

Identification	Subject (Code, title, credits)	ETR463, Digital Microelectronics, 8 ECTS
	Department	Physics and Electronics
	Program	Undergraduate
	Term	Spring 2026
	Instructor	Nijat Hajiyev
	E-mail:	hajiyev.nijat@khazar.org
	Phone:	
	Classroom/hours	11 Mehseti str. (Neftchilar campus)
	Office hours	
Prerequisites	-	
Language	English	
Compulsory/ Elective	Elective	
Required textbooks and course materials	Textbooks: [1] - Kang, S.-M., and Y. Leblebici, CMOS Digital Integrated Circuits: Analysis and Design, 3rd ed., McGraw-Hill, 2003. [2] - Kaeslin, H., Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication, Cambridge University Press, 2008. [3] - Rabaey, J. M., A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd ed., Prentice Hall, 2003. [4]. Microelectronic Circuits— Adel S. Sedra & Kenneth C. Smith, 2019 [5]. Advanced CMOS Integrated Circuit Design and Application. JY Jong-Ryul Yang, SH Seong-Tae Han, 2022	
Course description	This course introduces students to the fundamental concepts of CMOS digital integrated circuits, with an emphasis on transistor-level operation and digital circuit design. Starting from MOSFET fundamentals, students study CMOS inverters, logic gates, timing, and power dissipation. The course gradually progresses to sequential circuits, fabrication concepts, and layout considerations. Practical understanding is reinforced through problem-solving exercises and hands-on laboratory work using breadboards and standard logic ICs. By the end of the course, students will understand how digital circuits are designed and analyzed from the transistor level to basic system blocks.	
Course objectives	<ul style="list-style-type: none"> • To develop a foundational understanding of MOSFET operation and CMOS technology for digital integrated circuits. • To introduce students to the analysis and design of CMOS inverters, logic gates, and basic digital building blocks. • To teach students how to evaluate performance metrics such as delay, power dissipation, and noise margins in CMOS circuits. • To enhance practical understanding through hands-on experiments using breadboards and standard CMOS logic ICs.. 	
Learning outcomes	By the end of the course, students will be able to: <ul style="list-style-type: none"> • Understand and explain the operating principles of MOSFETs and CMOS technology in digital integrated circuits. • Analyze and design basic CMOS digital circuits, including inverters, logic gates, and simple sequential blocks. • Evaluate key performance parameters of CMOS circuits such as propagation delay, power dissipation, and noise margins. 	

	<ul style="list-style-type: none"> Apply theoretical knowledge through practical experiments using breadboards and standard CMOS logic ICs to verify circuit behavior. 		
Teaching methods	Case analysis		x
	Group discussion		x
	Lecture		x
	Simulation		x
Evaluation Criteria	Methods	Date/deadlines	Percentage (%)
	Midterm Exam		30
	Attendance	At each lesson	5
	Quiz	2 quizzes during the semester	10
	Practical Assignments	2 lab works after midterm	10
	Activity	At each lesson	5
	Final Exam		40
	Total		100
Policy	<ul style="list-style-type: none"> Preparation for class The structure of this course makes your individual study and preparation outside the class extremely important. The lecture material will focus on the major points introduced in the text. Reading the assigned chapters and having some familiarity with them before class will greatly assist your understanding of the lecture. After the lecture, you should study your notes and work on relevant problems and cases from the end of the chapter and sample exam questions. Withdrawal (pass/fail) This course strictly follows the grading policy of the School of Science and Engineering. Thus, a student is normally expected to achieve a mark of at least 60% to pass. In case of failure, he/she will be required to repeat the course the following term or year. Cheating/plagiarism Cheating or other plagiarism during the Quizzes, Midterm, and Final Examinations will lead to paper cancellation. In this case, the student will automatically get zero (0) without consideration. Professional behavior guidelines The students shall behave in a way to create a favorable academic and professional environment during class hours. Unauthorized discussions and unethical behavior are strictly prohibited. Attendance Students who attend the whole classes will get 5 marks. For three absence student loses 1 mark. Practical Assignment There will be 2 lab works after midterm. Students are required to design, implement, and test basic CMOS digital circuits using breadboards and 74HC series logic ICs. Assessment is based on correct circuit construction, proper use of laboratory instruments, accurate observation of outputs, analysis of circuit behavior, and successful demonstration of logic functionality. The laboratory work evaluates students' understanding of CMOS principles and their ability to apply theoretical knowledge in hands-on experiments. Quizzes 		

	<p>There will be 2 quizzes during the semester. The quiz will be announced in the classroom two weeks before and will relate to homework.</p> <ul style="list-style-type: none"> ▪ Activity Students who will be active during the discussion of past lessons and who will solve homework problems in a lesson will be awarded one activity mark.
--	---

Tentative Schedule			
Weeks	Date/Day	Topics	Reference to textbooks
1.		Introduction to the course and a circuit design example	[1] p1
2.		Introduction to fabrication processes. Layout design rules.	[1] p20
3.		MOS Transistors. Electrical characteristics of MOSFETs. Modelling and simulation of MOSFETs.	[1] p47
4.		MOS inverters. Electrical characteristics of MOS inverters. MOS inverter design and calculations.	[1] p141
5.		MOS Logic Circuits. Electrical parameters and calculations of MOS Logic Circuits.	[1] p259
6.		MOS Logic Circuits. Electrical parameters and calculations of MOS Logic Circuits.	
7.		Semiconductor Memories. ROM and RAM circuits	[1] p402
8.		Midterm exam.	
9.		Low-Power CMOS Logic Circuits and optimizing design parameters.	[1] p451
10.		Low power design and system level consideration	[1] p474
11.		BiCMOS Logic Circuits. BJT transistor behaviors and operations.	[1] p491
12.		Chip Input and Output (I/O) Circuits. ESD Protection and Noise considerations.	[1] p534
13.		VLSI Design Methodology. Design Flow and hierarchy of VLSI design	[1] p566
14.		Design for Manufacturability. Basic Concepts and parametric optimizations.	[1] p598
15.		Solving additional problems and ambiguities of students about the course	
	TBC	Final exam	

This syllabus is a guide for the course and any modifications to it will be announced in advance.