



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

**BME 321: Analysis of 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.

<b>Text Book(s)</b>	
<b>Title</b>	Signals, Systems, and Transforms
<b>Author(s)</b>	C. L. Philips
<b>Publisher</b>	Prentice Hall
<b>Year</b>	2003
<b>Edition</b>	3rd

<b>References</b>	
<b>Books</b>	<ul style="list-style-type: none"> <li>• Oppenheim, A.V., Willsky, A.S. and Young, I.A, “Signals and Systems,” Prentice-Hall, Inc.(ISBN 0-13-811175-8)</li> <li>• Bruce, E.N., “Biomedical Signal Processing and Signal Modeling,” John Wiley and Sons, Inc., 2000. (ISBN 0-471-34540-7)</li> </ul>
<b>Journals</b>	<ul style="list-style-type: none"> <li>• <a href="#">Annals of Biomedical Engineering</a></li> <li>• <a href="#">Journal of Medical Engineering and Technology</a></li> <li>• <a href="#">Computer Programs and Methods in Medicine</a></li> <li>• <a href="#">Medical Engineering and Physics</a></li> <li>• <a href="#">IEEE EMBS Book Series</a></li> <li>• <a href="#">IEEE Transactions on Biomedical Engineering</a></li> <li>• <a href="#">IEEE Transactions on Information Technology in Biomedicine</a></li> <li>• <a href="#">Physiological Measurement</a></li> </ul>
<b>Internet links</b>	<ul style="list-style-type: none"> <li>• <a href="http://www.bmes.org/">http://www.bmes.org/</a></li> <li>• <a href="http://arjournals.annualreviews.org/loi/bioeng?cookieSet=1">http://arjournals.annualreviews.org/loi/bioeng?cookieSet=1</a></li> <li>• <a href="http://www.aami.org/publications/BIT/index.html">http://www.aami.org/publications/BIT/index.html</a></li> <li>• <a href="http://www.biophysj.org/">http://www.biophysj.org/</a></li> <li>• <a href="http://emb-magazine.bme.uconn.edu/">http://emb-magazine.bme.uconn.edu/</a></li> <li>• <a href="http://emb-magazine.bme.uconn.edu/">http://emb-magazine.bme.uconn.edu/</a></li> <li>• <a href="http://www.iee.org/Publish/Journals/ProfJourn/MBEC/">http://www.iee.org/Publish/Journals/ProfJourn/MBEC/</a></li> <li>• <a href="http://spic.org/app/Publications/index.cfm?fuseaction=journals&amp;type=jbo">http://spic.org/app/Publications/index.cfm?fuseaction=journals&amp;type=jbo</a></li> <li>• <a href="http://www.biomedical-engineering-online.com/start.asp">http://www.biomedical-engineering-online.com/start.asp</a></li> </ul>

<b>Prerequisites</b>	
<b>Prerequisites by topic</b>	Introduction to Linear Systems
<b>Prerequisites by course</b>	EE 240
<b>Co-requisites by course</b>	NA
<b>Prerequisite for</b>	NA

<b>Objectives and Outcomes</b>	
<b>Objectives</b>	<b>Outcomes</b>
<b>Understand the linear system theory (a,e,k)</b>	<ul style="list-style-type: none"> <li>• Properties of Linear systems</li> <li>• Modelling of Signals</li> <li>• Matlab</li> </ul>
<b>Understand the basic properties of signals and systems(a,e,k)</b>	<ul style="list-style-type: none"> <li>• Continuous time systems</li> <li>• Transformation of Signals</li> <li>• Common Signals in Engineering</li> <li>• Properties of CT systems</li> <li>• CT linear time invariant systems</li> </ul>
<b>Understand the modeling of signals in different domain(a,e,k)</b>	<ul style="list-style-type: none"> <li>• Approximation of periodic functions</li> <li>• Periodic Functions</li> <li>• Fourier Series</li> <li>• System Analysis</li> </ul>
<b>Understand the frequency domain analysis(a,e,k)</b>	<ul style="list-style-type: none"> <li>• Fourier Transform</li> <li>• Properties of Fourier Transform</li> <li>• Applications of FT</li> <li>• Laplace Transform and its properties</li> <li>• LTI characteristics</li> </ul>
<b>Learn how to discretize medical signals and understand the discrete time systems(a,e,k)</b>	<ul style="list-style-type: none"> <li>• DT common functions</li> <li>• Discrete Time Signals</li> <li>• Properties of Discrete time systems</li> <li>• DTLTI systems</li> </ul>
<b>Apply the above principles is processing biomedical signals (a,e,k)</b>	<ul style="list-style-type: none"> <li>• Analyze the ECG and EMG signals</li> <li>• Representation of an ECG signal using Fourier series.</li> </ul>
<b>Learn How to use Data acquisition to record signals (a,e,k)</b>	<ul style="list-style-type: none"> <li>• Acquiring ECG and EMG signals from the ECG Instruments</li> </ul>
<b>Learn How to use Matlab to show Bio signals(a,e,k)</b>	<ul style="list-style-type: none"> <li>• Plot ECG signals</li> <li>• Perform FFT of the ECG signal</li> </ul>

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

<b>Policy</b>	
<b>Attendance</b>	Class attendance is required and applied according to the university regulations ( <b>student's guide page 43</b> ). Data support the idea that class attendance improves learning. It is very difficult as well as uninspiring for me to help a student who does not attend lectures. What is created in the classroom cannot be reenacted. Make-up tests will be done according to the university regulations. Please see student's guide pages <u>44-45</u> .
<b>Homework</b>	Working homework problems is an essential part of this course and they represent a key opportunity to learn the subjects discussed. All homework problems assigned during a given week are due at the beginning of class on the second meeting of the following week unless otherwise stated. Late homework will not be accepted. Failure to turn in this particular homework <b>on time</b> will result in a grade of 0 (zero) for the homework contribution to your final grade. Team work is encouraged; however, the work one hands in must represent his/her own effort. Homework solutions will be discussed in class. There will be no handouts of homework solutions.
<b>Student Conduct</b>	All University regulations apply to this course. In particular, the policies concerning academic dishonesty and withdrawal from a course apply.

<b>Contribution of Course to Meeting the Professional Component</b>	
The course contributes to building the fundamental basic concepts in Biomedical Engineering.	

<b>ABET Category Content</b>	
<b>Engineering Science</b>	3.0 Credits
<b>Engineering Design</b>	

<b>Evaluation</b>		
<b>Assessment Tool</b>	<b>Expected Due Date</b>	<b>Weight</b>
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 %

<b>Teaching &amp; Learning Methods</b>
<ul style="list-style-type: none"> <li>- 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.</li> <li>- Different active learning methods/approaches such as: Engaged Learning, Project-Based Learning, Cooperative Learning, Problem-based Learning, Structured Problem-solving, will be used.</li> <li>- 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.</li> <li>- 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.</li> </ul>

Signals, systems, and transforms / Charles L. Phillips, John M. Parr, Eve A. Riskin. 4th ed. p. cm. Includes bibliographical references and index. 2.1 Transformations of Continuous-Time Signals 24 Time Transformations, 24 Amplitude Transformations, 30. 2.2 Signal Characteristics 32 Even and Odd Signals, 32 Periodic Signals, 34.