EN.500.130: Biomedical Engineering Innovation

Course Developed by

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Course Description

Engineering Innovation is an exciting college-level summer program for motivated high school students with an aptitude in math and science and an interest in (or curiosity about) engineering. This program has been available to high school students since 2006. In the program, students learn to think and problem-solve like engineers and have the opportunity to earn Johns Hopkins University (JHU) credit.

Biomedical Engineering Innovation introduces biomedical engineering to high school students by (1) modeling biological systems and designing experiments to test those models and (2) introducing engineering principles to solve design problems that are biological, physiological, and/or medical. Students will model human efficiency, the arm, and the cardiovascular system. Students are expected to use the informational content being taught in math, physics and biology and to apply this knowledge to the solution of practical problems encountered in biomedical engineering.

Prerequisites

- High school algebra II and trigonometry
- High school lab science (chemistry and physics)
- As and Bs in high school math and science courses
- Engineering Innovation

Course Topics

- Introduction to modeling physiological systems, specifically the static and dynamic arm, circulatory system, and human efficiency
- Introduction to the design process through a transport design project
- Demonstration or presentation (written or oral) of projects
- Development of an independent project including proposing a hypothesis, designing an experiment, obtaining and analyzing data, and preparing an online poster
- Completion of a computer programming assignment and programming movement in a modular prosthetic limb.
Course Structure

This is a 14-week, fully online course with most elements being completely asynchronous, meaning they can be completed at any time within a given time period (typically 1 or 2 weeks). The course materials are divided into modules which can be accessed in the Blackboard LMS. A module will have several sections, including an overview, video lectures, readings, quizzes, discussions, and assignments/labs. Each module will also include multiple live office hour sessions.

Course Materials

This course does not have a textbook, but will instead include various lecture videos and readings provided by the instructors through the Blackboard Learning Management Systems (LMS).

All additional course materials will be provided to the student as part of the course. There will be a lab kit of materials needed for the various labs in the course which will be mailed out to students after the third week of the course.

Technical Requirements

Students will need a computer that meets our technical requirements in order to participate in this course.

Student Coursework Requirements

It is expected that each module will take approximately 7–10 hours per week to complete. Here is an approximate breakdown:

- listening to the audio annotated slide presentations and completing the quizzes (approximately 2–3 hours per week)
- completing pre lab homework assignments and additional outside readings (approximately 2–3 hours per week)
- completing the lab or project for each module, preparing a lab report or presentation with results of the lab, and completing post-lab reflections (approximately 3-4 hours per week)

This course will consist of the following basic student requirements:

1. Module Quizzes
2. Module Assignments
   - Introduction to physiology
   - Developing a free body diagram
   - Review of trigonometry
   - Review of Newton’s laws and equations of motion
   - Review of electrical circuits
   - Introduction to computer programming
3. Lab Reports
   - Exercise & efficiency model
   - Arm model (static, dynamic, and modular prosthetic limb)
   - Transport design (detailed sketches and equations, video presentation)
   - Circulatory model (circuit and tubing analyses)
4. Final Project – model, experimental data and analysis, online presentation, and poster
5. Reflections
6. Participation (Discussions, peer reviews, and Office Hour attendance)
Grading

Final grades will be determined by the following weighting:

<table>
<thead>
<tr>
<th>Item</th>
<th>% of Grade</th>
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<tbody>
<tr>
<td>Quizzes</td>
<td>5%</td>
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<tr>
<td>Assignments</td>
<td>20%</td>
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<tr>
<td>Lab Reports</td>
<td>40%</td>
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<tr>
<td>Final Project</td>
<td>15%</td>
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<tr>
<td>Reflections</td>
<td>10%</td>
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<tr>
<td>Participation</td>
<td>10%</td>
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Course Outline

- Module 1 (Week 1): Introduction to Modeling
- Module 2 (Week 2): Human Efficiency Model
- Module 3 (Week 3): Oxygen Transport
- Module 4 (Weeks 4-5): Transport Design Project
- Module 5 (Weeks 6-7): Cardiovascular System
- Module 6 (Week 8): Static Arm Model
- Module 7 (Week 9): Dynamic Arm Model
- Module 8 (Weeks 10-11): Modular Prosthetic Limb Project
- Module 9 (Weeks 12-13): Independent Project
- Module 10 (Week 14): Independent Project Presentations

For More Information

For more information, please contact the Engineering Innovation Office by email at ei.jhu.edu or by phone at 410-516-6224.