revised September 12, 2013

Syllabus

Course Name & Number: Biomedical Signal Processing CR331/ECE431

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. Three credits

Prerequisite – CS131 or CS141 or SW408, and MA126 or MA122, or permission of the instructor.

Computer Usage: Students MUST have access to a computer. E-mail access is required.

Course Notes: Handouts/diskettes/e-mail, web page

Where: Mc 203

Who: Prof. Lyon

Voice Phone: (203)641-6293

Fax: 801-665-6008

Web: http://www.DocJava.com

Email:lyon@docjava.com

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

Office Hours

Monday .... 1:00-2:00 pm **Mca113**
Tuesday .... 1:00-2:00 pm **Mca102**
Wednesday .... 1:00-2:00 pm **Mca113**

Or by appointment.

Course Offerings

CR331/ECE431 .... Mca113 Mon. 2-4:30
CR245 Dig. Des. I. .... Mca113 Wednesday 2-4:30
EG31 C02. .... Mca102 Tu/F 2-3:15
EG31 C03. .... Mca102 M/R 11-12:15

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COURSE LEARNING GOALS:

G1. The students will learn the principles of biomedical signal modeling.
G2. The student will become proficient with the tools needed for simulating the models.
G3. The Students will learn how to analyze the biomedical signals
G4. Students will learn about various biomedical devices.
OC1 Students synthesize biomedical signals
OC2 Students analyze biomedical signals
OC3 Students use a simple biomedical device

Performance Indicators:
Course Requirements:
All homework is to be submitted on time.
The course includes three reporting periods (exam, quiz, project, etc.) and a comprehensive final.

Week 1: Introduction
Confirmation Bias, Linear, stationary, normal - the stuff biology is not made of.

Week 1-4: Linear systems
Impulse response
Discrete Fourier transform and z-transform
Convolution
Sampling

Week 5-8: Random variables and stochastic processes
Random variables
Moments and Cumulants
Multivariate distributions
Statistical independence and stochastic processes

Week 9-14: Examples of biomedical signal processing
Maximum likelihood (ML) and maximum *a-posteriori* (MAP) estimation will be presented as it represents the basis for most of the methods to be developed. Binary linear classification will be explained on the task of predicting motor action from MEG signals. Issues concerning statistical performance and over-training will be highlighted. Harmonic analysis will be derived from ML and demonstrated on ECG hart rate estimation. Estimation of the auto-regressive parameters will be derived from ML. The relationship to linear prediction will be highlighted. The relevance for spectral estimation and an application to spectrum identification in EEG will be presented. Matched filter for detection and Wiener filtering for noise reduction will be presented and demonstrated on Ultrasound data. Finally an overview of linear decomposition methods such as Wavelets, principal components and independent components will be given. The focus will be placed on independent component analysis (ICA) and its application to the analysis of MEG signals.
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Note
The material covered will depend on the amount the students can assimilate in each class.