

Microelectronic Devices and Circuits

TOPICS
Bipolar junction transistors: two coupled diodes, terminal characteristics, regions of operation
Solar cells and LEDs (light emitting diodes).
MOS capacitors: the DA applied to two-terminal MOS capacitor accumulation, depletion, and inversion; V_{FB} , V_T , Q_A , and Q_N
The three-terminal MOS capacitor. MOSFETs: begin gradual channel approximation (GCA) using DA and ignoring subthreshold carriers.
Complete GC/DA model for i_{DS} : saturation, channel length modulation. Output characteristics; regions of operation.
Subthreshold operation of MOSFETs. Development of model; compare to full numerical solution. Compare to/contrast with BJTs.
Linear equivalent circuits for MOSFETs and BJTs at low and high frequency; transconductance of subthreshold MOSFETs.
Logic inverter basics. Introduction to CMOS: transfer characteristics, noise margins, optimal device sizing.
CMOS analysis, continued: switching delays, power dissipation, speed/power trade-offs.
CMOS analysis, continued: subthreshold leakage, scaling rules, and where it is all going.
Linear amplifier basics: performance metrics, current source biasing, current mirrors, mid-band range, two-port representation.
Single-transistor building block stages: common-source, common-gate, and common-drain (follower) stages; characteristics and features.
Differential amplifiers: large signal transfer characteristics; small signal analysis using common- and difference-mode inputs.
Multi-stage amplifiers I: cascading diff stages; current source biasing; output stages.
Multi-stage amplifiers II: active loads, biasing for maximum gain, input and output swings.
Multi-stage amplifiers III: examples, stage selection, speciality stages, looking at a commercial op-amp schematic. Begin frequency response.
Frequency response of CS amplifiers, the Miller effect. Intrinsic frequency limitations of MOSFETs. Biasing to maximize speed, power trade-off.
OCTC method for estimating frequency response. Subthreshold amplifiers for ultra-lower power electronics, frequency performance.
MOS imagers. Semester wrap-up; life after 6.012.

Required Textbook

Fonstad, Clifton. Microelectronic Devices and Circuits. 2006 Electronic Edition.

Howe, Roger, and Charles Sodini. Microelectronics: An Integrated Approach. Upper Saddle River, NJ: Prentice Hall, 1996. ISBN: 9780135885185.

Modular Series on Solid State Devices

Pierret, Robert. Volume I: Semiconductor Fundamentals. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1988. ISBN: 9780201122954.

Neudeck, George. Volume II: The PN Junction Diode. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1998. ISBN: 9780201122961.

The Bipolar Junction Transistor. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1989. ISBN: 9780201122978.

Pierret, Robert. Volume IV: Field Effect Devices. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1990. ISBN: 9780201122985.