Lahore University of Management Sciences
EE340+L – Devices and Electronics + Lab
Fall 2015 – 16

Instructor	Wasif Tanveer Khan and Hassan Abbas Khan
Room No.	L301, 9-347A
Office Hours	TBA
Email	Wasif.tanveer@lums.edu.pk hassan.khan@lums.edu.pk
Telephone	X8471; X8356
TA	TBA
TA Office Hours	TBA
Course URL (if any)	

Course Basics				
Credit Hours	3+1			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 minutes each
Recitation (per week)	Nbr of Lec(s) Per Week	0	Duration	N/A
Lab (per week)	Nbr of Lec(s) Per Week	1	Duration	150 minutes

Course Distribution	
Core	Y
Elective	N
Open for Student Category	Electrical Engineering, Physics
Close for Student Category	

COURSE DESCRIPTION

This course lays down the foundations for the design of electronic devices and systems for a variety of applications. This includes the construction, characteristics and working of diodes, bipolar junction transistors (BJT) and field effect transistors (FET). It will cover topics on modeling of microelectronic devices, basic microelectronic circuit analysis and design, physical electronics of semiconductor junction and MOS devices, development of circuit models, and understanding the uses and limitations of various models. The semiconductor fundamentals, doping and carrier densities, carrier transport and generation-recombination, and the "semiconductor equations," which provide a mathematical description of electrons and holes in semiconductors will be covered. The course will use incremental and large-signal techniques to analyze and design bipolar and field effect transistor circuits as well as an overview of multistage amplifiers. The small signal behavior of BJT and FET transistors is studied along with appropriate mathematical models and frequency response. The course also provides an introduction to the design of power amplifiers and switching circuits.

COURSE PREREQUISITE(S)

• EE240	• Circuits I (required)
• EE242	• Electricity and magnetism (May be waived through Instructor's permission)

COURSE OBJECTIVES

1.	To introduce the students to the fundamentals of semiconductors and semiconductor devices.
2.	Study the structure, characteristics and behavior of fundamental set of discrete electronic devices.
3.	Develop skills needed for analysis and design of electronic circuits and systems using these components.

	Course Learning Outcomes
EE340:	The students should be able to:
CLO1:	Develop an understanding of the semiconductor bonding and energy band models, semiconductor carrier properties and statistics, and carrier action.
CLO2:	An ability to apply standard device models to explain/calculate critical internal parameters and standard terminal characteristics of the pn-junction diode
CLO3:	Understand the diode circuit models and analyze different application circuits using these models

Lahore University of Management Sciences

CLO4:	Understand the transistor circuit models for MOSFETs and analyze different application circuits using these models
CLO5:	Understand the transistor circuit models for BJTS and analyze different application circuits using these models
CLO6:	Apply the knowledge in lab environment working as a group

Relation to EE Program Outcomes

EE-352 CLOs	Related PLOs	Levels of learning	Teaching Methods	CLO Attainment checked in
CLO1	PLO1	Cog 3	Instruction, Tutorial, Assignments	Midterm, Final
CLO2	PLO2	Cog 4	Instruction, Tutorial, Assignments	Midterm, Final
CLO3	PLO2	Cog 3	Instruction, Tutorial, Assignments	Midterm, Final
CLO4	PLO2	Cog 3	Instruction, Tutorial, Assignments	Final
CLO5	PLO2	Cog 3	Instruction, Tutorial, Assignments	Final
CLO6	PLO5	Psycho 3	Instruction, Labs	Lab Reports + Project

Grading Breakup and Policy

Assignment(s):
Home Work: → 5%
Quiz(s): 6-8 → 10%
Class Participation: N/A
Attendance: N/A
Labs + Projects: 15%+10%
Midterm Examination: 01 → 25%
Project: N/A
Final Examination: Comprehensive → 35%

Examination Detail	
Midterm Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Preferred Date: During Mid-week Exam Specifications: Closed book, closed notes, 1 A4 double sided, hand written help sheet, calculators
Final Exam	Yes/No: Yes Combine/Separate: Combined Duration: 03 hrs Exam Specifications: Closed book, closed notes, 2 A4 double sided, hand written help sheets, calculators

COURSE OVERVIEW

Lecture	Topics	Recommended Readings	Related CLOs & **Additional Remarks**
1.	Semiconductors – General Introduction	SDF: Ch. 1	CLO1
2.	Material properties – Crystal lattices and energy bands	SDF: Ch. 1, 2	CLO1
3.	Carrier Modeling: Carrier densities, Doping	SDF: Ch. 2	CLO1
4.	Density of States, Fermi Energy, Carrier distributions	SDF: Ch. 2	CLO1
5.	Transport mechanism	SDF: Ch. 3	CLO1
6.	Drift and Diffusion Currents	SDF: Ch. 3	CLO1
7.	Recombination/Generation	SDF: Ch. 3	CLO1
8.	pn Junction structure and electrostatics	SDF: Ch. 5	CLO2
9.	Electrostatics and Junction I-V characteristics	SDF: Ch. 5, 6	CLO2
10.	I-V characteristics, Small signal admittance	SDF: Ch. 6, 7	CLO2
11.	Junction capacitance, diffusion admittance	SDF: Ch. 7	CLO2
12.	Introduction to circuit analysis with non-linear elements	S&S: Ch. 4	CLO3
13.	Diode circuits – models	S&S: Ch. 4	CLO3
14.	Diode circuits – analysis and applications	S&S: Ch. 4	CLO3

15.	Diode circuits – analysis and applications	S&S: Ch. 4	CLO3
16.	**Midterm**		
17.	MOSFET – Structure and physical operation	S&S: Ch. 5	CLO4
18.	MOSFET – device operation and models	S&S: Ch. 5	CLO4
19.	MOSFET – Biasing and DC analysis	S&S: Ch. 5	CLO4
20.	MOSFET – Small signal models and analysis	S&S: Ch. 5	CLO4
21.	MOSFET – Amplifier configurations and characteristics	S&S: Ch. 5	CLO4
22.	MOSFET – Amplifier configurations and characteristics	S&S: Ch. 5	CLO4
23.	Transistor Switch and Inverter	S&S: Ch. 13	CLO4
24.	BJT – Structure and physical operation	S&S: Ch. 6	CLO5
25.	BJT – device operation and models	S&S: Ch. 6	CLO5
26.	BJT – Biasing and DC analysis	S&S: Ch. 6	CLO5
27.	BJT – Small signal models and analysis	S&S: Ch. 6	CLO5
28.	BJT – Amplifier configurations and characteristics	S&S: Ch. 6	CLO5

Textbook(s)/Supplementary Readings

Textbook:

Semiconductor Device Fundamentals (SDF) by Robert Pierret, Addison Wesley, 1996

Microelectronic Circuits by Sedra and Smith, 6th Edition, Oxford University Press, 2010

Supplementary Reading:

Microelectronic Devices & Circuits by Clifton Fonstad, 2006 Electronic Edition, http://dspace.mit.edu/handle/1721.1/34219

	Labs		
1.	Session 1: Lab No. 1: Diode characteristics - Characteristics of different semiconductor diodes and understand the parameters used to model their behavior.	1 week	CLO6
2.	Session 2: Lab No. 1: Diode characteristics - Characteristics of different semiconductor diodes and understand the parameters used to model their behavior.	1 week	CLO6
3.	Session 3: Lab No. 2: Diode applications - Use of diode as a rectifier, ripple reduction with capacitor filter, regulation using a zener diode, clamping circuit and voltage multipliers	1 week	CLO6
4.	Session 4: Lab No. 2: Diode applications - Use of diode as a rectifier, ripple reduction with capacitor filter, regulation using a zener diode, clamping circuit and voltage multipliers	1 week	CLO6
5.	Session 5: Lab No. 3: MOSFET Characteristics - Characteristics of a MOSFET device and understanding the parameters used to model its behavior.	1 week	CLO6
6.	Session 6: Lab No. 4: Transistor as an amplifier - Biasing schemes and amplification characteristics of a single stage common source MOSFET amplifier.	1 week	CLO6
7.	Session 7: Lab No. 4: Transistor as an amplifier - Biasing schemes and amplification characteristics of a single stage common source MOSFET amplifier.	1 week	CLO6
8.	Session 8: Lab No. 5: Common Drain and Common Gate Amplifiers - Biasing and amplification characteristics of a common gate and common drain MOSFET amplifiers	1 week	CLO6
9.	Session 9: Lab No. 6: Frequency Response - High frequency and low frequency response of a common source MOSFET amplifier	1 week	CLO6
10.	Session 10: Lab No. 7: CMOS Digital Logic Inverter - Voltage transfer characteristics and dynamic operation of CMOS digital logic	1 week	CLO6

	inverter		
11.	Session 11: Lab No. 8: Switching Circuits and Timers - Design and working of discrete component multi-vibrators with BJTs and applications of 555 timer	1 week	CLO6
12.	Sessions 12 – 14: Final Project: Group project (4 members maximum) - Proposal to be submitted in week 10.	1 week	CLO6