North East University Bangladesh
Department of Computer Science and Engineering

Course Outline
CSE 431 – Digital Signal Processing

Instructor

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Email

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Class Schedules:

08:30 AM – 10:00 AM, Saturday

08:30 AM – 10:00 AM, Wednesday

Consultation Hours

01:00 PM – 02:30 PM, Saturday at Room 303

01:00 PM – 02:30 PM, Tuesday at Room 303

Course Overview

This course is designed for the student to understand the basics of Electrical engineering. After completing this course, students should be able to understand and solve simple to complex electrical circuits using different engineering techniques. This is an introductory level course and has no prerequisite course.

Text Book

- Signal Processing and Linear Systems - B. P. Lathi (Lathi)
- Digital Signal Processing: Principles, Algorithms, and Applications - John G. Proakis and Dimitris G. Manolakis, 4th edition. (Proakis)

Reference Books

- Signals and Systems-Alan V. Openheim and Alan S. Wilsky, 2nd edition (Openheim).
- Discrete-Time signal processing – Alan V. Openheim, Ronald W. Schafer, 2nd edition. (Openheim2)
- Digital Signal Processing: A Practical Approach - Emmanuel C. Ifeachor (Ifeachor)
- Schaum's Outlines of Digital Signal Processing - Monson H. Hayes (Hayes)

Course Materials

All the course materials (Including name for any new books) will be available at

- http://www.neub.shparvez.net/cse-431/
- http://www.neub.shparvez.net/cse-432/

Course Learning Outcomes

The intended learning outcomes from this course are as follows

- To be able identify and distinguish between different type of signals.
- To be able identify and distinguish between different type of systems.
- To be able to understand the difference between analog and digital systems.
- To be able to do mathematical analysis and manipulation of different type of signals.
- To be able to design different type of analog and digital systems.
- To be able to process different signals using tools like
  - Fourier Transform
  - Laplace Transform
  - Z Transform
- To be able to design different types of digital filters

Course Schedule

Week	Topic to be Covered	Learning Outcomes

Week 1	Lecture 1: Introduction to Signals and Systems
	• Introduction to Signals
	• Introduction to Systems
	• Why Study Signals and Systems
	• Classification of Signals
	  ○ Continuous and Discrete Time signal
	  ○ Analog and Digital Signal
	  ○ Periodic and Aperiodic Signal
	  ○ Energy and Power Signal
	  ○ Deterministic and Probabilistic Signal
	  ○ Even and Odd Signal
	  ○ Casual and Non-causal Signal
	  ○ Real and Complex Signal
	• Some Useful Signal Models
	  ○ Unit step function
	  ○ Unit impulse function
	  ○ Unit Ramp function
	  ○ Sinusoidal signal
	  ○ Exponential signal
	• Basic Operations on signals
	  ○ Time shifting
	  ○ Time scaling
	  ○ Time reversal
	Reading Lists:
	• Lathi Chapter 1 Section 1.1-1.5
	• Openheim Chapter 1 Section 1.0-1.3
		Student should be able to
		• Understand the fundamentals of Signals and systems
		• Understand the necessity of studying signals and systems
		• Distinguish between different types of signals
		• Represent different mathematical model of signal into graphical form
		• Do basic mathematical operations like time shifting, time reversal and time scaling on different types of signals

Week 2	Lecture 1: Introduction to Signals and Systems
	• Sampling
	• Properties of impulse Function
	• Classification of System
	  ○ Linear and non-linear system
	  ○ Time invariant and Time varying System
	  ○ Instantaneous (memoryless) and Dynamic (with memory) system
	  ○ Casual and non-casual system
	  ○ Lumped parameter and Distributed parameter system
	  ○ Continuous time and Discrete Time system
	  ○ Analog and digital system
	  ○ Invertible and non-invertible system
	  ○ Stable and unstable system
	• System Model: Input-output Description
	Reading Lists:
	• Lathi Chapter 1 Section 1.6-1.8
	• Openheim Chapter 1 Section 1.4-1.7
		Student should be able to
		• Understand the bass of sampling
		• Understand the properties of impulse Function
		• Identify and distinguish between different types of systems
		• Model different systems using input-output descriptions

Week	Topic to be Covered	Learning Outcomes
Week 3	Lecture 2: Linear Time Invariant System • Impulse Response • Representation of Discrete Time Signals in terms of impulses • The Discrete-Time Impulse Response and the Convolution-Sum Representation of LTI Systems • Continuous-Time LTI Systsem (LTIC) • Impulse response of an LTI system • Convolution Integral • Properties of Convolution • Computing Convolution • Graphical Understanding of Convolution **Reading Lists:** • Lathi Chapter 2 • Openheim Chapter 2	Student should be able to • Understand impulse response • Represent different signals using impulse signal • Do convolution mathematically • Understand the fundamental of convolution • Graphically understand convolution operation.
Week 4	Lecture 3: Fourier Series and Fourier Transform • Signals and Vectors • Components of a Signal • Orthogonality in Complex Signals • Signal Comparison: Correlation • Signal Representation by Orthogonal Signal Set • Trigonometric Fourier Series • Compact Trigonometric Fourier Series • Exponential Fourier Series • The Gibb's Phenomenon **Reading Lists:** • Lathi Chapter 3 • Openheim Chapter 3	Student should be able to • Represent signals using Vectors • Identify orthogonal signals • Compare signals using correlation • Understand that a signal can be represented using Fourier series • Identify the similarities between trigonometric, compact trigonometric and exponential Fourier Series.
Week 5	Lecture 3: Fourier Series and Fourier Transform • Fourier Transform • Properties of Fourier Transform • Examples of Fourier Transform • Signal transmission through LTI system • Application of Fourier transform • Proofs of different properties of Fourier Transform **Reading Lists:** • Lathi Chapter 4 • Openheim Chapter 4	Student should be able to • Understand that Fourier Transform can be Used to transform a signal in time domain to frequency domain • Do Fourier Transform of different signals • Apply Fourier Transform • Understand the basis of Laplace Transform. • Understand the importance of Region of Convergence of Laplace Transform

Week	Topic to be Covered	Learning Outcomes
	Lecture 4: Laplace Transform • Problems with Fourier Transform • What is Laplace Transform • Linearity of Laplace Transform • The Region of Convergence (ROC) • Relationship between Fourier Transform and Laplace Transform **Reading Lists:** • Lathi Chapter 6 • Openheim Chapter 9	• Understand the relationship between Laplace Transform and Fourier Transform
Week 6	Lecture 4: Laplace Transform • Role of region of Convergence • Properties of ROC • The Unilateral Laplace Transform • Finding Inverse Laplace Transform • Properties of Laplace Transform • Proofs of Properties of laplace Transform **Reading Lists:** • Lathi Chapter 6 • Openheim Chapter 9 Revision and Solve Class	Student should be able to • Understand the properties of ROC of Laplace Transform • Understand the difference between Unilateral and Bilateral Laplace Transform • Comprehend the properties of Laplace Transform • Find Inverse Transform
Week 7	Lecture 5: Laplace Transform Application • Causality and Stability • Solution of Differential and Integro-Differential Equations • Zero Input and Zero state components of Response • Zero-State Response: The Transfer Function of an LTIC System • Analysis of Electrical Networks: The Transformed Network **Reading Lists:** • Lathi Chapter 6	Student should be able to • Solve differential equations using Laplace Transform • Understand the difference between Zero Input and Zero State response of LTIC system • Solve Electrical network using Laplace Transform
Week 8	Lecture 5: Laplace Transform Application • Block Diagrams • System realization • System Realization using Op-Amp **Reading Lists:** • Lathi Chapter 6	Student should be able to • Represent system using block diagram • Realize any given system using canonical approach • Realize different systems using Op-Amps • Understand the fundamental difference between Analog signals and Digital Signals

Week	Topic to be Covered	Learning Outcomes
	Lecture 6: Introduction to Digital Signal Processing and Sampling • Signals, Systems, and Signal Processing • Types of Signal Processing • Application of DSP • Advantage of DSP over Asp • Disadvantages of DSP • Generation of Digital Signals • Classification of digital signals • Elementary digital signals **Reading Lists:** • Proakis Chapter 1	• Understand the application, advantage and disadvantage of DSP • Able to represent different signals using elementary digital signals • Generate Digital Signals
Week 9	Lecture 6: Introduction to Digital Signal Processing and Sampling • Discrete time sinusoid signals • Sampling • Nyquist Criterion • Aliasing • Quantization • Operations on digital sequence • Correlation **Reading Lists:** • Proakis Chapter 1 and 2	Student should be able to • Understand the basics of Sampling • Importance of choosing proper sampling frequency to avoid Aliasing • Able to do correlation to compare different signals
Week 10	Lecture 7: Z Transform • Direct Z Transform • Inverse Z Transform • ROC of Z Transform • Properties of Z Transform • Examples of Z Transform • Pole Location and Time-Domain Behavior for Causal Signals • The System Function of a Linear Time-Invariant System • Inverse z-transform by power series expansion • Inverse z-transform by Partial-Fraction expansion **Reading Lists:** • Proakis chapter 3	Student should be able to • Understand How to do Z Transform • Do inverse Z Transform • Understand the properties of Z Transform • Understand the importance of Pole-Zero locations

Week	Topic to be Covered	Learning Outcomes

Week 11	Lecture 7: Z Transform
	• Unilateral Z Transform
	• Properties of The ROC of Z-Transform
	• Stability, Causality, and the ROC
	Reading Lists:
	• Proakis chapter 3
	Lecture 8: Digital Filters
	• Digital Filters
	• General Block Diagram of Realtime Digital Filers
	• Advantage of Digital Filter
	• Classes of Digital filters
	  ○ FIR Filter
	  ○ IIR Filter
	• Choosing Between FIR and IIF filter
	• Filter Design Steps
	• Key Characteristics of FIR filters
	• FIR filter Specification
	• Running average filter
	Reading Lists:
	• Proakis chapter 10
	• Ifeachor Chapter 5 and 6
		Student should be able to
		• Understand properties of the ROC of Z Transform
		• Understand the fundamentals of Digital Filter design
		• Design different digital Filters using given specification

Week 12	Revision and Solve Class	

Assignments

Assignment	Topic	Due Date
Assignment 1	Questions from Lecture 1, 2,3	Last Class before midterm
Assignment 2	Questions from Lecture 5, 6, 7	Last class day of the semester

Assignment Policy

Assignments Must be submitted within due dates. No excuse or requests will be considered regarding late submission.

Grading Policy

Attendance	: 10 marks
Tutorial	: 15 marks
Assignment	: 5 marks
Mid Semester Examination	: 30 marks
Semester Final Examination	: 40 marks

Grades and grades point will be based on the following criteria.

Marks Range	Letter Grade	Grade Point
80% and Above	A+	4.00
75% - 79%	A	3.75
70% - 74%	A-	3.50
65% - 69%	B+	3.25
60% - 64%	B	3.00
55% - 59%	B-	2.75
50% - 54%	C+	2.50
45% - 49%	C	2.25
40% - 44%	D	2.00
Less than 40%	F	0.00

Exam Schedule

Exam	Schedule
Tutorial Exam #1	3rd Week of October (Probable date 17th October 2019)
Mid Semester Examination	Announced by the Controller of Examination Office
Tutorial Exam #2	1st Week of December (Probable date 5th December 2019)
Semester Final Examination	Announced by the Controller of Examination Office

Attendance Policy

Attendance will be taken based on the following criteria:

- Students who are on time will get full attendance without any penalty.
- Students who are no more than 30 minutes late will get 50% attendance penalty (Meaning half of the attendance will be accounted).
- Students who are more than 30 minutes late will get 90% attendance penalty.

Mark for attendance will be awarded as follows.

Level of Attendance	Mark
96% to 100%	10
91% to 95%	9
86% to 90%	8
81% to 85%	7
76% to 80%	6

Level of Attendance	Mark
71% to 75%	5
66% to 70%	4
61% to 65%	3
60%	2
Below 60%	0

Other policies

Bunking of class will be severely penalized. Mass bunking during tutorials will result in zero marks for all students. Other than bunking, unusual distractions during lectures by any students will also be severely penalized.