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New Jersey Institute of Technology

ECE 271 Electronic Circuits I

3 credits; Mon 2:00-2:55 KUPF211, Tue, Thu: 1:00-2:30 CKB204

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Office Hours (ECEC203)**:** M: 3:30-5:45; T: 11:30-1:00, 4:00 5:30; R: 11:30-1:00, 4:00 5:30; and by appointment (email)..

Text Microelectronic Circuit Design / Jaeger & Blalock, 4th Edition, McGraw Hill, 2011. ISBN 978-0-07-338045-2

Course description: The electronic devices, junction diodes, bipolar transistors and field-effect transistors, are introduced and studied based on semiconductor physics models. The study then continues with analysis and design of main digital electronic circuits (NMOS and CMOS inverters and logic gates, MOS memory and storage circuits) and with introduction to analog electronic circuits such as simple one transistor amplifiers.

Prerequisite: ECE 231, Corequisite ECE 232 Required course.

Specific course learning outcomes

By the end of the course students are supposed to being able to perform the following tasks.

#	Topic	Outcome
1	2	Calculate the major physical parameters in doped semiconductors and pn-junctions.
2	3	Analyze (calculate voltages and currents) simple diode circuits using different diode models. [1]
3	3	Analyze (find voltages and currents and sketch their time graphs) and design different types of rectifier circuits. [1]
4	4	Demonstrate the knowledge of MOSFET (JFET) region models and their IV-characteristics. Draw the IV-characteristics of a MOSFET from its parameters and find parameters using the IV-characteristics. [1]
5	4	Analyze (calculate voltages and currents) a simple MOSFET (JFET) bias circuit and find its Q-point.
6	4	Design a simple MOSFET (JFET) bias circuit for a given specification.
7	5	Identify different models of BJT, regions of operations, and their IV-characteristics. [1]
8	5	Analyze (calculate voltages and currents) a simple BJT circuit and find its Q-point. [1]
9	5	Design a simple BJT bias circuit for a given specification..
10	6	Formulate the concept of ideal operational amplifier; identify its major properties and main types of op-amps circuits.
11	6	Analyze the simple circuits that include op-amps (find voltages and currents using op-amps properties and circuit laws) . [1]
12	6	Analyze one transistor (MOSFET, BJIT) amplifier circuit (draw DC, AC, small signal model equivalent circuits, find their parameters and parameters of amplifier).
13	7	Identify the different types of NMOS logic inverter gates and list their major benefits and deficiencies.
14	7	Analyze (find logic voltage levels and currents) and design 5 types of NMOS inverter gates
15	7	Determine the logic function of an arbitrary complex NMOS logic gate and design it for a given logic function and specifications.
16	8	Draw a CMOS inverter gate voltage transfer characteristic from IV-characteristics of a NMOST and PMOST. Identify and explain its regions.
17	8	Determine the logic function of an arbitrary complex CMOS logic gate and design it for a given logic function and time response specifications.
18	9	Draw the schematic of a static (6T) and dynamic (1T) memory cell and explain in details the process of reading and writing a bit of information in it.
19	9	Draw the schematic of a typical sense amplifier and explain how it works
20	9	Draw a schematic of a simple (2-3 bit) NOR/NAND NMOS address decoder and explain how it decodes a given address.
		[1] Includes use of Multisim simulation.

Student outcomes addressed by the course

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (CLO 1-12)

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (CLO 11-20)

3.an ability to communicate effectively with a range of audiences (CLO 10)

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (CLO 2, 4, 8, 11).

Course Topics

Week	Topic	Topic details	Text section
1	1. Introduction	Intro and history. Analog and digital signals. AC-DC converters Review of circuit analysis Elements parameter variation in circuit design	1.1. 1.2 1.5 1.8
1,2	2. Semi-conductors	Semiconductor materials. Covalent bonds Drift current and mobility Doping. Diffusion and total currents PN junction physics	2.1, 2.2 2.3 2.5-2.7. 2.8-2.9 3.1
2,3	3. Diodes	*IV* characteristics and equation. Reverse and forward bias. Reverse breakdown. Diode models and diode circuit analysis Diode analysis in breakdown region. Diode rectifier circuits and other applications	3.2-3.4 3.6 3.10, 3.11 3.12,3.13-3.16
		Test 1	
4,5,6	4. MOSFET	MOS transistor physics NMOSFET analysis. PMOS transistor MOSFET circuit analysis and biasing JFET Transistors	4.1-4.2.0 4.2.1-4.2.8. 4.3 4.9-4.10 4.11
6,7	5. BJT	BJT physics and models (npn-pnp) *IV* characteristics. Circuit models simplification Biasing and circuit design	5.1, 5.2, 5.3 5.5. 5.4-5.7 5.11
		Test 2	
8,9	6. Intro to OpAmps (Ampl. as a system) Single transistor amplifier (Ampl. as a circuit)	Amplifiers and two port models Op amp intro. Ideal op amp. Circuit analysis with op amps Transistor as an amplifier. DC, AC equiv. models Small signal BJT model. Common emitter amplifier Small signal MOSFET model. Common source amplifier	10.2, 10.3 10.5, 10.7. 10.8,10.9 13.1, 13.2. 13.3 13.4,13.5. 13.6, 13.7 13.8, 13.9. 13.10, 13.11
10,11	7. Intro to digital circuits	Logical gates and definitions, Boolean algebra review NMOS inverter, resistive load. NMOS inverter, transistor load. NMOS NAND and NOR gates. Complex NMOS logic design Power dissipation. Dynamic behavior of NMOS gates	6.1, 6.2, 6.4 6.5. 6.6, 6.7 6.8.1, 6.8.2. 6.9 6.10. 6.11.1,2,3
12		Test 3	
12,13	8. CMOS circuit design	CMOS inverter basics and Voltage Transfer Characteristic CMOS inverter dynamic behavior. Power dissipation CMOS NAND and NOR gates. CMOS complex gates	7.1, 7.2 7.3.1, 2, 3. 7.4 7.5. 7.6, 7.7
13,14	9. MOS memory	Static memory cells Dynamic memory cells Sense amplifiers. Memory architecture and address decoders Read-only memory (ROM). Flip-flops	8.2 8.3.1, 8.3.2. 8.4.1, 8.4.2 8.1.1,2; 8.5.1,2 8.6. 8.7
15		**FINAL EXAM**	

Homework Policy
The list of the assignment is on the course website and in Moodle. A significant number of homework problems will be assigned for each topic. The homework will not be graded (solutions will be posted on the web); instead, short quizzes (10p.each) will be conducted every week. 5 best results will be counted toward your quiz grade of 50.

Circuits simulation
Circuit simulation is very important part of the project. There will be five graded simulation assignments during the course. A Multisim simulation project will be offered as an extra credit of up to 30p.

Grading Policy
The course grade will be based on tests, quizzes and simulation assignments:

3 Tests @100 points	300
Short Quizzes	50
Simulation assignments	50
Final examination	100
(Honors project for honors students	100)
Total	500 (600)

Tests and final exam are closed books and notes. A list of formulas will be provided by instructor.

NJIT Honor Code
NJIT Honor Code will be strongly upheld. Violation will be brought to the immediate attention of the Dean of Students.