Koç University
Department of Electrical & Electronics Engineering

ELEC 201 - Signals and Systems

Instructor:	Alper Demir
Class Time and Place:	Monday, Wednesday, 9:30-10:45, Room SCI 103
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Course web-page:	https://sites.google.com/a/ku.edu.tr/elec-201-signals-systems-alper-demir/
Office Hours:	Monday, Wednesday 15:30-16:30

Teaching Assistants:

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Problem Sessions:

Section 1. Tuesday, 16:30-18:20 Room CAS B40

Section 2. Friday, 9:30-11:20 Room STD CENTER B228D

Course Description

Introduction to discrete and continuous time signals and systems. Time-domain signal representations, impulse response of linear time-invariant (LTI) systems, and convolution. Frequency domain signal representations, frequency response of LTI systems, and Fourier analysis. Filtering of continuous and discrete time signals. Sampling and discrete time processing of analog signals. Laplace-transform domain analysis of continuous-time LTI systems.

Credits: 4

Course Prerequisites

Math 106 (Calculus), Math 203 (Multivariate Calculus and Linear Algebra) or Math 107 (Calculus II). No background in electrical engineering or computer science is needed. Students should have some exposure to calculus, elementary set theory, series, first-order linear differential equations, trigonometry, and elementary complex numbers. It is highly recommended that you read Appendix A.4 (10 pages) of the Calculus book (Thomas' Calculus) during the first week of classes to (re)-familiarize yourself with elementary complex numbers. Also read page 71 of the textbook. Homework # 0, which will be handed out during the first week, will concentrate on the review of some of the mathematical background needed to follow this course.

Textbook

Signals and Systems, Second Edition;

Alan V. Oppenheim, Alan S. Willsky, with S. H. Nawab; Prentice Hall, 1997.

Grading

Course grade will be calculated according to (tentative)

Midterm 1: 25%

Midterm 2: 25%

Final: 40%

Homeworks & Quizzes: 10%

The final exam will be inclusive of all material covered during the semester.

Exam Information, Schedule and Location

Midterm 1: TBD

Midterm 2: TBD

Final: TBD

Homeworks and Problem Sessions

Homeworks aim to help students practice the theory covered in class, expose them to more complex problems, and write MATLAB code for practical applications. Students must be prepared to spend **six (6) hours per week** to do the homeworks. Each student must prepare the solutions for the homework problems **alone**. Showing complete or incomplete problem solutions to others, sharing or transfer of files, acquiring or using problem solutions before the homeworks are due, are strictly prohibited. Students who are suspected of any of these activities will be sent to the University Disciplinary Committee immediately, without any warning. See the section on Academic Honesty. Help may only be sought from the TAs or the instructor. Late homeworks will not be accepted. There will be weekly problem sessions, during which the course TAs will solve homework problems and review some course material. Quizzes on homework problems will be given during problem sessions. Students must attend the problem sessions.

Course Webpage

Weekly homework assignments, other important information, and last minute announcements will be posted in the course webpage.

Attendance

Students must attend all lectures and problem sessions in order to properly digest the material of this course.

Academic Honesty

Academic dishonesty is a serious violation of the trust upon which an academic community depends. The students must submit their own work in all exams, quizzes, and homeworks. In exams and quizzes, all forms of information exchange and talking between students is forbidden. Obtaining an exam prior to its administration or use of unauthorized material during an exam are also acts of academic dishonesty. In homework and project assignments, showing complete or incomplete problem solutions to others, sharing or transfer of files, acquiring or using problem solutions before the homeworks are due, are strictly prohibited. Cooperative work on homeworks may be allowed with instructor's approval, in which case the students have to convince the instructor that everyone working together understands all aspects of the problem solutions. Assisting someone else to engage in an act of academic dishonesty is also considered as an act of academic dishonesty. Students who are involved in any act of academic dishonesty will be sent to the Disciplinary Committee immediately, without any warning. The penalties may range from getting a grade of zero, to failing a class, to expulsion from the University.

Topics to be covered in Class (tentative)

Lecture	Subject	Reading
Lecture 1	**Introduction to Signals**	Sec. 1.1, 1.2
	Continuous-time (functions), Discrete-time (sequences), and digital signals	
	Basic signals (Real exponential, cosine and sine, sinc, rectangular pulse, unit step)	
	Periodic signals	
	Energy and power signals	
	Transformations of the independent variable (shifting, reflection, scaling)	
	Even and odd symmetric signals	
Lecture 2	**Introduction to Systems**	Sec. 1.5, 1.6
	Linear vs. nonlinear systems	
	Time-invariant vs. time-varying systems	
	Causal vs. non-causal systems	
	Stable vs. unstable systems	
	Systems with and without memory	
	Systems described by linear, constant-coefficient differential equations	
Lecture 3	**Impulse and Impulse Response**	Sec. 1.4, 2.5
	Dirac delta function	
	Sampling and sifting properties	
	Relationship between unit-step and impulse signals	
	Scaling property of impulse	
	Kronecker delta function	
	Impulse response of systems	
Lecture 4	**Discrete-time LTI Systems and Convolution Sum**	Sec. 2.1, 2.3
	Representation of DT signals in terms of Kronecker delta functions	

	Convolution summation	
	Properties of convolution summation	
	Stability and causality of DT LTI systems	
	Periodic convolution	
	Convolution of two finite-extent sequences	
Lecture 5	**CT LTI Systems and Convolution Integral**	Sec. 2.2, 2.3
	Representation of CT signals in terms of Dirac delta functions	
	Derivation of the convolution integral	
	Properties of the convolution integral	
	System properties and the convolution integral	
Lecture 6	**More on Convolution Integral and CT LTI Systems**	Sec. 2.2, 2.3
	Graphical interpretation of convolution integral	
	Computation of convolution integral for piecewise continuous signals	
	Unit step response and its relationship to impulse response	
	Periodic convolution integral	
Lecture 7	**CT Complex Exponentials and CT Fourier Series**	Sec. 1.3, 3.1, 3.3, 3.4
	CT complex exponentials	
	Derivation of CT Fourier series	
	Convergence of CT Fourier series	
	Trigonometric form of CT Fourier series for real-valued signals	
Lecture 8	**Properties of CT Fourier series**	Sec. 3.5
	Linearity and time-shifting property	
	CT Fourier series of real signals	
	CT Fourier series for periodic convolution and product of two signals	
	Parseval's theorem	

Lecture 9	**CT Fourier Series and LTI Systems**	Sec. 3.2, 3.8. 3.9, 3.10
	Output of an LTI system for a complex exponential input	
	Frequency response of an LTI system	
	Output of an LTI system for an arbitrary periodic input	
	Examples	
Lecture 10	**CT Fourier Transform**	Sec. 4.1
	Derivation of the CT Fourier transform	
	Existence of the CT Fourier transform	
	Examples	
Lecture 11	**Properties of the CT Fourier Transform**	Sec. 4.3, 4.4, 4.5
	Standard Properties	
	Convolution and modulation properties	
	Duality	
Lecture 12	**More on CT Fourier Transform**	Sec. 4.2, 4.6, 4.7
	Fourier transform of periodic signals	
	Frequency response of lumped systems	
	Bandwidth and uncertainty principle	
Lecture 13	**Continuous-time Analog Filtering**	Sec. 3.9-3.10, 6.1-6.5
	CT Filtering	
	Ideal vs. Realizable Filters	
	Example: 2-channel RF radio with FDM	
Lecture 14	**DT Complex Exponentials and DT Fourier Series**	Sec. 1.3, 3.6
	DT complex exponentials and their properties	

	DT Fourier series representation	
Lecture 15	**DT Fourier Series, Properties and LTI Systems**	Sec. 3.6-3.8
	DT Fourier series representation	
	Existence and uniqueness of DT Fourier series	
	Response of a DT LTI system to a complex exponential input	
	Frequency response of a DT LTI system	
	Response of a DT LTI system to an arbitrary periodic input	
	Properties of DT Fourier series	
Lecture 16	**DT Fourier Transform**	Sec. 5.1
	Definition and periodicity of DT Fourier transform	
	Existence of DT Fourier transform	
	Examples	
Lecture 17	**Properties of DT Fourier Transform**	Sec. 5.3, 5.4, 5.5, 5.6
	Standard properties	
	Examples	
Lecture 18	**More on DT Fourier Transform**	Sec. 5.2, 5.8, 6.6, 6.7
	DT Fourier transform of periodic signals	
	Discrete-time filtering	
	Examples	
Lecture 19	**Review of CT and DT Fourier Series and Fourier Transform**	Sec. 5.7, Ch. 3, 4, 5
	Review of CT and DT Fourier series and Fourier transform	
	Duality relationships	
	Partial fraction expansions	

Lecture 20	**Sampling of CT Signals**	Sec. 7.1, 7.2
	Bandlimited signals and Nyquist Sampling theorem	
	Modeling ideal sampling in time and frequency domains	
	Reconstruction filtering (Bandlimited interpolation)	
Lecture 21	**Aliasing**	Sec. 7.2, 7.3
	Definition of Aliasing	
	Examples	
	Anti-alias filtering	
	Ideal reconstruction from samples	
Lecture 22	**DT Processing of CT Signals**	Sec. 7.4
	System diagram	
	Mapping between CT frequencies (Hz) and DT frequencies (rad)	
	Examples	
Lecture 23	**More on Sampling and DT Processing of CT Signals**	Sec. 7.5
	Correspondence between DT filters and CT filters	
	Sampling in the frequency domain	
	DFT	
Lecture 24	**Laplace transform and Region of Convergence**	Sec. 9.1, 9.2
	Definition of the Laplace transform and ROC	
	Relationship between Laplace transform and CTFT	
	Rational Laplace transforms, poles and zeros	
Lecture 25	**Properties of Laplace transform and ROC**	Sec. 9.2, 9.5, 9.6
	Rules for ROC	

	Properties of the Laplace transform	
	Examples	
Lecture 26	**Inverse Laplace transform**	Sec. 9.3, Appendix
	Partial fraction expansion method	
	Examples	
Lecture 27	**Analysis of LTI Systems using Laplace Transform**	Sec. 9.7. 9.8
	Stability analysis	
	Causality analysis	
	Examples	