Syllabus for BIEN 130: Bioinstrumentation

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Spring 2017

Class Schedule

Lecture: 12:40 – 2:00 TR SPIETH 2200
Discussion: 1:10 – 2:00 M MSE 003
12:10 – 1:00 F MSE 003

Course description

Introduces basic components of instruments for biological applications. Explores sources of signals and physical principles governing the design and operation of instrumentation systems used in medicine and physiological research. Topics include data acquisition and characterization; signal-to-noise concepts and safety analysis; and interaction of instrument and environment. 4 units total: 3 units lecture, 1 unit discussion.

Textbooks

None required, but a reader will be provided on iLearn containing selections from Bioinstrumentation by John G. Webster, The Art of Electronics by Paul Horowitz and Winfield Hill, and other resources.

Course outline

Introduction to bioinstrumentation. Case study of the Coulter counter. Importance of bioinstruments.

**AC circuits.** Characteristics of AC signals. Capacitors. Case study of the defibrillator and AEDs. Timescales for charging and discharging a capacitor. Building an electronic filter. Low-pass, high-pass, and band-pass filters. Bode plots. Case study of removing 60 or 120 Hz noise due to electrical lines.


**Data acquisition.** Analog world vs. digital world. Analog inputs and outputs. Analog-to-digital conversion (ADC). ADC resolution. The Nyquist sampling theorem. Case study of recording an electrocardiogram (EKG or ECG) on a computer. Counters for frequency measurement.

**Introduction to sensors.** Sensor response and dynamic range. Single vs. multi-channel sensors.


**Flow sensors.** Thermal mass flow meters. Ultrasonic flow meters.

**Force, mass, and pressure sensors.** Strain gauges. Piezoelectric sensors.


**Electrochemical detection.** Electrochemical cells and batteries. Standard electrodes. Three-electrode cell. Case study of blood glucose meter.


**Grading**

- 40% Homework
- 20% Midterm exam
- 20% Presentation
- 20% Final exam
A+ $\geq$ 97.00
97.00 $>$ A $\geq$ 92.00
92.00 $>$ A– $\geq$ 90.00
90.00 $>$ B+ $\geq$ 87.00
87.00 $>$ B $\nless$ 82.00
82.00 $>$ B– $\geq$ 80.00
80.00 $>$ C+ $\geq$ 77.00
77.00 $>$ C $\nless$ 72.00
72.00 $>$ C– $\geq$ 70.00
70.00 $>$ D+ $\geq$ 67.00
67.00 $>$ D $\nless$ 62.00
62.00 $>$ D– $\geq$ 60.00
60.00 $>$ F

**Homework**

- Assigned via iLearn, due one week later by 5pm.
- Solutions posted on iLearn after grading is finished.

**Presentations**

- Abstracts due in Week 5.
- Presentations to the class in Week 10.
- Critical, in-depth analysis of a commercial bioinstrument, including:
  1. How the instrument works (in terms of the material learned in class)
  2. Assessment of the commercial success/potential of the instrument (how much does it cost, how large is the market for the instrument)
  3. How would you improve it to make it less expensive/more useful/etc.
- Teams of 1, 2, or 3 people.
- Visuals in PowerPoint, Keynote, PDF, Google Docs, or on the chalkboard. No Prezi or similar tools please.