Jordan University of Science and Technology
Faculty of Engineering
Biomedical Engineering Department

BME 421: Digital Signal Processing
Course Catalog
The basics of discrete sequences, studying the terms Linearity, Time-invariance, Causality, and Stability, Fourier transform theorems, Z-transform, the sampling theorem and the Nyquist rate, complete (A/D – DSP – D/A) system in both time and the frequency domains, frequency response of linear time invariant systems, frequency selective filters and Phase Distortion and Delay, IIR and FIR systems, design of different types of digital filters, bilinear transformation, and MATLAB use in designing different types of analog and digital filters, introduction to adaptive filters.

Textbook	
Title	Discrete-time Signal Processing
Author(s)	Oppenheim A. and Schafer R.
Publisher	Prentice Hall
Year	1999
Edition	2nd

References	
Books	• Oppenheim, A.V., Willsky, A.S. and Young, I.A, "Signals and Systems," Prentice-Hall, Inc.(ISBN 0-13-811175-8) • Bruce, E.N., "Biomedical Signal Processing and Signal Modeling," John Wiley and Sons, Inc., 2000. (ISBN 0-471-34540-7)
Journals	• Annals of Biomedical Engineering • Journal of Medical Engineering and Technology • Computer Programs and Methods in Medicine • Medical Engineering and Physics • IEEE EMBS Book Series • IEEE Transactions on Biomedical Engineering
Internet links	• http://www.bmes.org/ • http://arjournals.annualreviews.org/loi/bioeng?cookieSet=1 • http://www.aami.org/publications/BIT/index.html • http://www.biophysj.org/

Instructor	
Instructor	**Dr. Khaldon Lweesy**
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Office hours
To be determined

Teaching assistant
To be determined

Pre-requisites	
Pre-requisites by topic	Introduction to Linear Systems Introduction to discrete-time systems Electrical Circuits Fourier Series and Fourier Transform
Pre-requisites by course	BME 321
Co-requisites by course	NA
Pre-requisites for	NA

Objectives	Outcomes
1. Understanding the basics of discrete sequences **(1)**	1.1 Being able to obtain a discrete signal from a continuous time signal 1.2 Being able to sample a continuous time signal 1.3 Being able to perform certain operations on discrete signals
2. Understanding the terms Linearity, Time invariance, Causality, and Stability **(1)**	2.1 Being able to determine whether a system is linear or not 2.2 Being able to determine whether a system is time invariant or not 2.3 Being able to determine whether a system is causal or not 2.4 Being able to determine whether a system is stable or not 2.5 Being able to determine whether a system is memoryless or not
3. Understanding the Fourier Transform theorems **(1)**	3.1 Being able to distinguish between the time and frequency (Fourier) domains 3.2 Being able to move from one domain to another 3.3 Being able to find the frequency spectrum of different signals 3.4 Being able to analyse signals in the frequency domain

4. Understanding the Z-transform and its region of convergence **(1)**	4.1 Being able to distinguish between the time and frequency (Z) domains 4.2 Being able to move from one domain to another 4.3 Being able to evaluate the Z-transform 4.4 Being able to evaluate the region of convergence (ROC)
5. Understanding the sampling theorem and the Nyquist rate **(1)**	5.1 Being able to sample a continuous time signal 5.2 Being able to apply the conditions for sampling a continuous time signal 5.3 Being able to apply the sampling theorem 5.4 Being able to define and apply the Nyquist rate in sampling
6. Understanding the complete (A/D – DSP – D/A) system **(1)**	6.1 Being able to apply A/D conversion 6.2 Being able to deal with the DSP part of the system 6.3 Being able to reconstruct a sampled signal correctly (D/A) 6.4 Being able to apply the conditions and limitations of each part
7. Being able to deal with the complete (A/D – DSP – D/A) system in both time and frequency domains **(1)**	7.1 Being able to deal with A/D part in time and frequency domains 7.2 Being able to deal with DSP part in time and frequency domains 7.3 Being able to deal with D/A part in time and frequency domains 7.4 Being able to deal with the whole system (A/D – DSP – D/A) in time and frequency domains
8. Being able to evaluate the frequency response of Linear Time Invariant systems **(1)**	8.1 Being able to identify a linear time invariant (LTI) system 8.2 Being able to analyse LTI systems 8.3 Being able to check whether a system is LTI or not 8.4 Being able to deal with an LTI system in the frequency domain
9. Understand the frequency selective filters and phase distortion and delay **(1)**	9.1 Being able to identify different filter types 9.2 Being able to identify frequency selective filters 9.3 Being able to distinguish different types of filters 9.4 Being able to define and analyse the "Phase Distortion" 9.5 Being able to eliminate the effect of Phase Distortion
10. Understand the FIR and IIR systems **(1)**	10.1 Being able to deal with infinite impulse response (IIR) systems 10.2 Being able to deal with finite impulse response (FIR) systems 10.3 Being able to determine whether a certain impulse response in finite or not 10.4 Being able to deal with IIR and FIR systems in the time domain 10.5 Being able to deal with IIR and FIR systems in the frequency domain
11. Being able to design different types of digital filters **(2, 6)**	11.1 Being able to design lowpass digital filters 11.2 Being able to design highpass digital filters 11.3 Being able to design bandpass digital filters 11.4 Being able to design bandstop digital filters
12. Being able to design different types of analog filters and perform bilinear transformation to obtain the equivalent digital filter **(2, 6)**	12.1 Understand Bilinear transformation 12.2 Being able to design lowpass analog filters then perform transformation to the discrete domain 12.3 Being able to design highpass analog filters then perform transformation to the discrete domain 12.4 Being able to design bandpass analog filters then perform transformation to the discrete domain 12.5 Being able to design bandstop analog filters then perform transformation to the discrete domain

Topics covered		
Week	**Topics**	**Chapters in textbook**
1	Introduction	Chapter 1
2 – 3	Discrete time signals and systems	Chapter 2
4 – 5	The z-transform	Chapter 3
6 – 8	Sampling of continuous time signals	Chapter 4
9–10	Transform analysis of LTI systems	Chapter 5
11	Structures for discrete time systems	Chapter 6
12 – 13	Digital filter design techniques	Chapter 7
14 – 15	Analog filter design and A/D transformation	Chapter 3 Ludeman

Evaluation		
Assessment tool	**Date**	**Weight**
First exam	According to the university examination schedule	30%
Second exam	According to the university examination schedule	30%
Final exam	According to the university examination schedule	40%

Contribution of Course to Meeting the Professional Component								
Outcomes (%)								
1	2	3	4	5	6	7	8	9
60	25				15			

Relationship to Biomedical Engineering Program Objectives

PEO1	PEO2	PEO3	PEO 4
√		√	√

Prepared by: Dr. Khaldon Lweesy
Last modified: October 14th, 2019