

Identification	Subject (Code, title, credits)	ETR 454 – Signals and Systems 6 ECTS	
	Department	Physics and Electronics	
	Program (Undergraduate, Graduate)	Undergraduate	
	Term	Fall, 2026	
	Instructor	MSc, Yusif Shamayev	
	E-mail:	yusifshamayev@gmail.com	
	Phone:	+994776432030	
	Classroom/hours	11 Mehseti str. (Neftchilar campus)	
		Consultations	Saturday 13:00 – 14:00
Prerequisites	None		
Language	English		
Compulsory/ Elective	Compulsory		
Required textbooks and course materials	Textbooks: 1. A. V. Oppenheim, A. S. Willsky with S. Hamid Nawab; Signals and Systems, Prentice Hall, 1997 (2nd edition). 2. Mohammed Ferdjallah: Introduction to Digital Systems, 2011 3. John Wakerly: Digital design, Principles and practices, 2000		
Course description	This course introduces the fundamental concepts of signals and systems, covering both continuous-time and discrete-time domains. Students will explore the characteristics, parameters, and classifications of signals, along with the theoretical foundations and methods of signal analysis. The course emphasizes mathematical techniques for signal representation and the processing of analog and digital signals.		
Course objectives	This course provides a rigorous, mathematically deep treatment of signals and linear time-invariant systems - covering Fourier, Laplace and Z-transform analysis in depth - and connects these theoretical foundations to real-world systems such as satellite communications, GSM/mobile networks, and wireless data networks.		
Learning outcomes	Having successfully completed this course, students will be able to: LO-1: Define continuous-time and discrete-time signals and systems. LO-2: Identify linear time-invariant systems. LO-3: Calculate impulse response and convolution. LO-4: Calculate Fourier series coefficients. LO-5: Define and calculate continuous-time Fourier transform. LO-6: Define and calculate discrete-time Fourier transform. LO-7: Express sampling theory.		
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
	Quizzes	2 quizzes during the semester	20
	Activity	During the semester	5
	Final Exam		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. 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. ▪ Generative AI Policy GAI tools may not be used to complete or generate answers for quizzes, midterm exams, final exams, or other assessed work, unless explicitly authorized by the instructor. For activities where participation credit is given based on instructor-assigned tasks, students may use GAI to better understand the assignment and to help develop their own contributions. Submitted work must still reflect the student's own understanding, analysis, and intellectual input, and students remain responsible for the accuracy of any information obtained through GAI. Any permitted use of GAI must be properly acknowledged. ▪ 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. ▪ Quizzes There will be 2 quizzes in the semester. The quizzes will be announced in the classroom two weeks before and will relate to homework. ▪ Activity Students who will be active during discussion of past lessons will be awarded with one activity mark.
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Weeks	Topics	Reference to textbooks
1.	<i>Classification of Signals and Systems:</i> Standard signals: Step, Ramp, Pulse, Impulse. Real and complex exponentials and sinusoids - the mathematical building blocks used to model carrier waveforms in telecom systems. Conduction of oral and written survey. Problem solving	[1] p. 2-16
2.	<i>Classification of Signals and Systems:</i> Classification of Signals- Continuous Time (CT) and Discrete Time (DT) signals, Periodic and Aperiodic signals. Real-world: analog vs. digital signal paths in satellite and GSM links. Conduction of oral and written survey. Problem solving	[2] [1] p. 4-20 [3] [1] p.30-52 [4] [1] p. 24-28
3.	<i>Classification of Signals and Systems:</i> Deterministic and Random signals. Real-world: modeling noise and interference (AWGN) in wireless and satellite channels. Energy and Power signals - power budget analysis in satellite link design Conduction of oral and written survey. Problem solving	[2] p. 31-57 [2] p. 76-85
	<i>Classification of Systems:</i> CT systems and DT systems. Linear vs. non-linear, Time-variant vs.	[2] p. 113-146

4.	time-invariant, Causal vs. non-causal, Stable vs. unstable - deep-math stability criteria (BIBO stability) applied to satellite control-loop and network router stability Conduction of oral and written survey. Problem solving	[2] p. 153-155
5.	<i>Analysis of Continuous Signals:</i> Fourier series for periodic signals; Fourier Transform (deep math: Dirichlet conditions, convergence). Real-world: spectrum allocation and channel bandwidth in GSM/wireless communication.	[1] p. 216-240 [2] p. 124-148 [3] p. 242-251
6.	<i>Analysis of Continuous Signals:</i> Properties of the Fourier Transform (linearity, time-shift, modulation - deep math derivations). Laplace Transform and properties (deep math: Region of Convergence, poles/zeros). Real-world: transfer-function modeling of satellite transponders Conduction of oral and written survey. Problem solving	[2] p. 173-198 [2] p. 201-208 [2] p. 201-208
7.	<i>Linear Time Invariant Continuous Time Systems:</i> Impulse response, Convolution Integrals; Real-world: matched filtering in satellite/GSM receivers, Differential equations - modeling of RF/analog front-end circuits Quiz 1 - Lecture 1 – Lecture 6	[2] p. 271-300 [2] p. 310-314
8.	Midterm exam	
9.	<i>Linear Time Invariant Continuous Time Systems:</i> Fourier and Laplace transforms in analysis of CT systems - deep math applications Systems connected in series/cascade; Real-world: cascaded RF stages in GSM base-station receivers Conduction of oral and written survey. Problem solving	[2] p. 384-422 [2] p. 425-427
10.	<i>Analysis of discrete time signals</i> Baseband Signal Sampling - Nyquist theorem, aliasing (deep math); Real-world: satellite downlink digitization Fourier Transform of discrete-time signals (DTFT) Conduction of oral and written survey. Problem solving	[2] p. 565-588 [2] p. 596-600
11.	<i>Analysis of discrete time signals</i> Properties of DTFT; Real-world: OFDM subcarrier spectrum analysis in WiFi/4G/5G networks	[2] p. 602-635 [2] p. 667-693 [2] p. 636-638
12.	<i>Linear Time Invariant- Discrete Time Systems</i> Impulse response and difference equations - deep math derivation for digital filters Convolution Sum; Real-world: digital filtering in GSM base-station DSP chips, Discrete Fourier Transform (DFT) - computational spectrum analysis Quiz 3 (Lec9-Lec12)	[2] p. 764-788 [2] p. 801-805
13.	<i>Linear Time Invariant- Discrete Time Systems</i> Z-Transform: ROC, poles/zeros, stability (deep math); DT systems connected in series and parallel. Real-world: network router feedback-loop and satellite control-system stability Conduction of oral and written survey. Problem solving	[2] p. 807-825 [2] p. 845-850
14.	Case Study: End-to-end Satellite & GSM/Wireless Communication System - combining sampling, Fourier/Laplace/Z-transform analysis and filtering. Working with GNU Radio software	
15.	Solving problems and ambiguities of students about the course, including satellite link-budget and GSM channel-filter design problems Solving extra examples Solving problems and ambiguities of students about the course	