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