National University of Sciences & Technology (NUST)
School of Electrical Engineering and Computer Science (SEECS)
Department of Electrical Engineering

EE-232 Signals and Systems			
Course Code:	EE-232	**Semester:**	Fall 2022
Credit Hours:	3+1	**Prerequisite Codes:**	Complex variables and transforms
Instructor:	Dr. Salman Ghafoor	**Class:**	BEE-12CD
Office:	B-205, IAEC	**Telephone:**	+92 (0)51 9085 2560
Lecture Days:	Monday & Tuesday	**E-mail:**	salman.ghafoor@seecs.edu.pk
Class Room:	CR-13 Computing Lab 2	**Consulting Hours:**	Wednesday 1500 – 1700
Lab Engineers:	Munadi Sial, Fahad Khalid	**Lab Engineer Email:**	
Knowledge Group:	Digital Systems and Signal Processing	**Updates on LMS:**	After Each Lecture

Course Description:

This is an introductory course to Signals and Systems. The course will provide an insight into how physical processes can be mathematically modelled using signals and systems. The course will also focus on how signals can be represented in time domain and how they can be transformed into other domains. The transform domain allows more intuitive/simpler solutions to various engineering problems. The students will also learn about analytical techniques that allow modelling the behaviour of the systems and gain an insight into the characteristics of systems. The course will provide skills to model, analyse and design signals and systems.

Course Learning Outcomes:

CLO	Description After the completion of the course the students will be able to:	BT Level	PLOs
1.	**Describe** continuous-time/discrete-time signals and systems and their properties such as causality, stability, linearity, and time invariance.	C2	1
2.	**Analyze** continuous and discrete-time signals and systems in the time/frequency-domain using Fourier, Laplace and Z-transforms.	C4	2
3.	**Apply** various signal analysis and transformation techniques (such as Fourier-, Laplace-, or Z-) on discrete-time signals (such as sound or image) and systems (such as communication or compression) using MATLAB software.	P4	5
4.	**Exhibit** good professional and ethical behavior while **adhering** to lab safety rules.	A3	8

Mapping of CLOs to Program Learning Outcomes

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO 1 (Engineering Knowledge)	√			
PLO 2 (Problem Analysis)		√		
PLO 3 (Design/Development of Solutions)				
PLO 4 (Investigation)				
PLO 5 (Modern tool usage)			√	
PLO 6 (The Engineer and Society)				
PLO 7 (Environment and Sustainability)				
PLO 8 (Ethics)				√
PLO 9 (Individual and Team Work)				
PLO 10 (Communication)				
PLO 11 (Project Management)				
PLO 12 (Lifelong Learning)				

Assessment Modules, Weightages, and Mapping to CLOs

Assessments/CLOs	CLO1	CLO2	CLO3	CLO4
Quizzes: 10.5% of the course	√	√		
Assignments: 4.5% of the course	√	√		
OHTs: 22.5% of the course	√	√		
Labs: 25% of the course			√	√
End Semester Exam: 37.5% of the course	√	√		

Books:

Text Book:	1. Signals and Systems by Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab (2nd Edition)
Reference Books:	1. Linear Systems and Signals by B.P. Lathi 2. Signal Processing First by James H. McClellan, Ronald W. Schafer and Mark A. Yoder

Main Topics to be Covered:

1. Introduction to Signals and Systems
2. Linear Time Invariant Systems
3. Interaction of sinusoids with LTI systems
4. Continuous Time Fourier Series: Frequency domain representation of CT periodic signals
5. Properties of Continuous Time Fourier Series
6. Discrete Time Fourier Series: Frequency domain representation of CT periodic signals
7. Properties of Discrete Time Fourier Series
8. Continuous time Fourier Transform: Frequency domain representation of CT aperiodic signals & systems
9. Properties of Continuous Time Fourier Transform
10. Discrete time Fourier Transform: Frequency domain representation of DT aperiodic signals & systems
11. Properties of Discrete Time Fourier Transform
12. Laplace Transform
13. Description of Systems in terms of Laplace transform
14. Z-Transform
15. Description of Systems in terms of Z-transform

Lecture Breakdown:		
Chapter	**Topics**	**Lectures**
1	**Introduction, Types of Signals** ▪ Motivation, Applications ▪ Signal Classification ▪ CT, DT, Analog, Digital, Deterministic, Periodic, Aperiodic; Even & Odd signal decomposition	3
1	**Signal Transformations/Signal Fundamentals** ▪ Signal Transformations ▪ Fundamental signals: Complex Exponentials; Decaying exponentials; sinusoids; Unit Impulse; Unit Step ▪ Signal representation using fundamental signals	4
1	**System Classification** ▪ Continuous/Discrete; Analog/Digital Linear/Nonlinear; Time-invariant/Time varying; Causal/Anti-causal; Stable/Unstable	2
2	**LTI Systems Theory** ▪ Intro to LTI Systems ▪ Impulse response as system characterization ▪ LTI System Properties ▪ Commutative/Distributive/Associative ▪ Linearity ▪ Convolution (CT and DT) Difference equations for LTI system	6
	Revision	1
	OHT 1	
3	**Fourier Series** ▪ Frequency domain view of LTI systems ▪ Concept of complex frequency ▪ Fourier series representation of CT periodic signals (CTFS) ▪ Properties of CTFS ▪ Fourier series representation of DT periodic signals (DTFS)	4
4	**Continuous Time Fourier Transform (CTFT)** ▪ FT of continuous time aperiodic signals ▪ Properties of CTFT ▪ Fourier Transform of periodic signals	7
5	**Discrete Time Fourier Transform (DTFT)** ▪ FT of discrete time aperiodic signals ▪ Properties of DTFT	4
	Revision	1
	OHT 2	
7	**Introduction to Sampling** ▪ Time Domain and frequency domain description; Nyquist criterion ▪ Aliasing; Under/Over sampling	2
9	**Laplace transform (LT)** ▪ Convergence of CTFT and motivation of Laplace transform ▪ Properties of LT ▪ Pole-zero plots; significance	6

	▪ Filter design by pole zero placement (time permitting)	
10	**Z-transform** ▪ Convergence of DTFT and motivation of z-transform ▪ Properties of z-transform ▪ Difference equations and z-transform ▪ LTI system interconnections using z-transforms	7
	Revision	1
	Total:	48

Lab Experiments:	
Lab 01:	Introduction to Matlab
Lab 02:	Plotting and Array Processing in MATLAB
Lab 03:	Signal Transformations
Lab 04:	Introduction to Complex Exponentials
Lab 05:	Introduction to Properties of Systems
Lab 06:	Convolution
Lab 07:	Simulink
Lab 08:	Continuous Time Fourier Series
Lab 09:	Discrete Time Fourier Transform
Lab 10:	Fourier Transform
Lab 11:	Sampling
Lab 12:	Modulation

Tools / Software Requirement:
MATLAB for Lab work.

Grading Policy:	
Quiz Policy:	The quizzes will be unannounced and normally last for ten minutes. The question framed is to test the concepts involved in last few lectures. Number of quizzes that will be used for evaluation is at the instructor's discretion. Grading for quizzes will generally be on a scale of 0 to 10.
Assignment Policy:	In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments will not be accepted / graded. All assignments will count towards the total (No 'best-of' policy). The students are advised to do the assignment themselves. Copying of assignments is highly discouraged and violations will be dealt with severely by referring any occurrences to the disciplinary committee. The questions in the assignment are meant to be challenging to give students confidence and extensive knowledge about the subject matter and enable them to prepare for the exams.
Lab Conduct:	Copying of lab work or late submission of report shall result in reduction of marks.
Plagiarism:	SEECS maintains a zero tolerance policy towards plagiarism. While collaboration in this course is highly encouraged, you must ensure that you do not claim other people's work/ ideas as your own. Plagiarism occurs when the words, ideas, assertions, theories, figures, images, programming codes of others are presented as your own work. You must cite and acknowledge all sources of information in your assignments. Failing to comply with the SEECS plagiarism policy will lead to strict penalties including zero marks in assignments and referral to the academic coordination office for disciplinary action.