Fall 2018 Syllabus

Fairfield University School of Engineering

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| Course Number: CR331-BEN331 | Course Name: BioEngineering DSP |
| Course Time: Mon/Thur 12:30 - 1:45 PM | Course Location: **Bannow 333** |
| Schedule: 9/05/18-12/11/18 | Final Exam: **Project** |
| Instructor: Jeffrey Denenberg | Office: **BNW 301C** |
| Office Phone: 203-254-4000x3330 | Hours: **M/R 11:00 AM-Noon,  W/R 5:00 - 6:00 PM or by appt.** |
| Email1: [jeffrey.denenberg@ieee.org](mailto:jeffrey.denenberg@ieee.org) | Goggle Voice: **203-513-9427** |
| Email2: [jdenenberg@fairfield.edu](mailto:jdenenberg@fairfield.edu) | **WWW:** [**http://doctord.webhop.net**](http://doctord.webhop.net) |

## Course Description:

This course presents an overview of different methods used in biomedical signal processing. Signals

with bioelectric origin are given special attention and their properties and clinical significance are

reviewed. In many cases, the methods used for processing and analyzing biomedical signals are

derived from a modeling perspective based on statistical signal descriptions. The purpose of the

signal processing methods ranges from reduction of noise and artifacts to extraction of clinically

significant features. The course gives each participant the opportunity to study the performance of a

method on real, biomedical signals.

**Prerequisites:** CS131 or CS141 or SW408, and MA126 or MA122, or permission of the instructor

## Textbook:

Smith, Steven W., [The Scientist and Engineer’s Guide to Digital Signal Processing](http://www.dspguide.com), California Technical Publishing, 1997, ISBN: 0-9660176-3-3 - [Homework Problems](../../Textbooks/Smith_DSP/homework.pdf)

## References:

Java for programmers, by D. Lyon, Java Digital Signal Processing by Lyon and Rao

[Earlier Course at DocJava.com](http://www.docjava.com/courses/ece431/)

[Digital Signal Processing](https://www.amazon.com/Digital-Signal-Processing-John-Proakis/dp/0131873741), John G. Proakis, Dimitris K Manolakis, 4th Edition, Pearson, 2006, ISBN: 978-0131873742

[Schaum’s Outline of Digital](http://www.amazon.com/Schaums-Outline-Feedback-Control-Systems/dp/0070170525) Signal Processing, Monson H. Hayes, McGraw-Hill 2012,   
ISBN: 976-0-07-163509-7

[DSP Video Lectures](https://www.ecse.rpi.edu/~rjradke/dspcourse.html), Rich Radke, Rensselaer Polytehnic Institute

## Required Software:

1. MatLab / Simulink (download directly from [mathworks](http://www.mathworks.com/) following instructions posted on Blackboard).
2. Java JDE and an IDE (e.g. Eclipse)
3. Recommended general computer requirements – PC running Windows 10 or later, Adobe reader, high-speed internet access, Internet Explorer or Firefox browser. You may encounter difficulties with the lectures, simulation software, or internet testing software if you use Mac OS or Linux. Please check all software compatibilities for your system promptly.

## MatLab Tutorials: Mathworks [Tutorial](http://www.mathworks.com/academia/student_center/tutorials/launchpad.html), Prof. Aliane [Tutorial](../../Topics/Matlab/Index.htm)

## Signals and Systems References:

## U. of Washington Interactive Notes (Phillips and Parr), [EE235](http://www.ee.washington.edu/class/235dl/) (analog) and [EE341](http://www.ee.washington.edu/class/341/riskin/) (Discrete).

[**Recorded Lectures**](Recorded%20Lectures)

## Objectives and Outcomes:

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| --- | --- | --- |
| **No.** | **Objective** | **Outcomes** |
| 1 | The students will learn the principles of biomedical signal modeling. The student will become proficient with the tools needed for simulating the models. | Students will understand the fundamental concepts and principles of Digital Signal Processing.  (1, Comprehension) |
| 2 | Students will use the Matlab and/or Java to analyze and synthesize biomedical signals.  (2, Application) |
| 3 | The Students will learn how to analyze the biomedical signals | Students analyze biomedical signals. (2, Analysis) |
| 4 | Students synthesize biomedical signals (2, Synthesis) |
| 5 | Students will learn about various biomedical devices and how they work. | Students will research and report (Oral and written) on a class of biomedical instruments.  (3, b, c, Analysis, Synthesis) |
| 6 | Students will demonstrate the use and application of MatLab/Java software in the above application.  (2, Application) |

\*Objectives, [**ABET Criteria**](file:///D:\htdocs\Courses\ABET-Criteria.pdf) outcomes (1, 2, 3), and Bloom [**Cognitive Level**](http://en.wikipedia.org/wiki/Bloom's_taxonomy)in parenthesis

**Grade allocation:**

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| --- | --- |
| Mid terms | 40% |
| Project | 40% |
| Homework | 20% |
| Total | 100% |

## [Grade Histogram](Grade%20Histogram)

## Exam:

The purpose of the exams is to convey your understanding of the material; therefore, it is important that you show your work. Even if you feel that the solution to a problem is obvious; you must still explain why it is obvious. Furthermore; if you are asked to solve a problem using a given technique; then please use that technique; otherwise, I have no way to judge your understanding of the technique being tested.

## Homework policy:

Homework will be assigned from the book as your primary preparation for the exams. We will review select homework problems in class and you will be asked to work them on the board for a participation grade. Homework must be completed on time or it will not help with the exams. We will also incorporate design problems as appropriate to the material. These problems are designed to challenge you to think beyond what the book has told you, and do real engineering. There may be more than one correct answer.

**If you understand how to do the homework problems you will have an easier time with the exams.**

## Academic Integrity:

Working with classmates to study, resolve problems, and learn the material is expected and encouraged during normal course work. However, during individual evaluations (e.g. quizzes, exams, individual projects, etc.) you are expected to comply with all standards of academic honesty. You will be graded fairly, and so your work should fairly represent your knowledge, abilities, and effort, not that of others. Any breach of integrity (including but not limited to: copying solutions, internet solutions, copying from peers, claiming work or designs without proper citation, etc.), will not only impact your ability to learn the material and my ability to help you through proper feedback, it will result in academic penalty. Any individual found in breach of this code will fail the afflicted assignment and will be asked to meet privately; any other offenses will be referred to the Dean for further action, and could result in penalties as severe as expulsion from the University.

## Disability:

If you have a documented disability and wish to discuss academic accommodations, please contact: Academic and Disability Support Services (203) 254-4000, x2615 and notify the course instructor within the first two weeks of the semester.

## Class Expectations:

TEACHER:

Distribute syllabus.

Review the material described in the syllabus.

Explain material.

Identify additional materials, Internet sites or books that clarify the material.

Relate material to "real world" situations when possible.

Answer questions.

Be available to discuss problems.  
Be receptive to new ideas.

Announce business/class conflicts in advance.

Make up missed classes.

Prepare and administer exams and projects.

Grade fairly.

Assign appropriate homework problems.

STUDENT:

Be familiar with the prerequisite material

Ask questions.

Stay current.

Study the material described in the syllabus, preferably before it is covered in class.

Complete the assigned homework (all chapter problems with answers).

Obtain class notes and homework if a class is missed.

Use the library and the Internet to obtain supplemental material.

Prepare for exams.

Ask for help (tutors are available for assistance)

Follow standards of academic integrity.

**Class Topics and Order of Material**

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| --- | --- | --- | --- | --- | --- | --- |
| **Wk** | **Date** | **Topic** | **Text Materials** | **Homework** | **Lecture Notes** | **Outcome** |
| 1 | 9/06 | Course Introduction: Why Digital? Projects! | [Ch1](../../Textbooks/Smith_DSP/dsp_book_Ch1.pdf) | Review programming,  Get ahead in reading | [Why Digital?-Mitra](../../Textbooks/Mitra_2e/Ch01/Ch1(1).pdf) [Ibrahimy](Ibrahimy.pdf) Biomedical Signal Processing |  |
| 2 | 9/10  9/13 | Matlab |  |  | [Matlab Tutorial](../../Topics/Matlab/Index.htm) by Dr Aliane |  |
| 3 | 9/17  9/20 | Fourier Series/Transform,  Impulse Response, Convolution | [Ch13](../../Textbooks/Smith_DSP/dsp_book_Ch13.pdf), [Ch33](../../Textbooks/Smith_DSP/dsp_book_Ch33.pdf)  [Ch5](../../Textbooks/Smith_DSP/dsp_book_Ch5.pdf), | [Ch13](homework.pdf): 1 - 3, 5, 6  [Ch5](homework.pdf): 1 – 4; | [DoctorD-Linear Systems](../../Tutorials/Linear_Systems.pdf)  [FourierSeries](../../Tutorials/Generalized_Fourier_Series.pdf), [FourierTransform](../../Tutorials/Fourier_Transform.pdf) |  |
| 4 | 9/24  9/27 | Sampling: The analog world in a computer Discrete Fourier Transform and FFT | [Ch3](../../Textbooks/Smith_DSP/dsp_book_Ch3.pdf), [Ch8](../../Textbooks/Smith_DSP/dsp_book_Ch8.pdf), [Ch9](../../Textbooks/Smith_DSP/dsp_book_Ch9.pdf),  [Ch10](../../Textbooks/Smith_DSP/dsp_book_Ch10.pdf), [Ch11](../../Textbooks/Smith_DSP/dsp_book_Ch11.pdf), [Ch12](../../Textbooks/Smith_DSP/dsp_book_Ch12.pdf) | [Ch3](homework.pdf): 1, 3, 4, 7, 8; [Ch8](homework.pdf): 1-3,6; [Ch9](homework.pdf): 2,5;  [Ch10](homework.pdf): 1, 4, 5, 6; [Ch11](homework.pdf): 1, 3, 4; [Ch12](homework.pdf): 1-4 | [Sampling](../../Tutorials/Sampling.pdf), [DFT1.ppt](2-dft1.ppt), [DFT2.ppt](3-dft2.ppt)  [Discrete-Fourier-Transform](../ECE411/Discrete-Fourier-Transform.ppt) |  |
| 5 | 10/01  10/04 | Laplace Transform, z-Transform  Review for Exam 1 | [Ch32](../../Textbooks/Smith_DSP/dsp_book_Ch32.pdf), [Ch33](../../Textbooks/Smith_DSP/dsp_book_Ch33.pdf) |  | [Laplace-1](https://class.ece.uw.edu/235dl/EE235/Project/lesson21/lesson21.html), [Laplace-2](https://class.ece.uw.edu/235dl/EE235/Project/lesson22/lesson22.html), [Laplace-3](https://class.ece.uw.edu/235dl/EE235/Project/lesson23/lesson23.html), [z-transform](../../Tutorials/Ztransform.htm) |  |
| **6** | **10/08**  **10/11** | **Columbus Day – No Classes**  **Exam 1 – DSP Basics (Thru 9/27)** |  |  |  |  |
| 7 | 10/15  10/18 | Exam 1 Reprise, Introduce Project Topics Discrete Number systems | [Ch4](../../Textbooks/Smith_DSP/dsp_book_Ch4.pdf) | [Ch4](homework.pdf): 1, 3, 5, 7, 8 | [Project Topics](BioSignalProcessingTeamProjects.pdf),  [Fixed-Point](Fixed-Point-Numbers.ppt), [Floating Point](floating-point-numbers.pptx) |  |
| 8 | 10/22  10/25 | Discrete Convolution, Correlation  Random Signals and Noise | [Ch6](../../Textbooks/Smith_DSP/dsp_book_Ch6.pdf), [Ch7](../../Textbooks/Smith_DSP/dsp_book_Ch7.pdf)  [Ch2](../../Textbooks/Smith_DSP/dsp_book_Ch2.pdf) | [Ch6](homework.pdf): 1 - 3, 5, 6; [Ch7](file:///D:\htdocs\Courses\Textbooks\Smith_DSP\homework.pdf): 1 - 3, 5, 6 | [FIR.ppt](7-FIR.ppt), [Discrete-Convolution](Discrete-Convolution.pptx)  [Noise Intro](Noise.ppt) |  |
| 9 | 10/29  11/01 | Electrocardiograms  Noise Reduction techniques |  |  |  |  |
| 10 | 11/05  11/08 | Ultrasound imaging  Tomography |  |  | [UltraSound-1](file:///D:\htdocs\Courses\BEI\CR331-BEN331\2-dft1.ppt), [Ultrasound-2](FRCR-Lecture-2.pptx) [ComputedTomography](Computed_Tomography.pptx) |  |
| 11 | 11/12  11/15 | Project discussion |  |  |  |  |
| 12 | 11/19  **11/22** | Review for Exam 2  **Thanksgiving – No Classes** |  |  |  |  |
| **13** | **11/26**  **11/29** | **Exam 2 (10/1-11/08)**  Exam 2 Reprise |  |  |  |  |
| 14 | 12/03  12/06 | Project Presentations |  |  |  |  |
| 15 | 12/10  TBD | Project Presentations | Exam Week  (12/13 – 12/19) | Last day to submit materials |  |  |