C. J. Spanos August 26, 2000

Instructional Objectives: EE 105 Microelectronic Devices and Circuits

Devices and Technology:

- Understand the control of holes and electrons by doping with acceptors and donors.
- Understand drift and diffusion current densities
- Understand the IC fabrication process and be able to sketch cross sections from mask layouts and process sequences.
- Find potential and carrier concentrations in thermal equilibrium; the 60 mV rule.
- Be proficient at one-dimensional electrostatics in semiconductors
- Understand the pn junction and MOS capacitances as a function of DC bias.
- Describe the internal operation of the MOSFET (channel charge and drift current) and its current-voltage characteristics in the cutoff, triode, and saturation regions.
- Understand the concept of a small-signal device model and be able to apply it to an arbitrary multi-terminal device.
- Understand the connections between the MOSFET small-signal model and the physical device.
- Describe the internal operation of the bipolar junction transistor and its current-voltage characteristics in the cutoff, forward active, saturation, and reverse-active regions.
- Understand the connections between the BTJ small-signal model parameters and the physical device.
- Become proficient in the use of the HP 4155 parameter analyzer.

Circuits:

- Become a proficient user of SPICE as an analysis tool for analog circuits.
- Become competent at breadboard construction and characterization of discrete analog circuits.
- Understand the four basic amplifier types and their two-port models (voltage, current, trans-conductance, and trans-resistance).
- Find the operating points of single and multistage MOSFET and BJT amplifiers, by judicious use of approximations.
- Familiarity with the input resistance, appropriate gain parameter, and output resistance for all single-stage amplifier building blocks and their use in analyzing small-signal amplifiers.
- Become proficient in the analysis of linear resistive networks with dependent sources.
- Become proficient in the phasor analysis of linear networks and the construction of Bode plots.
- Identify the single-stage building blocks, analyze inter-stage loading, and find the overall two-port model parameters for multistage amplifiers.
- Analyze the DC and small-signal characteristics of simple transistor current sources and voltage sources.
- Estimate the bandwidth of multistage amplifiers using open-circuit time constant analysis. Recognize and apply the Miller approximation for voltage amplifiers.