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

BME 321: Biomedical Signals and Systems

Course Catalog
Concepts of linear time invariant systems; discrete and continuous time systems; application of Laplace and Fourier transforms to linear systems; Z-transform; system function; frequency response and simulation in the frequency domain; discrete Fourier series and fast Fourier transform; computer applications.

Text Book(s)	
Title	Signals, Systems, and Transforms
Author(s)	C. L. Philips
Publisher	Prentice Hall
Year	2003
Edition	4th

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. Rabah Al abdi**
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Pre-requisites	
Prerequisites by topic	Introduction to Linear Systems
Prerequisites by course	EE 240
Co-requisites by course	NA
Prerequisite for	NA

Topics Covered		
Week	**Topics**	**Chapters in Text**
1	**Introduction** Modeling, CT and DT physical systems, Matlab	**1.1-1.4**
1-2	**Continuous Time (CT) Signals and Systems** Transformations, Signal Characteristics, Special functions, Functions, CT systems, Properties of CT times.	**2.1 -2.7**
3-4	**CT Linear Time Invariant Systems** Impulse representation of CT Signals, Convolution and its properties, Differential equation models, Natural systems. System response for complex-exponential inputs.	**3.1-3.8**
5-6	**Fourier Series** Periodic functions, Fourier series, Fourier Coefficients, Frequency Spectra, Properties of Fourier Series, System analysis.	**4.1-4.5**
7-8	**The Fourier Transform** Definition, Properties, Fourier Transform of Time Functions, Sampling, Applications, Energy and power spectra.	**5.1-5.6**
9-10	**The Laplace Transform** Definitions, Examples, Properties, Response of LTI Systems and Its characteristics	**7.1-7.7**
11-12	**Discrete – Time Signals and Systems**	**9.1-9.6**
13	**DT linear invariant systems**	**10.1-10.5**
14	**Fourier Transform of DT Signals** Definition and properties	**12.1-12.2**
15-16	**The Z-Transform** Definition and properties	**11.1-1**

Evaluation		
Assessment Tool	**Expected Due Date**	**Weight**
Homework, Quizzes, and semester works	One week after homework problems are assigned	10%
First Exam	According to Dept. schedule	25 %
Second Exam	According to Dept. schedule	25 %
Final Exam	According to the University final examination schedule	40 %

Objectives and Outcomes	
Objectives	**Outcomes**
Understand the linear system theory [1,2,6,7,8,9]	• Properties of Linear systems • Modelling of Signals • Matlab
Understand the basic properties of signals and systems [1,2,6,7,8,9]	• Continuous time systems • Transformation of Signals • Common Signals in Engineering • Properties of CT systems • CT linear time invariant systems
Understand the modeling of signals in different domain [1,2,6,7,8,9]	• Approximation of periodic functions • Periodic Functions • Fourier Series • System Analysis
Understand the frequency domain analysis [1,2,6,7,8,9]	• Fourier Transform • Properties of Fourier Transform • Applications of FT • Laplace Transform and its properties • LTI characteristics
Learn how to discretize medical signals and understand the discrete time systems [1,2,6,7,8,9]	• DT common functions • Discrete Time Signals • Properties of Discrete time systems • DTLTI systems
Apply the above principles is processing biomedical signals [1,2,6,7,8,9]	• Analyze the ECG and EMG signals • Representation of an ECG signal using Fourier series.
Learn How to use Data acquisition to record signals [1,2,6,7,8,9]	• Acquiring ECG and EMG signals from the biopotential amplifier
Learn How to use Matlab to show Bio signals [1,2,3,6,7,8,9]	• Plot ECG signals • Perform FFT of the ECG signal
Numbers in brackets refer to the Program outcomes	

Contribution of Course to Meeting the Professional Component

The course contributes to building the fundamental basic concepts, applications, and design of Biomedical signals and systems.

Relationship to Program Outcomes (%)

1	2	3	4	5	6	7	8	9
15	10	5			20	20	15	15

Relationship to Biomedical Engineering Program Objectives

PEO 1	PEO 2	PEO 3	PEO 4
√		√	√

Teaching & Learning Methods
- Active learning, where students should be active and involved in the learning process inside the classroom, will be emphasized in the delivery of this course. - Different active learning methods/approaches such as: Engaged Learning, Project-Based Learning, Cooperative Learning, Problem-based Learning, Structured Problem-solving, will be used. - The teaching method that will be used in this course will be composed of a series of mini lectures interrupted with frequent discussions and brainstorming exercises. PowerPoint presentations will be prepared for the course materials.

- A typical lecture would start with a short review (~ 5 minutes) using both PowerPoint presentations and the blackboard. This review will also depend on discussions which will gauge the students' digestion of the previous material. Then, the students would have a lecture on new materials using PowerPoint presentations and blackboard. The lecture presentation will be paused every 15 – 20 minutes with brainstorming questions and discussions that will allow the students to reflect and think in more depth about what they learned in that presentation. Then, some example problems will be presented and discussed with the students to illustrate the appropriate problem solving skills that the students should learn. The lecture will be continued for another 15 – 20 minutes, followed by examples and/or a quiz covering the materials taught in the previous two weeks.

Prepared by: Dr. Rabah Al abdi,
Oct. 15, 2019