

# BME 698

## Biomedical Signal and Imaging Processing

3 Credits, 3 Contact Hours  
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### Course Description:

This will be a graduate course in biomedical signal and image processing. This course will provide a general understanding of biomedical and signal image processing algorithms and their implementation. This course will provide sufficient information to allow intelligent application of the concepts, including a description of the underlying mathematical principals when needed. Throughout this textbook, signal and image processing concepts are implemented using the MATLAB® software package. A project using real biomedical data will be provided to test the various concepts covered in the class.

### Textbook:

Biosignal and Medical Image Processing, Third Edition  
by John L. Semmlow (Author), Benjamin Griffel  
Publisher: CRC Press; 3 edition (February 25, 2014)

### Prerequisite:

Familiarity with Signal and Systems, and MATLAB software.

Week	Topics	Problems	Reading
Week 1	Measurement Transducers Noise sources, Filter basics	1-1, 1-2, 1-3, 1-4	Chapt 1 pp 1-17

	ADC Basics, Time sampling basics Noise characteristics, Ensemble avg. Covariance and correlation	1-6 1-7, 1-8, 1-9 2-1, 2-2, 2-3 2-8	Chapt 1 pp 15-27 Chapt 2 pp 1-13 Chapt 2 pp 15-19
Week 2	Convolution, Matlab implementation Sampling theory, Edge effects Continuous FFT, Digital FFT, Window	2-4, 2-5, 2-7, 3-1, 3-2, 3-3, 3-6	Chapt 2 pp 13-15; 19-24 Chapt 2 pp 14-19 Chapt 3 pp 1-14
Week 3	Power Spectrum Welch's method MATLAB Implementation	3-7, 3-8, 3-9	Chapt 3 pp 14-23
Week 4	Digital filter FIR filters classic method Differentiation	4-2, 4-3, 4-4	Z- Transform, Digital Transfer Function 4-1 Chapt 4 pp 7-19
Week 5	IIR Filter design and application Model-based spectral analysis, AR	4-6, 4-8, 4-10 5-1, 5-2, 5-3	Chapt 4 pp 19-36 Chapt 5 pp 1-11
Week 6	Midterm. Proposals due		
Week 7	Eigenanalysis spectral analysis	5-4, 5-5, 5-6	Chapt 5 pp 11-17 Time-frequency methods: Spectrogram 6-1
Week 8	Wigner-Ville and other methods Exam	6-2, 6-3, 6-4, 6-5	Chapt 6 pp 6-9; 15-27
Week 8	Continuous Wavelet Transform Discrete Wavelet Transform	7-1, 7-2, 7-4 7-5, 7-6, 7-7	Chapt 7 pp 1-10 Chapt 7 pp 10-33
Week 9	Optimal filters, Weiner Filters Adaptive filters, Phase Sensitive Detection	8-1, 8-2, 8-3 8-4, 8-5, 8-6	Chapt 8 pp 1-10 Chapt 8 pp 10-27
Week 10	Principal Component Analysis Independent Component Analysis	9-1 9-2	Chapt 9 1-17 Chapt 9 17-27
Week 11	Fundamental Image Processing Advanced Protocols	10-1, 10-2, 10-3 10-4, 10-5, 10-6	Chapt 10 1-24 Chapt 10 24-32
Week 12	Two-D Spectral Analysis and Filtering Spatial Transformation and Registration	11-2, 11-3, 11-4 11-6, 11-7, 11-8	Chapt 11 1-16 Chapt 11 24-36
Week 13	Image Segmentation I (Pixel and Texture) Image Segmentation II (Morphological)	12-1, 12-2, 12-3 12-4, 12-5	Chapt 12 1-20 Chapt 12 20-31
Week 14	Image Reconstruction: Radon Transform MRI, fMRI	13-1, 13-2, 13-3 13-5, 13-6, 13-7	Chapt 13 1-16 Chapt 13 16-33
Week 14.	Project Discussion		
Week 15	Final Project and Final Examination		

## Learning objectives:

At the end of the course the student should be able to:

1. Demonstrate knowledge about different biomedical signal and image processing algorithms.
2. Implement the various algorithms in MATLAB.
3. Demonstrate a strong understanding of the algorithms and processing underlying different modalities.
4. Demonstrate an appreciation for the strengths and weaknesses of various imaging modalities and what kind of anatomical and physiological information can be obtained from them.

**Grading:**

Participation	-	5%
Homework	-	15%
Quizzes	-	20%
Projects	-	20%
Midterm	-	20%
Final Exam	-	20%