



## Lahore University of Management Sciences

### EE 341 – Microelectronic Design Spring 2015 - 16

Instructor	Nauman Zafar Butt & Farasat Munir
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Course URL (if any)	LMS page

Course Basics				
Credit Hours	03			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 mins
Lab (per week)	Nbr of Lab(s) Per Week	Nil	Duration	Nil
Tutorial (per week)	Nbr of Lec(s) Per Week	Tbd	Duration	Tbd

Course Distribution	
Core	BS Electrical Engineering
Elective	MS/BS in EE/CS/Physics
Open for Student Category	Junior / Senior / MS
Close for Student Category	Freshman / Sophomore

COURSE DESCRIPTION
<p>This is a core course in the area of microelectronic circuits. It teaches essential techniques required to design, analyze and simulate modern analog and digital circuits for wide variety of applications. The topics covered include fundamental building blocks of circuits such as operational amplifiers, cascode stages and current mirrors, differential amplifiers. The concepts of frequency response, feedback and stability in circuits are covered. Oscillators, and phase locked loop circuits are explored. The use of SPICE tools in the design, simulation, synthesis and implementation is explored.</p>

COURSE PREREQUISITE(S)
<ul style="list-style-type: none"><li>EE340 Devices and Electronics Course</li></ul>

COURSE OBJECTIVES
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	To teach fundamental elements and essential techniques to design and analyze microelectronic circuits for analog applications.
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### Course Learning Outcomes

EE341- CLO1:	The students should be able to: Analyze the building blocks of analog ICs such as OPAMPS, cascade stages, current mirrors, differential amplifiers etc.
CLO2:	Analyze frequency response of various types of amplifiers and their building blocks.
CLO3:	Analyze feedback circuits and be able to evaluate stability in circuits.
CLO4:	Design amplifiers and building blocks of analog ICs according to the specified constraints of stability, frequency response, gain, power consumption etc.

### Relation to EE Program Outcomes

EE-240 CLOs	Related PLOs	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	Instruction, Tutorial, Assignments	Midterm, Final
CLO2	PLO2	Instruction, Tutorial, Assignments	Midterm, Final
CLO3	PLO2	Instruction, Tutorial, Assignments	Midterm, Final
CLO4	PLO3	Instruction, Tutorial, Assignments	Midterm, Final

### Grading Breakup and Policy

Assignments (about 6): 15%  
 Quiz(s) (about 12): 15%  
 Midterm Examination: 30%  
 Final Examination: 40%

### Examination Detail

Midterm Exam	Yes/No: Yes Combine Separate: Combine Duration: 75 minutes Preferred Date: Exam Specifications: Calculators allowed
Final Exam	Yes/No: Yes Combine Separate: Combine Duration: 120 mins Exam Specifications: Comprehensive, Calculators allowed



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Lecture / Week	Course Topics	Readings
1 / Wk 1	Introduction to microelectronics, review of basic diode, BJT & MOSFET circuits	Razavi, Ch. 1-7
2 / Wk 1	Operational Amplifier (OPAMP) basics, Linear OPAMP circuits	Razavi, Ch. 8
3 / Wk 2	Non linear OPAMP circuits and OPAMP non idealities	Razavi, Ch. 8
4 / Wk 2	Cascode stage, Cascode as a current source	Razavi, Ch. 9
5 / Wk 3	Cascode as an amplifier	Razavi, Ch. 9
6 / Wk 3	Frequency response of Cascode stages	Razavi, Ch. 11
7 / Wk 4	Differential pair general considerations	Razavi, Ch. 10
8 / Wk 4	Bipolar differential pairs	Razavi, Ch. 10
9 / Wk 5	MOS differential pair	Razavi, Ch. 10
10 / Wk 5	Cascode differential pair, common mode rejection, pair with active load	
11 / Wk 6	Current mirror circuits	Razavi, Ch. 9
12 / Wk 6	Current mirror circuits	Razavi, Ch. 9
<b>13 / Wk 7</b>	<b>Mid Term Exam</b>	
14 / Wk 7	Frequency response of differential pairs	Razavi, Ch. 11
15 / Wk 8	Feedback in circuits: General considerations	Razavi, Ch. 12
16 / Wk 8	Feedback in circuits: General considerations	Razavi, Ch. 12
17 / Wk 9	Feedback in circuits: Amplifier types and sense/return techniques	Razavi, Ch. 12
18 / Wk 9	Analysis of feedback circuits	Razavi, Ch. 12
19 / Wk 10	Stability and compensation in Feedback systems	Razavi, Ch. 12
20 / Wk 10	Stability and compensation in Feedback systems	Razavi, Ch.12
21 / Wk 11	Oscillator circuits	Sedra/Smith
22 / Wk 11	Linear Oscillators: OPAMP-RC oscillators, LC and crystal oscillators	
23 / Wk 12	Non Linear Oscillators or function generators	Sedra/Smith
24 / Wk 12	Phase locked loop	Sedra/Smith
25 / Wk 13	Phase locked loop	Sedra/Smith
26 / Wk 13	Digital CMOS design: Overview, power-speed trade-offs of CMOS inverter	Notes
27 / Wk 14	Ring Oscillators, Static and dynamics memory cells, sense amplifiers, decoders	Razavi, Ch. 15
28 / Wk 14	Review	Razavi, Ch. 15
	<b>Final Exam Week 15</b>	



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### Textbook(s)/Supplementary Readings

#### **Text book:**

1. Razavi, Behzad. Fundamentals of Microelectronics. John Wiley & Sons. © 2008

Low cost edition is available: <http://www.bookshopofindia.com/search.asp?action1=default&bookid=9067099>

#### **Supplementary Reading:**

1. Sedra/Smith. Microelectronic Circuits. Oxford University Press. 5<sup>th</sup> Edition