580.436/636 APPLIED BIOELECTRICAL ENGINEERING II March 18, 2019
The Johns Hopkins University

Introduction to the course

The format of this half-semester course is less structured than the first half-semester course and involves laboratory work. The goal of the course is for you to master basic elements of measuring biopotentials and optionally, performing electrical stimulation. You will undertake several semi-supervised laboratory exercises, culminating in a project exercise.

The course will be team-based, so you will work in groups of three. A single grade will be assigned per team, with slight adjustments depending on peer review. You will need to self-organize into teams during the first class. Classes will take place during the same time slot as for the first half semester (3-4:15pm). Classroom discussion will be in Croft G02, while laboratory work will be in the BME Design Studio. The location of the first class will be announced on Blackboard. The general outline of the course is as follows.

Laboratory 1. Electrical measurements of a dipole in a volume conductor.

Here, you will fabricate an electrical current dipole source consisting of a bipolar electrode connected to a signal generator. You will be given an assortment of metal wires, heat shrink tubing, micromanipulators, electrical circuit components, and an equipment cart containing a signal generator and oscilloscope. You will learn how to make a voltage-controlled current source and to wire up an instrumentation amplifier to measure field potentials. You will place the dipole source in a volume conductor and measure the field potentials at various locations.

Laboratory 2. Electrical measurement of bioelectrical field potentials arising from a beating heart.

Here, you will replace the electrical current dipole source with a beating frog heart immersed in physiological solution and measure the bioelectrical potentials at various locations around the heart.

Laboratory 3. (Optional) Electrical pacing of the heart.

Here, you will connect a pacing electrode to the frog heart and stimulate the heart at different pacing rates. You will explore the strength-duration relation for electrodes having different configurations, and determine the minimum and maximum capture rates. You can add chronotropic agents to test the physiological response of the heart.

Project Laboratory

The assigned project for this year is to <u>design and fabricate a cardiac beat rate monitor.</u> You will need to design a chamber for a frog heart and associated hardware that will measure and output the beat rate of the heart. You free to use any one of a number of methods to measure the beat rate signal (e.g., direct ECG recording, impedance change, optical sensor, other).

You will need to think about this design problem in parallel with the laboratories. We will use class time to work through various issues so that you can refine the approach you will adopt for the project. Bring your laptop to class so that we can investigate ideas in real time. The final day of class (May 2) will be dedicated to project presentations by each of the teams.