reduced conduction angle mode analysis; Effect of transistor "Knee" and high injection; Power transfer characteristics and linearity; Efficiency enhancement techniques.