Analog CMOS Circuit Design (ECE 315/ ECE 515)

Instructor: Mohammad Hashmi
Credits: 4
Pre-requisites: Circuit or Network Analysis, Basic Electronics Devices and Circuits
Post Condition (on student capability after successfully completing the course):
At the end of the course the student will:

- Have a basic knowledge of the fundamental concepts of active circuits and their analysis techniques.
- Particularly understand the theory and operation of circuit components and circuits such as Current Mirror, Linear Amplifier, Differential Amplifier, Power Amplifier etc.
- Acquire the ability to solve, analyze, design, and simulate moderately complex MOS based circuits.

Brief Description

This course introduces the basic analog building blocks and quantifies their performance parameters. More advanced circuits are derived from these basic building blocks. Concepts of feedback and stability are introduced to enable analysis of complex circuits. The course also includes a self-learning lab component in which the students are expected to learn circuit simulation and design tools such as LTSpice, Eldo, Cadence Analog Suite etc. A design project is an essential component of this course.

Schedule

Week	Topics Covered	Nature of assignments / labs / Instructions
1	Introduction to the semiconductor industry, introduction to layouts and industry design flow for analog circuits (design flow for analog circuits, introduction to layout, case study)	LTSpice and Eldo Tutorials by TAs
2	Single Stage MOS Amplifiers (Intro to CS, CD, CG Amplifiers, analysis of CS amplifier with resistive load, analysis of CS amplifier with diode connected load, analysis of CS amplifier with current source load)	Students to first analyze some circuits and then verify using LTSpice and Eldo (HA#1)
3	Analysis of Source Follower (CD amplifier), analysis of CG amplifier	Students to first analyze some circuits and then verify using LTSpice and Eldo (HA#1)
4	Analysis of CS amplifier with source degeneration, analysis of cascode and folded cascade, cascade as a current source	Cadence Tutorials by TAs
5	Introduction to current mirror, simple CMOS current mirror, source-degenerated current mirror, small-signal analysis, large-signal analysis (PA), and common mode properties of current mirror	Students to first analyze some circuits and then verify using Cadence (HA#2)
6	Differential amplifier (single ended operation, differential mode operation, common mode response, common mode rejection)	Carry out the overall design flow process of HA#2 until gerber (HA#3)

7	Differential amplifier (differential pair with active loads, cascade differential amplifier), Gilbert Cell	
8	Frequency Response (fundamental concepts, relationship between transfer function and frequency response, Bode's Rules, Association of Poles with Nodes, Miller Effect and Miller's Theorem and its dual, General Frequency Response, Frequency Response of CS Amplifier, Frequency Response of Differential Amplifier)	HA #4 to be based on some design specifications. Students need to use analytical technique to solve them and then verify using Cadence/Eldo.
9	Feedback, Feedback Topologies, Properties of Feedback Circuits, Stability in Feedback Systems	
10	Multi-stage Op Amps (one-stage and two-stage Op Amps, Comparison, Common-Mode Feedback, Input Range Limitations, Slew Rate)	
11	Noise in CMOS Circuits (Concepts, PSD, PDF, Noise in Single Stage Amplifier)	
12 and 13	• Noise in CMOS Circuits (contd.) • Recap	

Lab Component

SPICE and Cadence Tools will be available for self-learning. TAs can assist the students during consultation hours.

Evaluation

Home Assignments (on ELDO and Cadence Suite): **15%**
Surprise Quizzes: **15%**
Mid-sem Exam: **20%**
End-sem Exam: **20%**
Project: **30%**

Attendance and Classroom Behavior

- Students will be responsible for all course materials, announcements, notes etc. made during the regular class times.
- Prompt arrival to the class is requested.
- Smoking, drinking, and eating are prohibited during the class times.

Texts/Other Resources

The text books for the course are:

- Design of Analog CMOS Circuits ***by*** Behzad Razavi
- CMOS Analog Circuit Design ***by*** Allen & Holberg