ECE 381 (3 credits)

Introduction to Discrete-time Signal Processing

INSTRUCTOR: Jiang Li, Assistant Professor, ECE Department.
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COURSE DESCRIPTION: This course covers fundamental digital signal processing (DSP) techniques that form the basis to a wide variety of application areas. Topics include discrete-time signals and systems, time domain analysis, solutions of difference equations, Z-transform analysis, discrete Fourier transforms (DFT), sampling theorem, and Fourier analysis of linear time-invariant systems. The course also analyzes the broader impacts of DSP in a global, economic and societal context.

OFFICE HOUR: 10am – 11:30am, M&R

TA: Manar Samad (msama005@odu.edu)

PREREQUISITE: ECE 202.

TEXTBOOK: B. P. Lathi, "Linear Systems and Signals", Second Edition, New York: Oxford University Press, 2005.

SUGGESTED READING LIST: (provided)

- Borgmann, A., *Technology and the Character of Contemporary Life: A Philosophical Inquiry*, Chicago: The University of Chicago Press, 1984.
- Papers from the *International Multi-Conference on Society, Cybernetics and Informatics* (IMSCI) and the *International Conference on Politics and Information Systems*, Technologies and Applications (PISTA)
- Estrada, R. F. and Starr, E.A.; , "50 years of acoustic signal processing for detection: coping with the digital revolution," *IEEE Annals of the History of Computing*, vol. 27, no. 2, pp. 65- 78, April-June 2005
- Marx, L., "Does Improved Technology Mean Progress?". From *Technology Review*, January 1987, pp. 33-41. As reprinted in *Technology and the Future*, 6th ed., ed. Albert H. Teich. New York: St. Martin's Press, 1993, pp. 3-14.

GRADING POLICY:

Homework	20
Test 1	15
Test 2	15
Final	25
Projects	15
Research paper	10

EXAM DATES:
Test 1: Feb. 20th, class time.
Test 2: Apr. 3rd, class time.
Final: TBA

LEARNING OUTCOMES:

1. Know basic concepts of discrete-time signals and systems. Be able to analyze discrete-time systems by solving difference equations.
2. Understand the Z-transform and be able to analyze linear time-invariant systems' characteristics (causality and stability) and to solve systems' responses using the Z-transform.
3. Understand the sampling theory and know techniques for processing continuous-time signals using digital systems.
4. Be able to apply digital Fourier transformation (DFT) to solve practical engineering problems. Know the procedure of the DFT.
5. Be able to analyze linear time-invariant systems in frequency domain. Understand and be able to apply low pass, high pass and band pass filters to discrete-time signals.
6. Be able to recognize different filter structures. Understand advantages/disadvantages of parallel and cascade filter structures and be able to convert from one to another.
7. Describe the use and development of a given technology as a human and cultured activity
8. Describe the role of technology in defining ideas of progress and modernism

TENTATIVE OUTLINE OF TOPICS:

- Discrete-Time Signals and Systems
- The Z-Transform
- Impact of Technology
- Sampling and Digital Processing of Continuous-Time Signals
- The Discrete Fourier Transform (DFT)
- Fourier Analysis of Linear Time-Invariant Systems

RESEARCH PAPER: Topics on the broader impacts of digital signal processing will be given to students and students are required to turn in three research papers during the semester. The students will work in groups for the first two papers. The last paper is to be done individually. The list of possible topics includes the history and utilization of DSP, the impact of DSP in the global economy, the socio-political context, and concerns of its utilization throughout its history and in the future. The group research papers will be discussed in class.

HOMEWORK ASSIGNMENTS: Assignments will be given every one or two weeks and due at the beginning of the class on the due date. Late submissions will not be accepted.

PROJECTS: Three small projects will be assigned. No late assignments will be accepted except under extreme non-academic circumstances.

SOFTWARE REQUIREMENT: MATLAB is available on most department laboratory machines. However, other equivalent software can be used or the student can develop his/her own software.

HONOR CODE: Students are expected to follow the ODU Honor Code for all assignments and exams. Any violations will be dealt with strictly according to university policy. However, this

is also a course, which requires a lot of interaction, and sharing of ideas is encouraged. You are encouraged to discuss assignments with others. ***Even though discussion is encouraged, the work that you turn in must be your own***. If at any time you have a question about whether you are violating the Honor Code, please ask me to make sure.

DISABILITIES: Students who have documented disabilities in accordance with university guidelines will be provided appropriate opportunities if the documentation is brought to the instructor's attention. As a faculty member, I am required by law to provide reasonable accommodation to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.

ACADEMIC DISHONESTY: It is the philosophy of ODU that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts. **ANY CHEATING WILL RESULT IN SEVERE PENALTIES.**

Topics Covered:

	Topic	Text Sections
	(This schedule is subject to change. However, Changes, if necessary, will be announced in class and posted on blackboard.)	
I.	Introduction (Jan. 14th, 16th)	---
	A. Basic math review	
	B. Matlab programming	
II.	Time-domain analysis of discrete-time systems	Ch. 3
	(Jan. 23rd, Jan. 28th, 30th, Feb. 4th, 6th, 11st, 13rd No class on Jan 21st, Holiday.)	
	A. Signal representation, operation and models	
	B. Discrete-Time system examples	
	C. Convolution sum, solutions for linear difference equations	
	D. Causality, stability and time-invariant properties of systems	
	E. Time domain solutions for difference equations	
	F. Classical solutions for difference equations	
III.	Impact of Technology In-Class Discussions	
	(Feb. 18rd)	
	A. History and utilization of digital signal processing.	
	B. Impact in a global, economic, environmental, and societal context.	
	C. Concerns of the utilization of digital signal processing throughout it history and in the future.	
	(Feb. 20th, test 1)	
IV.	Discrete-time system analysis using the Z-Transform	Ch. 5
	(Feb. 25th, 27th, Mar. 4th, Mar. 6th, Mar. 18th)	
	A. Definition of the Z-transform	
	B. Z-transform solution of linear difference equations	
	C. Frequency response of discrete-time systems	
	D. Pole-Zero location analysis	
	E. The Bilateral z-transform	

(Mar. 11th – Mar. 16th, Spring break, No class)

V. Sampling of continuous-Time Signals — Ch. 8
(Mar. 20th, 25th, 27th, Apr. 1st)
A. Sampling theorem
B. Signal reconstruction
D. Sampling rate reduction by an integer factor
E. Changing the sampling rate by a noninteger factor
(Apr. 3rd, test 2)

VI. Discrete-Time Fourier Transform — Ch. 8
(Apr. 8th, 10th, 15th, 17th)
A. Discrete Fourier Transform (DFT)
B. Properties of the DFT
C. Applications of the DFT

VII. Fourier analysis of discrete-time signals — Ch. 9
(Apr. 22nd, 24th, 29th)
A. Discrete-time Fourier series (DTFS)
B. Aperiodic signal representation by Fourier integral
C. Properties of the DTFT
D. LTI discrete-time system analysis by DTFT

Class Schedule: TR, twice a week. Each class is 75 minutes duration.
Engineering Science Hours: 3 Engineering Design Hours: 0