ECE4781 Course Syllabus

ECE4781

Biomedical Instrumentation (3-0-0-3)

CMPE Degree

This course is Elective for the CMPE degree.

EE Degree

This course is Elective for the EE degree.

Lab Hours

0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator

Inan,Omer T

Prerequisites

ECE 3030 [min C] or ECE 3040 [min C] or ECE 3710 [min C] or ECE3043 [min C]

Corequisites

None

Catalog Description

A study of physiological sensing topics from a systems viewpoint. Pertinent physiological and electro-physiological concepts will be covered. Crosslisted with CHE and ME 4781

Textbook(s)

Webster, *Medical Instrumentation: Application and Design* (4th edition), John Wiley, 2009. ISBN 0471676004, ISBN 9780471676003 (required)

Course Outcomes

Upon successful completion of this course, students should be able to:

1. Analyze op amp based circuits and systems for biomedical sensing
2. Describe challenges in real-world biomedical sensing problems such as motion artifacts, skin-electrode interface, and low signal to noise ratio
3. Develop strategies for mitigating these real-world challenges including through the design of multi-modal sensing systems and high performance circuit design
4. Design biomedical sensing systems based on discrete analog and embedded systems hardware
5. Communicate the design of biomedical sensing systems to a diverse audience of engineers and / or clinicians via written and oral presentation

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this

outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (P) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (P) An ability to communicate effectively with a range of audiences
4. (LN) 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. (M) 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. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

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(5 hours) Basic Concepts of Instrumentation
            Static and dynamic characteristics
            Design criteria
            Instrumentation Amplifiers

(5 hours) Membrane Biophysics
            Diffusion across cell membranes
            Nernst potentials
            Diffusion potentials
            Goldman equation

(6 hours) Action Potentials
            Membrane behavior
            Origin of action potential
            Hodgkin-Huxley equations
            Modeling
            Propagation of action potentials
            Subthreshold stimuli

(4 hours)  Biopotential Electrodes
             Fundamentals
             Body surface electrodes
             Microelectrodes

(5 hours) Electrophysiology of the Heart
            Anatomy/physiology of heart
            Body surface potentials
            Electrocardiogram
            Heart vector
            Standard leads

(6 hours) Electrophysiology of Neuromuscular System
            Neuromuscular Junction
            Transmitters
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Poisson statistics for transmitters
Postjunctional response
Anatomy/physiology of muscle
Myofibrils and filaments
Excitation contraction
Electromyography
Functional neuromuscular stimulation

(3 hours) Miscellaneous Electrophysiology
Electroencephalography
Electroretinogram

(5 hours) Biomedical Transducers
Displacement transducers
Thermocouples and thermistors

(4 hours) Measurement of Blood and Gas Flows
Electromagnetic flowmeter
Ultrasonic flowmeter
Thermodilution catheter

(2 hours) Exams