

Identification	Subject	ETR393 - Basics of Circuitry - 6 ECTS credits
	Department	Physics and Electronics
	Program (Undergraduate, Graduate)	Undergraduate
	Term	Fall 2026
	Instructor	Nijat Hajiyevev
	Email:	hajiyevnijat@gmail.com
	Classroom/hours	11 Mehseti str. (Neftchilar campus), Monday and Friday, 08:30-18:40
Prerequisites	None	
Language	English	
Compulsory/Elective	Compulsory	
Textbooks and course materials	Textbooks: 1 - Agarwal, Anant, and Jeffrey H. Lang. <i>Foundations of Analog and Digital Electronic Circuits</i>. San Mateo, CA: Morgan Kaufmann Publishers, Elsevier, July 2005. ISBN: 9781558607354. 2. Alexander, C. K., & Sadiku, M. N. O. (2021). <i>Fundamentals of Electric Circuits</i> (7th ed.). McGraw-Hill Education. 3. Ulaby, F. T., Maharbiz, M. M., & Furse, C. (2025). <i>Circuit Analysis and Design</i> (3rd ed.). Michigan Publishing Services. 4. Hayt, W. H., Kemmerly, J. E., & Durbin, S. M. (2023). <i>Engineering Circuit Analysis</i> (9th or latest regional ed.). McGraw-Hill.	
Course description	The course introduces the fundamentals of the lumped circuit abstraction. Topics covered include: resistive elements and networks; independent and dependent sources; switches and MOS transistors; digital abstraction; amplifiers; energy storage elements; dynamics of first-and second-order networks; design in the time and frequency domains; and analog and digital circuits and applications. Design and lab exercises are also significant components of the course. By end of the course, you will gain fundamental concepts of electrical circuits - starting from foundational principles such as voltage, current, and resistance, students will gradually explore more complex concepts such as nodal and loop analysis, reactive components (capacitors and inductors), and resonance in RLC circuits.	
Course objectives	1. Understand the basic electrical engineering principles and abstractions on which the design of electronic systems is based. These include lumped circuit models, digital circuits, and operational amplifiers. 2. Use these engineering abstractions to analyze and design simple electronic circuits. 3. Formulate and solve differential equations describing the time behavior of circuits containing energy storage elements. 4. Use intuition to describe the approximate time and frequency behavior of circuits containing energy storage elements. 5. Understand the concepts of employing simple models to represent non-linear and active elements-such as the MOSFET-in circuits.	

	6. Build circuits and take measurements of circuit variables using tools such as oscilloscopes, multimeters, and signal generators. Compare the measurements with the behavior predicted by mathematic models and explain the discrepancies. 7. Understand the relationship between the mathematical representation of circuit behavior and corresponding real-life effects. 8. Appreciate the practical significance of the systems developed in the course.		
Learning Outcomes	1. Employ simple lumped circuit models for resistors, sources, inductors, capacitors, and transistors in circuits. 2. Analyze circuits made up of linear lumped elements. Specifically, analyze circuits containing resistors and independent sources using techniques such as the node method, superposition and the Thevenin method. 3. Employ Boolean algebra to describe the function of logic circuits. 4. Design circuits which represent digital logic expressions. Specifically, design a gate-level digital circuit to implement a given Boolean function. 5. Check static discipline constraints in circuits. For example, determine if the circuit representing a gate provides adequate noise margins. 6. Determine the output produced by a circuit for a given set of inputs using the switch resistor model of a MOSFET. 7. Perform a small-signal analysis of an amplifier using small signal models for the circuit elements. 8. Calculate the time behavior of first order and second order circuits containing resistors, capacitors and inductors. 9. Calculate the frequency response of circuits containing resistors, capacitors and inductors. 10. Construct simple gates, amplifiers, or filters in the laboratory. 11. Determine in the laboratory the time-domain and frequency-domain behavior of an RLC circuit. 12. Use operational amplifier models in circuits which employ negative feedback.		
Teaching methods	Lecture		x
	Case analysis		x
	Group discussion		x
	Simulation		x
Evaluation Criteria	Methods	Date/deadlines	Percentage (%)
	Midterm Exam	TBA	30
	Quiz	After the midterm	5
	Homework	At each lesson	5
	Final Project	After the midterm	15
	Activity	At each lesson	5
	Final Exam	TBA	40
	Total		100
Class Policy	▪ 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. You must have a copybook and take notes at each lesson. 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 relevant problems and cases from the end of the chapter and sample exam questions. Also, you must explore additionally and try to make circuits on your own after the lessons. Before using the laboratory at additional times, please inform faculty or department staff.

- **Withdrawal (pass/fail)**

This course strictly follows 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 Quiz, Mid-term and Final Examinations will lead to paper cancellation. In this case, the student will automatically get zero (0), without any considerations.

- **Professional behavior guidelines**

The students shall behave in the way to create favorable academic and professional environment during the class hours. Unauthorized discussions and unethical behavior are strictly prohibited.

- **Quiz**

There will be a quiz after the midterm. The quiz will be announced in the classroom two weeks before and will relate to homeworks. Students will get maximum 5 marks in a quiz.

- **Activity**

Students who will be active during classroom exercises, laboratory tasks and answering questions in the classroom will get 5 marks at each lesson. All students marks will be recorded in teacher's personal copybook and average mark will be calculated according to all marks at the end of semester.

- **Final project**

Students should make a circuit on the breadboard, calculate and measure all parameters. When they get proper results they should note all measured parameters and the circuit on their copybook. Final project should be prepared during out of lessons. But students can ask any questions to the teacher with email or whatsapp. Final project can be made by a student or a group. Maximum 3 students can be grouped. The final project topic will be chosen by students or teacher during the semester.

- **Homework**

Homework will be issued in lectures and collected a week later in recitation. You are welcome and encouraged to discuss the homework among your colleagues. However, the final formulation and write up of your homework answers must be your own. More importantly, although homework counts for only 5 percent of the grade, they are critical to learning the material and to doing well on the quizzes and final exam.

- **Rulings on using Generative AI**

Within this course, artificial intelligence tools can be used to support the learning process, brainstorm ideas, structure data, and assist with language editing. However, the core content, scientific analysis, and results of

assignments must be independently prepared by the student. The use of AI tools is strictly prohibited during quiz, midterm and final exams. Students who use AI must appropriately cite its usage. Students must design, draw, and perform the calculations for circuits entirely by themselves. However, they are permitted to use AI for assistance with tasks such as calculating resistor color codes or looking up transistor pinouts. The main rule is to use AI strictly as an auxiliary helper.

Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook/Assignments
1		Introduction and lumped abstraction, Basic circuit analysis method	Chapter 1, Chapter 2.1-2.5
2		Superposition, Thévenin and Norton	Chapter 3.1-3.6
3		The digital abstraction	Chapter 5.1-5.4
4		Boolean logic, Digital logic, comb. gates review, examples	Chapter 5.1-5.4, 5.6-5.7
5		Nonlinear analysis, Incremental analysis	Chapter 4.1-4.3
6		Dependent sources, analog amplification, MOS SCS model and MOS amplifier, Amplifier large signal analysis	Chapters 2.6, 7.1-7.2 Chapter 7.6-7.7
7		Amplifier small signal circuit models and analysis examples	Chapter 8.1-8.2
		Midterm exam	
8		Capacitors, first order circuits, examples	Chapters 9.1, 10.1
9		Inductors and their physics, first order step response, First order examples	Chapter 10.2 Chapter 12.1
10		Second order examples, Transients in second order systems Second order systems with damping	Chapter 12.1 Chapter 12.2, 12.5
11		Quiz	
12		Impedance methods, Filters, Q factor, radio tuner	Chapter 13.3-13.4.2, Chapter 13.5, 14.5
13		Time and frequency	
14		Op-amp abstraction,  view, inverting amplifier, Special op-amp circuits	Chapter 15.1-15.4 Chapter 15.1-15.4
15		Final Project	
		Final exam	