ENGR 116 Introduction to Biomedical Engineering

Instructor: Dr. Harry Blaise (harry.blaise@trincoll.edu)

Class Time: TR 10:50-12:05
Classroom Location: TBD

Office Hours: TBD
(and by appointment)
Office Location: MECC 395

Course Description: Biomedical engineering is a diverse, interdisciplinary field of engineering that integrates the physical and life sciences. Its core includes biomechanics, biomaterials, bioinstrumentation, physiological systems, medical imaging, rehabilitation engineering, biosensors, biotechnology, and tissue engineering. This course will highlight the major fields of activity in which biomedical engineers are engaged. A historical perspective of the field and discussion of the moral and ethical issues associated with modern medical technology is included.

Required Text:
"Bioengineering: A Conceptual Approach" by Mirjana Pavlovic, Springer, 2015. (The textbook is open-source and is freely available on the Moodle course page).

Reference Text: available at the Library for reference only, no need to purchase: "Introduction to Biomedical Engineering" by Enderle and Bronzino. Academic Press, 3rd edition, 2011.

Course Policy:

- Attendance is mandatory and lateness to class will carry a penalty.
- Spend at least 8-9 hours per week outside of class preparing for the class.
- Do the assigned reading and assignment before coming to class.
- Review your notes for completeness and clarity.
- Homework assignments should be word-processed and uploaded on Moodle before the due date/time, otherwise there will be a late penalty.
- Homework will not be accepted more than 24 hours after the due date/time.
- Students who miss a test due to a **verifiable medical reason (must have doctor's note)** may **make up the test as an oral exam** administered by the professor no later than a week after the missed test.

Grading Policy: *A range = 94-96.9 %*
Weekly Homework Assignments: 10 %
Attendance, in-class discussion, and Participation: 5%
3 Tests: 20 % each **(approx. ~Feb. 18, ~Mar. 25, ~Apr. 22)**
Final exam: 25 % (comprehensive of all course topics)

Learning Goals:

- Define the relationship between engineering and medicine
- Describe how biomedical devices are used to treat medical conditions
- Describe the fundamental principles underlying bioimaging systems
- Classify and describe the many subdisciplines of biomedical engineering
- Explain how the human body maintain homeostasis
- Understand the operation of passive filters, biosignal amplifiers, and bioinstruments.

Student Accessibility Resource Center Statement:
Trinity College is committed to creating an inclusive and accessible learning environment consistent with the Americans with Disabilities Act. Students with disabilities who may need some accommodation in order to fully participate in this class are

urged to contact the Student Accessibility Resource Center, as soon as possible, to explore accommodations. If you have approval for academic accommodations, please notify me by the end of week two of classes. For those students with accommodation approved after the start of the semester, a minimum of 10 days' notice is required. Please be sure to meet with me privately to discuss implementation.

Course Outline

1. Introduction to BME
   a. Definition of BME
   b. Early approach
   c. Bridge approach
   d. Integrative approach
   e. BME taxonomy

2. Introduction to Human Physiology
   a. Levels of organization
   b. Organ systems
   c. Body planes and directions
   d. Homeostatic control

3. Cell physiology
   a. Membrane biophysics and chemistry
   b. Cellular organization
   c. Organic compounds
   d. Membrane transport

4. Cardiovascular System
   a. Cardiac tissue
   b. Cardiac valves
   c. Cardiac cycle
   d. EKG – Electrocardiogram

5. Communication System
   a. Central and Peripheral Nervous System
   b. Neurons and Glia
   c. Neuronal Membrane
   d. Action Potential and Neurotransmitters

6. Respiratory System
   a. Lung compliance, elasticity, and surface tension
   b. Internal and external respiration
   c. Oxygen and carbon dioxide

7. Introduction to Biomechanics
   a. Repetitive and Acute Loading
   b. Composition and Structure of Bone
   c. Bone Response to Stress

8. Introduction to Biomaterials
   a. Biomaterial Attributes
   b. Biocompatibility and Bioactivity
   c. Metals, Ceramics, Polymers and Composites
   d. Implantable Biomaterials
   e. Immune Response

9. Introduction to Bioinstrumentation
   a. Measurement Systems
   b. Sensors and Transducers
   c. Instrumentation and Differential Amplifiers
   d. Cardiac Monitoring
   e. Blood Pressure Monitoring
   f. Pulse Oximeter
   g. Biosensors

10. Introduction to Biomedical Signal Processing
    a. Biosignal Modality (chemical, mechanical, electrical, thermal)
    b. Biosignal Acquisition and Digitization
    c. Sampling and Quantization
    d. Filtering

11. Introduction to Bioimaging
    a. Biomedical Imaging Modalities
    b. Radiography and Computed Tomography (CT)
    c. Ultrasound Imaging
    d. Positron Emission Tomography (PET)
    e. Magnetic Resonance Imaging (MRI)
    f. Transmission and Reflection Imaging
    g. Side Effects of Biomedical Imaging.

Final Exam (comprehensive of all course topics).