1. ECE 431: Biomedical Signal and Image Processing

2. 3 credits: 2-75 minute lecture sessions/week

3. Jesse Wilson

4. Biosignal and Medical Image Processing. Semmlow, J. & Griffel, B. 2014.

5. Course Information
    a. Principles, features and mathematical processing of biomedical signals and images including interference and noise filtering and feature enhancement
    b. Prerequisites: PH142 with a C or higher; ECE311 with a C or higher; ECE303 with a C or higher or STAT303 with a C or higher
    c. Selected Elective: Computer Engineering; Electrical Engineering

6. Goals for the Course
    a. Course Learning Objectives
        i. Define common biomedical signal and image terms including the acronyms ECG, EEG, EMG, MRI, PET and CT
        ii. Identify the physiological source of common biomedical signals and images
        iii. Recognize and describe unique primary features of common biomedical signals and images
        iv. Discuss typical sources of interference and noise and their impact on biomedical signals and images
        v. Mathematically transform and filter biomedical signals and images to reduce the impact of interference and noise
        vi. Quantitatively assess the quality of biomedical signals and images before and after processing
        vii. Employ computer aided engineering software, such as MATLAB, to beneficially process biomedical signals and images
        viii. Select appropriate signal and image processing methods to apply to example biomedical applications
    b. Student Outcomes
        1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
        2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and welfare, as well as global, cultural, social, environmental, and economic factors
        3. An ability to communicate effectively with a range of audiences
        4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability acquire and apply new knowledge as needed, using appropriate learning strategies

7. Topics Covered

Signal processing toolkit: measurements, noise, spectral analysis, filtering
Electrophysiology and intro to electrocardiogram (ECG)
ECG noise and filtering, cardiac vector, complexity analysis and wavelets
Abnormal ECG and intro to classification
Advanced classification methods and blind source separation
Electroencephalography
Image processing toolkit: filtering, registration, 2D wavelet and feature extraction
Computed tomography: physics and image reconstruction methods
Magnetic resonance imaging (MRI): pulse sequences, image acquisition, image reconstruction, and advanced contrast mechanisms
Acoustic and optical ranging (ultrasound and optical coherence tomography), phased array backpropagation and image reconstruction
Positron emission tomography (PET): physics, detectors, imaging agents and applications,
coregistration with MRI/CT data
Optical Microscopy: pathology, stains and dyes, cell count/size algorithms, cancer screening, and image stack deconvolution
Feature-preserving noise removal (nonlocal means and adaptive filtering); image segmentation methods