

EE 331: Topics to be covered

1. The physics of electrical conduction

- a. Single carrier conduction
 - i. Metals and insulators
 - ii. Conductivity and resistivity
 - iii. Electron density and mobility
- b. Semiconductor energy bands
 - i. Electrons and holes
 - ii. Donors and acceptors
 - iii. Equilibrium carrier concentrations
- c. Conduction processes in semiconductors
 - i. Drift, diffusion
 - ii. Generation and recombination
 - iii. Injection
- d. Junctions
 - i. Boundary conditions
 - ii. Diffusion currents
 - iii. Charge storage and capacitance

2. Semiconductor diodes

- a. Construction and characteristics
 - i. PN-junction structure
 - ii. I-V characteristics and regions of operation
 - iii. Ratings, specifications, and parameters
- b. Circuit models
 - i. Ideal diode
 - ii. Linearized diode
 - iii. Shockley diode equation
- c. Circuit analysis
 - i. Nonlinear elements in linear RLC circuits
 - ii. Determining the device state
 - iii. Voltage transfer characteristics
 - iv. Analysis using SPICE
- d. Applications and design
 - i. Rectifiers
 - ii. Zener diodes
 - iii. Clippers and clampers
 - iv. LEDs and photodiodes

3. Field-effect transistors

- a. Construction and characteristics
 - i. N-channel and P-channel JFETs
 - ii. N-channel and P-channel MOSFETs
 - iii. Enhancement and depletion mode devices
 - iv. I-V characteristics and regions of operation
 - v. Ratings, specifications, and parameters
- b. Circuit models
 - i. Ideal FETs
 - ii. Linearized FETs
 - iii. Schickman-Hodges FET equations
- c. Circuit analysis
 - i. Determining the device state
 - ii. Voltage transfer characteristics
 - iii. Analysis using SPICE
- d. Applications and design
 - i. Controlling higher power loads
 - ii. Complementary designs
 - iii. Memory cells

4. Digital logic families

- a. Characteristics and parameters
 - i. Output high and low voltages
 - ii. Input high and low voltages
 - iii. Noise margins
 - iv. Fan-out and Fan-in
 - v. Power-delay product
- b. NMOS and PMOS logic
 - i. Resistor loads
 - ii. Saturated e-mode load
 - iii. Non-saturated e-mode load
 - iv. Depletion mode load
- c. CMOS logic
 - i. Inverter characteristics
 - ii. NAND and NOR
 - iii. Transmission gates
 - iv. Bistable circuits