University of California, Berkeley Extension

Professional Sequence in Semiconductor Technology Fundamentals
Certificate Program in Semiconductor IC Design

EL ENG X483: Semiconductor IC Amplifiers
(1 semester unit in EL ENG, Online Format)

Course Syllabus

A. Course Description

Create a unique recipe for developing intuitive skills for analyzing microelectronic circuits – without doing lots of intricate mathematics. While some of the instructors or textbooks use the classical approach that requires a tedious derivation, which becomes more cumbersome when facing a complex circuit, this course's approach offers an alternative by focusing on the analysis-by-inspection method. Topics covered include: low-frequency BJT and MOS amplifiers, amplifier frequency response, high-frequency analysis-by-inspection vs. SPICE simulation, and case studies/homework by which you will explore some inspiring or challenging analog circuits.

Side-note: Student Testimony

This whole idea of "Analysis By Inspection" taught in X483 is very intriguing ....although it took a couple of iterations going back and forth with the lecture notes, it is absolutely worth it. The homework is the best part of it.....one gets a feeling of actually designing the circuit and appreciate the thought processing that goes behind it.—Roshan Shanbhag (2015)

B. Prerequisite

- *"EL ENG X480: Introduction to Microelectronics"*
- *"EL ENG X481: Introduction to Microelectronic Circuits"*
- *"EL ENG X488: Semiconductor Devices for IC Design"*

or possess working-level knowledge on semiconductor device modeling and basic electronics, such as

- *DC & AC analysis*
- *Frequency domain analysis*

C. Timeline

Timeline	Course events	Lecture pace
Day 30	**Homework 1**	30% of lectures done
Day 60	**Homework 2**	60% of lectures done
Day 90	**Homework 3**	100% of lectures done
Day 90	Final exam setup	
Day 120	**Midterm exam**	
Day 120	Final exam date confirmed	Review
Day 150	**Proctored final exam**	
Day 180	Course ends	

- Pacing yourself well is one of the key factors to succeed in this course. *Mark your calendar* for the timeline and course events.
- The course registration date (Day 1) is the date you receive the login information and welcome email.
- *It is strongly suggested you reserve the last month (Day 151-180) for contingency.*
- *You final exam request/setup process normally takes up to a couple of months to finalize.*

D. Required Readings

PDF Slides (Downloadable in the Classroom).

E. Learning Objectives

Upon successful completion of the course, students will be able to

- Familiarize the intuitive analysis and analysis-by-inspection skills for fundamental analog circuits.
- Clearly differentiate the natures and analysis methods between the high-frequency and low-frequency response of an amplifier.
- Possess the intuitive analysis skill to forecast/illustrate the circuit simulation results.

F. Intended Audience

This course is intended for technical professionals who want to enter the semiconductor market and are looking to acquire essential knowledge in this area.

G. Course Content Outline

Session 1. Midband BJT Amplifiers

While some of instructions or textbooks use the classical approach that requires starting from the sketch of the small-signal equivalent circuit first and then conducting a tedious or complex derivation which becomes more cumbersome when facing a multistage amplifier or increasing circuit complexity, our approach offers the students an alternative by focusing more efforts on cultivating intuitive analysis skills and an analysis-by-inspection method.

- *Small-Signal Analysis of Common-Emitter Amplifier*
- *Small-Signal Analysis of Emitter Follower*
- *Small-Signal Analysis of Common-Base Amplifier*

Session 2. Midband MOSFET Amplifiers

Working from the input resistance, output resistance, and voltage gain analysis for each of the three amplifiers, the instructor uses an efficient analogy to demonstrate the interrelationship between the BJT amplifiers and their MOS counterparts.

- *Midband MOSFET Amplifiers: Analysis-by-Inspection*

Session 3. Amplifier Frequency Response

High frequency and low frequency responses of the MOS common-source amplifier will be demonstrated in this session. For each frequency response, both hand analysis, simulation, and the final remark—intuitive analysis and analysis-by-inspection—will be instilled to students.

- *A MOSFET Amplifier at High Frequencies: Analysis-by-Inspection*
- *A MOSFET Amplifier at High Frequencies: Transfer-Function Approach*
- *Conventional vs. Analysis-by-Inspection Approach at Low Frequencies*

Session 4. Wideband Amplifiers: Analysis-by-Inspection

Inspired by the evolving process of the high-frequency model of the common-base amplifier, the students will realize the power of the T-equivalent circuit model. On the other side, cascode and cascade are important topics through which the students will thoroughly understand the techniques to extend the amplifier bandwidth by leveraging one amplifier's strengths and covering or compensating other amplifier's weaknesses. The design concepts and their SPICE simulation results will be presented.

- *Wideband Single-Stage Amplifier: Analysis-by-Inspection*
- *Compound-Amplifier Configurations for Wideband Applications*

H. Course Length

- The 15-hour course length covers not only the audio runtime but also the time to catch up by rewinding and replaying video. It also includes the time to take notes and to communicate/discuss with the instructor.
- Other than the 15-hour course length, you are expected to spend additional 30 hours studying the lectures, digesting the materials, working on the assignments, and preparing for the exams.
- Most students watch the lecture video or read PDF slides two or three times before they can fully grasp the concepts, cultivate problem-solving skills, and have a good grade on the final exam.

I. Course Grade Weighting (Grading)

The student's cumulative grade in the course will be based on the following criteria:

- Discussion Participation: 10 points
- Progress Updates: 10 points
- Written Homework Assignments: 30 points
- Midterm Exam (Take-home): 20 points
- Final Exam: 30 points

You must pass the final exam with a grade of at least 70 percent to pass the course.