University of California, Berkeley Extension

Professional Sequence in Semiconductor Technology Fundamentals

EL ENG X480: Introduction to Microelectronics

(1 semester unit in EL ENG, Online Format)

Course Syllabus

A. Course Description

With the consistent advances in nanotechnology, microelectronics is indisputably one of the most influential industries in our society. Taking an application-oriented approach, the instructor will present an overview in the realm of analog and digital integrated circuits. While starting from the most frequently used and applicable semiconductor device and circuit theories, the instructor will gradually channel them into more complex circuit schematics and application modules such as amplifiers, operational amplifiers with bipolar and CMOS technologies, digital inverters, precision rectifiers, voltage regulators, and biasing techniques of amplifiers.

B. Prerequisite

Fundamental knowledge on physics primarily focusing on very basic circuit theory, such as

- *Definitions of voltage, current, and power.*
- *Ohm's law*
- *Kirchhoff's Voltage Law (KVL)*
- *Kirchhoff's Current Law (KCL)*
- *Diodes, transistors, & amplifiers*

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

- Apply fundamental circuit theories to the circuit analysis.
- Perform basic microelectronic circuit analysis, such as inverters, rectifiers, voltage regulators, dc bias of BJT or MOS amplifiers.
- Receive an overview of broad applications from microelectronics in the realm of digital and analog circuits.

F. Intended Audience

This course is intended for technical professionals new to the field, who want to learn the fundamentals of microelectronics, semiconductors and integrated circuits (ICs).

G. Course Content Outline

Session 1. Circuit Theories

This session is intended for those who have some basic knowledge from physics at high-school level but know nothing about the microelectronic circuits. You will grasp the important theories and understand how to apply those theories, such as source transformation and Miller theorem, to the microelectronic circuit analysis.

- *Circuit Theories for Microelectronics*
  - *Ohm's law*
  - *Kirchhoff's Voltage Law (KVL)*
  - *Kirchhoff's Current Law (KCL)*
  - *Source Transformation*
  - *Miller's Theorem*

Session 2. Analog Amplifiers

Amplifiers form an essential part in most of the analog circuits and many of the digital circuits. You will learn the basic concepts of amplifiers and the performance parameters used to describe an amplifier, such as transfer characteristic and small-signal voltage gain. In addition, as operational amplifiers are the integral parts of many microelectronic systems, you will learn the ideal characteristics of an OPAMP and receive a brief overview of an integrated OPAMP implemented by the bipolar and CMOS technology, respectively.

- *Intro to Analog Amplifiers*
- *Intro to Operational Amplifiers*

Session 3. Digital Inverters

The development and applications of digital circuits have been significantly impacting our daily life. This session starts from real circuit implementation perspective to deliver basic concepts of digital circuits to avoid

the pitfall of misconnection between the definition of digital signals and measure voltage levels of a real circuit. In addition, the characteristics of the nucleus of all digital designs—an inverter—will be discussed.

- *Intro to Digital Inverters*

Session 4. Applications of Diodes

Two of primary applications of semiconductor diodes, voltage regulators and rectifiers, will be presented. This session covers the analysis of a simple diode circuit, the characteristic of a voltage regulator, the operation principle of the rectifier circuits, and the application of negative feedback on precision rectifiers.

- *Intro to Diode Circuit Analysis*
- *Applications of Diodes: DC Voltage Stabilizers*
- *Precision Rectifiers for Signal-Processing Applications*

Session 5. Biasing Techniques of Amplifiers

It's indispensable for students to have the skills of conduct a dc analysis through a central concept of pinpointing the operating point. Upon the completion of this session, you will thoroughly understand how we analyze the operating points for the BJT discrete bias circuits without being intimidated by many details from device physics or a complicated mathematical derivation.

- *Analysis Skills and Simulation Techniques of BJT Circuits*
- *Biasing Techniques for BJT Discrete-Circuit Amplifiers*

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.