Department of Biomedical Engineering

Course Number: BME680

Biomedical Signal Processing

CHH (South Waterfront) 13th floor conference room

FALL, 2016

COURSE DESCRIPTION/OBJECTIVES

This course will teach students the core principals of digital signal processing within a biomedical engineering applications framework. We will survey a variety of topics in class lecture/discussion based on assigned readings while exploring one or two specific topics/applications in depth through lab assignments and a final project. Specifically, we will cover the core topic areas in digital signal processing including an overview of discrete-time signals and systems, the discrete-time Fourier transform, the z-Transform, the discrete Fourier Series, the discrete Fourier transform, circular convolution, network structures for FIR systems, design of IIR and FIR filtersWe will also provide an introductory lecture on wavelets and time-series representations of data including the Kalman filter and the extended Kalman filter. This class is intended to be highly interactive and students are expected to participate in class discussions and lead some of the discussions.

Grading will be based on four criteria (see below for specific grade breakouts): 1) Class participation (participating in class discussions), 2) Labs/mini projects (3-4 small projects/labs which include performing a defined set of tasks and writing the results in a 1-2 page report), and 3) a final project (a larger project that will culminate in a 4 page report written in IEEE EMBS Conference format, which can be found at: http://embc2012.embs.org/program/paper-submissions/full-papers and in in-class demonstration/presentation of the project) and 4) a final exam.

The lab experiments will enable the students to take measurements from their own bodies using the BSL Biomedical Engineering System (BioPac Systems Inc.). Laboratories will be conducted within the OHSU Point-of-Care Laboratory, which is a simulated home environment that includes many sensors for passive monitoring of human activities. One of the laboratories will explore the use of convolution by using a head-related transfer function to position sounds within a 3-dimensional environment in space. Additional laboratories will include design and implementation of FIR and IIR filters to process signals from ECG and speech. The final project will have the student select a problem that can be solved with signal processing using the sensors explored during the term. Students will then design, implement, and validate a solution to the proposed problem. Alternative projects that fall within the area of biomedical signal processing but which do not use the sensors explored during the laboratories may also be done with instructor approval, and some example project topics will be provided. As stated above, the final project deliverables are a 4 page paper in the style of an IEEE EMBS conference paper, and in an in class presentation/demonstration (a 10-15 talk with slides and a short demonstration of the application if possible, or video or other method demonstrating to the class what was done).

CREDIT HOURS

3

PREREQUISITES OR CONCURRENT ENROLLMENT REQUIREMENTS

Senior or Graduate standing in an engineering or applied science degree program is required and some programming and statistical experience is helpful for the labs and term project. Advanced calculus and familiarity with introductory complex variable theory. Previous exposure to linear system theory for continuous-time signals, including Laplace and Fourier transforms, is required. No experience with discrete-time signals, z-transforms, or discrete Fourier transforms is assumed.

FACULTY INFORMATION

Peter Jacobs, PhD Email: jacobsp@ohsu.edu Office: (503) 494-3870 Cell: (503) 358-2291 Building & Office Number: 13039 Office hours: By Appointment	**Mahesh Shastry, PhD** Email: shastry@ohsu.edu Cell: (814)308-2757 Building & Office Number: CHH13B Office hours: By Appointment

GENERAL COURSE MEETING DAY AND TIME

TBD

REQUIRED TEXTS AND READINGS

Digital Signal Processing: Principals, Algorithms, and Applications, 4th edition John G. Proakis, Dimitris G. Manolakis ISBN: 0-13-187374-1. Pearson Prentice Hall, 2007. Additional readings may be taken from the literature and will be made available electronically or in the library for students.

GRADING CRITERIA, ACADEMIC STANDARDS, & RELEASE OF FINAL GRADES

Final course grades will be posted with the OHSU Registrar the Monday following the last day of the term.

COURSE SPECIFIC GRADING STANDARDS

Final Project: 30%
Final exam: 30%
Class participation: 10%
Labs/Assignments: 30%

COURSE SPECIFIC INCLEMENT WEATHER PROCEDURES

Inclement weather procedures can be found for each OHSU. In the case of inclement weather, the faculty member will place a voice-mail greeting on her/his office telephone number by 6:00am on the day of the clinical or class to give instructions to students about the class schedule.

COPYRIGHT INFORMATION

Every reasonable effort has been made to protect the copyright requirements of materials used in this course. Class participants are warned not to copy, audio, or videotape in violation of copyright laws. Journal articles will be kept on reserve at the library or online for student access. Copyright law does allow for making one personal copy of each article from the original article. This limit also applies to electronic sources.

SYLLABUS CHANGES AND RETENTION

This syllabus is not to be considered a contract between the student and the School of Medicine. It is recognized that changes may be made as the need arises. Students are responsible for keeping a copy of the course syllabus for their records.

ACCOMMODATIONS

OHSU is committed to providing equal access to qualified students with disabilities. Student Access determines and facilitates reasonable accommodations, including academic adjustments and auxiliary aids, for students with documented disabilities. A qualified student with a disability is a person who meets the academic and technical standards requisite to admission or participation in a particular program of study. As defined by the Americans with Disability Act (ADA), a person with a disability has a physical or mental impairment that substantially limits one or more major life activities of the individual. This may include, but is not limited to, physical conditions, chronic health issues, sensory impairments, mental health conditions, learning disabilities and ADHD. Student Access works with students with disabilities from all of OHSU's educational programs and at each campus.

Each school has an assigned Program Accommodation Liaison (PAL), who acts as an "in-house" resource for students and faculty concerning access issues for students with disabilities. The PAL works in collaboration with Student Access to implement recommended accommodations for students with disabilities.

It is recommended that you contact Student Access to consult about possible accommodations if you a) received disability accommodations in the past, b) begin experiencing academic difficulties, and/or c) are given a new diagnosis from your healthcare provider.

Learn more about Student Access:
Office: Mackenzie Hall, Room 1180
Phone: 503 494-0082
Email: studentaccess@ohsu.edu
Website: www.ohsu.edu/student-access

General Content Outline:	
Week 1	Introduction, types of biomedical signals • ECG • Speech

	• Gait Discrete-Time Signals and Systems 1 Reading: Chapter 1, 2 Lab 1: Measuring biologic signals
Week 2	Discrete-Time Signals and Systems 2 + convolution The z-transform Reading: Chapters 2, 3
Week 3	The z-transform Frequency analysis of systems Lab 2 – Convolution of sounds using head-related transfer function Chapter 3, 4
Week 4	Frequency analysis of systems Frequency-domain analysis of LTI Systems Reading: Chapter 3, 4
Week 5	Frequency Analysis of LTI Systems Sampling and reconstruction of signals Reading: Chapters 5, 6 Lab 3 – Designing filters to process biologic signals
Week 6	Sampling and reconstruction of signals 2 The discrete Fourier Transform: its properties and applications Reading: Chapter 6, 7
Week 7	Decision theory – detection (single criterion), machine learning (multi-criterion decisions) Lab 4 – Modulation filtering of speech signals Selection of final projects
Week 8	Signal and data representations (STFT, wavelets, filter banks)
Week 9	Kalman filters and other time-series methods
Week 10	Final project presentations and demonstration Final paper due, final exam