COURSE DESCRIPTION / SYLLABUS

Faculty	Faculty of Engineering				
Department	Communication and Computer Engineering			**NQF level**	7
Course Title	Digital Signal Processing	**Code**	**701454**	**Prerequisite**	**701452**
Credit Hours	3	**Theory**	2	**Practical**	1
Course Leader	Dr. Ahmad Bader	**E-mail**	abader@jadara.edu.jo		
Lecturers	Dr. Amer Al-Canaan	**E-mails**	a.alcanaan@jadara.edu.jo		
Lecture time	10:00 - 11:30 Mon, Wed	**Classroom**	D002		
Semester	Second 2021/2022	**Production**	2020	**Updated**	2022

Short Description

- This course provides students with capabilities in Digital Signal Processing (DSP) including basic principles governing the analysis and design of discrete-time systems. Topics include Linear-Time Invariant (LTI) systems, Discrete-Time Fourier Transform (DTFT), Fast Fourier Transform (FTT), sampling, convolution, impulse response, Finite and Infinite Impulse Response (FIR and IIR) digital filters, linear-phase systems, digital filter design and implementation.

Course Objectives

Upon successful completion of this course, student should be able to:

- Apply the principles of discrete-time signal analysis to perform various signal processing operations such as sampling and filtering.
- Apply the principles of z-transforms to finite difference equations.
- Apply the principles of Fourier transform analysis to describe the frequency characteristics of discrete-time signals and systems.
- Apply the principles of signal analysis to FIR and IIR digital filter design.
- Use computer-programming tools to process and visualise signals.

Learning Outcomes

A. Knowledge - Theoretical Understanding

a1. Understand/describe discrete-time signals and systems mathematically in terms of sum of weighted unit sample sequences, complex exponentials and other properties such as stability, causality, recursiveness and memory. (K1)

B. Knowledge - Practical Application

a2. Represent discrete-time signals and systems graphically using block diagrams, plots of poles, zeros, ROC, magnitude and phase. (K2)

C. Skills - Generic Problem Solving and Analytical Skills
b1. Compute/analyse output sequences, convolution sums, Fourier Transform, z-Transform, Frequency Response, impulse response and difference equations needed for the design, implementation and analysis of digital filters. (S2)
D. Skills - Communication, ICT, and Numeracy
E. Competence: Autonomy, Responsibility, and Context
Teaching and Learning Methods
• Lecture, Group work and discussion
Assessment Methods
• Lecture, lab, Group work and discussion • Midterm exam, Final exam, Class Assignment and Project • Observation of student contribution in teamwork and project presentations

Course Contents					
Week	**Hours**	**CILOs**	**Topics**	**Teaching & Learning Methods**	**Assessment Methods**
1, 2	6	a1	Syllabus, Course Schedule; **Chapter 2:** Discrete-time signals: Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, Sequences, periodic, energy, power, unit-sample, unit step, unit ramp 4 Complex exponentials, arithmetic operations on sequences.	Lectures,	
3, 4	6	a1, b1	**Chapter 3:** LTI systems: Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.	Lectures,	Assignment 1, (week 3) Quiz #1 (week 4)
5, 6	6	a1, a2, b1	**Chapter 4:** Z- Transforms: Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z-transform, initial value theorem, Parseval's relation, inverse Z-Transform by contour integration, power series & partial-fraction expansions with examples and exercises.	Lectures,	

7	3	a1, a2, b1	**Midterm Exam (30 % of assessment)** Revision/discussion	Lectures,	Midterm exam
8, 9	6	b1	**Chapter 5:** Discrete Time Fourier Transform (DTFT): Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.	Lectures,	Assignment #2, (week 8) Quiz #2 (week 9)
10, 11	6	b1	**Chapter 6:** Discrete Fourier Transform: Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.	Lectures,	
12, 13	6	a2, b1	**Chapter 7:** Fast Fourier Transforms: Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.	Lectures,	
14	6	a1, a2, b1	**Chapter 8:** Filter design: Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analogue filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.	Lectures,	Assignment #3
15	3	a1, a2, b1	**Final Exam (50 % of assessment)**	Lectures, online revision/discussion sessions	Final exam

Infrastructure	
Textbook	Discrete-Time Signal Processing, Alan V. Oppenheim, Herman Aihara, 2nd Ed., 2015. ISBN13: 9780137549207
References	- Digital Signal Processing: Principles, Algorithms & Applications, J.C. Proakis & M.G. Manslakis, Printice-Hall 2007. - Digital Signal Processing Using MATLAB, Vinay K. Ingle and John G. Proakis, Cengage Learning, 4th edition, 2017. - Digital Signal Processing with MATLAB Programs, Sanjay Sharma, Published by S.K. Kataria & Sons, Sixth Edition, 2013. - Digital Signal Processing-A computer-based approach, S. Mitra, TMH.

	- Fundamental of Digital Signal Processing using MATLAB, Robert J. Schilling, S.L. Harris, Cengage Learning. - Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.
Required reading	
Electronic materials	Lecture notes
Other	Questions bank

Course Assessment Plan							
Assessment Method		**Grade**	**CLOs**				
			a1	**a2**	**b1**		
First (Midterm)		30	18	6	6		
Second (if applicable)							
Final Exam		50	16	16	18		
Coursework		20					
Coursework assessment methods	Assignments		5		5		
	Case study						
	Discussion and interaction						
	Group work activities						
	Lab tests and assignments						
	Presentations						
	Quizzes			5	5		
Total		**100**	39	27	34		

Plagiarism
Plagiarism is claiming that someone else's work is your own. The department has a strict policy regarding plagiarism and, if plagiarism is indeed discovered, this policy will be applied. Note that punishments apply also to anyone assisting another to commit plagiarism (for example by knowingly allowing someone to copy your code). Plagiarism is different from group work in which several individuals share ideas on how to carry out the coursework. You are strongly encouraged to work in small groups, and you will certainly not be penalized for doing so. This means that you may work together on the program. What is important is that you have a full understanding of all aspects of the completed program. In order to allow proper assessment that this is indeed the case, you must adhere strictly to the course work requirements as outlined above and detailed in the coursework problem description. These requirements are in place to encourage individual understanding, facilitate individual assessment, and deter plagiarism.