ECE 322
Microelectronics II

Overview

Course Catalog Description: Semiconductor materials and diodes. Diode circuits. CMOS technology and device mode. Single-stage amplifier. Differential amplifier. Current source and mirrors. Frequency response. Output stages. Operational amplifiers.
Prerequisites: C or better in ECE 321.
Textbook: Behzad Razavi, "Fundamentals of Microelectronics," Preview Edition, John Wiley & Sons, Inc.
Class Goals: This course is to give an introduction of CMOS analog electronics. It will start with a comprehensive review of MOS device physics, and how large-signal and small-signal models of MOS transistors were developed. It will then introduce the basic analog circuit components, including the bias, the current source/sink, and current mirror. Different kind of amplifiers, including inverter amplifier, cascade, differential amplifiers, and multi-stage operational amplifiers will then be discussed. At the end, the frequency response of a CMOS analog circuit and the techniques of compensation will be introduced.
Course Coordinator: Prof. Jingkuang Chen

Table I: Objectives, Implementation, and Assessment

Objectives		Implementation	A	B	C	D	E	F	G	H	I	J	K
O_1	Understand physics of pn junction and MOS devices	9 hrs. lecture in 1st three weeks	X				X						
O_2	Introduction of sub-circuits	9 hrs. lecture in 4th-6th week	X		X								
O_3	Introduction of inverter amplifiers	3 hrs. lecture in 7th week	X									X	X
O_4	Introduction of CMOS cascode amplifier	6 hrs. lecture in weeks 8-9	X		X						X	X	X
O_5	Introduction of differential amplifier and operational amplifier	9 hrs. lecture in weeks 10-12	X				X						X
O_6	Introduction of frequency response and compensation	9 hours lectures in weeks 13-15,	X	X	X	X	X		X				X

Sample Course Schedule

Week	Date	Lect.	Topic	Assignment
1	20 Jan	1	Introduction & Course Administration	
	22 Jan	2	pn-jucntion	Ch. 2
2	27 Jan	3	MOS device physics	Ch. 3
	29 Jan	4	MOS device physics	Ch. 3
3	03 Feb	5	MOS device physics	Ch. 3
	05 Feb	6	MOS device models	Ch. 3
4	10 Feb	7	CMOS sub-circuit-bias circuits	Ch. 5
	12 Feb	8	CMOS sub-circuit-current sink/source	Ch. 5
5	17 Feb	9	CMOS sub-circuit-current sink/source	Ch. 5
	19 Feb	10	CMOS sub-circuit-current sink/source	Ch. 5
6	24 Feb	10	CMOS sub-circuit-current mirror	Ch. 5
	26 Feb	11	CMOS sub-circuit-current mirror	Ch. 5
7	03 Mar	12	CMOS Inverter amplifiers	Ch. 6
	05 Mar	13	CMOS Inverter amplifiers	Ch. 6
8	10 Mar	14	CMOS cascade	Ch. 7
	12 Mar	15	*CMOS cascade*	Ch. 7
9	17 Mar	16	Spring break	
	19 Mar	17	Spring break	
10	24 Mar	-	**exam I**	
	26 Mar	18	*CMOS cascade*	Ch. 7
11	31 Mar	19	*CMOS cascade*	Ch. 7
	02 Apr	20	CMOS differential amplifiers	Ch. 8
12	07 Apr	21	CMOS differential amplifiers	Ch. 8
	09 Apr	22	CMOS differential amplifiers	Ch. 8
13	14 Apr	23	CMOS output stages	Ch. 8
	16 Apr	24	CMOS operational amplifiers	Ch. 8
14	21 Apr	25	CMOS operational amplifiers	Ch. 8
	23 Apr	26	frequency response	Ch. 10
15	28 Apr	27	frequency response	Ch. 10
	30 Apr	28	frequency response	Ch. 10
16	05 May	29	Compensation	Ch. 11
	07 May	30	Compensation	Ch. 11
17	12 May		**Final Exam**	

Electrical and Computer Engineering Program Outcomes

The following is a list of outcomes for the undergraduate electrical and computer engineering programs at the University of New Mexico. This list is taken from the Criteria for Accrediting Engineering Programs (2008-09 Accreditation Cycle) document published by the Accreditation Board for Engineering and Technology (ABET). Qualifying statements have been added to interpret these outcomes consistent with program missions.

Students graduating with a degree in electrical or computer engineering have:

a. an ability to apply knowledge of mathematics, science, and engineering.

b. an ability to design and conduct experiments as well as analyze and interpret data.

c. an ability to design a system, component, or process to meet desired needs.

d. an ability to function on multidisciplinary teams.
[Multidisciplinary refers to fields that are diverse in scope and nature and include sub-disciplines within electrical/computer engineering. For example, a project requiring the design of an antenna and amplifier may be considered multidisciplinary in that it requires the marriage of skills covered separately in electromagnetics and electronics.]

e. an ability to identify, formulate, and solve engineering problems.

f. understanding of professional and ethical responsibility.

g. an ability to communicate effectively.

h. a broad education necessary to understand impact of engineering solutions in global/societal context.
[This can be considered primarily a general education requirement. However, there are economic and social implications of electrical/computer engineering that are, or may be, touched upon within ECE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy "wired" services. Additionally, smart-card and electronic information technologies have the potential to affect large changes in society.]

i. a recognition of need for and ability to engage in lifelong learning.
[Electrical and computer engineering are constantly changing disciplines that, for its practitioners, clearly requires "lifelong learning." This fact is often discussed in the introductory material presented in most upper-division courses.]

j. a knowledge of contemporary issues.
[Contemporary issues are those pertinent to electrical and computer engineers entering or in the work-force today. Contemporary issues include such things as the impact of

deregulation on the power industry, the infrastructural problems related to the creation of a "wireless society," and the difficulties of working in industries where Moore's law appears to hold, etc.]

k. an ability to use techniques, skills and modern engineering tools necessary for engineering practice.
[An "ability to" implies that students have actually participated in the performance of a function or action to an extent that demonstrates the potential to properly apply that skill in their profession. Lifelong learning is excepted from this definition since we cannot document students' (or alumni's) participation in something throughout their lives. For objective i, we take the fact that students recognize the need for lifelong learning and currently have the skills necessary to continue their learning as demonstrating their "ability to engage in lifelong learning."]