



JOHNS HOPKINS

# Biomedical Engineering Innovation

## Syllabus

### EN.500.130 Biomedical Engineering Innovation – Summer 2021

#### Course Description

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 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.

#### Instructor, TAs, and Graders

Instructor, teaching assistant (TA), and/or grader biographies can be found in the **Syllabus & Course Information** area of the Blackboard course menu. The Course Access section below provides more information about Blackboard.

While your teachers will not be “on call” for the course, they will make every effort to respond to your questions and reply in a timely fashion. Once the course begins, **please make every effort to contact your teachers through Microsoft Teams rather than email.**

Further information is provided in the Course Access and Communication sections below.

#### Course Schedule

While this course is largely self-paced, there are regular deadlines that you must meet. A calendar with exact dates for your course, including due dates, is available in the **Syllabus & Course Information** area of the Blackboard course menu. The calendar presents due dates, not the dates you are expected to work on an assignment. You are encouraged to start assignments at the beginning of the module so they can be complete by the deadline.

Expect to spend 7-10 hours a week on this course. We recommend that you set aside time each day to view the conversations occurring in Microsoft Teams, the communication platform for this course.

Unless otherwise noted, **all submissions are due by 11:59pm local Baltimore time**, which is in the Eastern time zone of the United States. This is true for all students regardless of their local time zone. Note that Maryland observes daylight savings time, so there is a time change in March and November each year.

Study sessions will be held on a regular basis using video calls in Microsoft Teams. The study session schedule will be set during the first week of the course to best accommodate the schedules of participating students.

#### Prerequisites

Prerequisites for this course are the following:

- High school algebra II and trigonometry

- High school lab science (biology, chemistry and physics)
- As and Bs in high school math and science courses

## Course Objectives

By the end of the course, you will be able to:

- Use mathematical and physics principles to model physiological systems
- Develop experiments to test mathematical models
- Analyze signal data gathered by analog sensors
- Undergo the design process of creation, synthesis and integration for mechanical project and evaluate the success of the design to meet the desired need
- Summarize the results of each project in a written and/or oral presentation

## Course Outline

- **Module 1:** Introduction to Modeling
- **Module 2:** Human Efficiency Model
- **Module 3:** Oxygen Transport
- **Module 4:** Cardiovascular System
- **Module 5:** Arduino Design Project
- **Module 6:** Transport Design Project
- **Module 7:** Final Project

## Course Materials

This course does not have a textbook. All course materials are found on the course Blackboard site.

A **lab kit** will be mailed to students early in the course. If you have issues receiving your lab kit, please contact the Engineering Innovation Office at [ei-biomed@jhu.edu](mailto:ei-biomed@jhu.edu).

## Course Access

### Required Software

Students will need access to a computer with the following capabilities:

- Access to a spreadsheet application which will allow them to analyze data
- Access to a word processing program that can be used to write their course lab reports
- Access to a presentation program so they can create a presentation for their final project
- Ability to install free Arduino IDE software on the computer
- Ability to upload videos to the internet
- USB port to communicate with the Arduino
- Reliable internet access

### Blackboard – Course Materials

All course materials will be provided through the [Blackboard Learning Management Systems \(LMS\)](#). Log in to Blackboard using your Johns Hopkins credentials (JHED Login ID), which you should have received in an email from the registrar. It is a string of 3-8 characters that typically begins with the first letter of your first name, contains the starting letters of your last name, and ends in a number. If you need assistance logging in, please email [webregistration@jhu.edu](mailto:webregistration@jhu.edu) or call 410-516-8080.

The course materials are divided into modules, which can be accessed by clicking Course Modules on the Blackboard course menu. A module will have several sections including the overview, lecture videos, discussions, and assignments. You are encouraged to preview all sections of the module before starting.

## Microsoft Teams – Communication

This course will use [Microsoft Teams](#) for communication. This is a platform that works in your browser, on your desktop, and has an app for tablet and phone (iOS and Android), so you can participate from whatever device you are most comfortable. You will receive points for activities such as answering discussion questions, responding to posts from your peers, and conducting peer reviews. Instructions for each activity are provided in Blackboard.

To access Teams, click the **Microsoft Teams** link on the course menu on Blackboard. Then sign in with your JHU email using [@jh.edu](#) (NOT [@jhu.edu](#)) and JHU password. You should see your course Team listed on the left-hand side with the Team channels (discussion areas) listed below.

There are various channels for discussion, including a **General** channel that is for discussion general topics and questions related to the course. Use the **Module** channels for questions and topics related to specific modules.

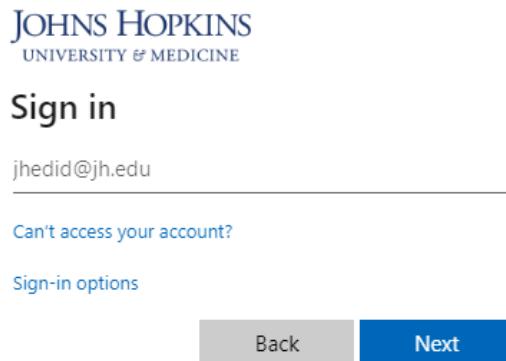
To customize your channel notifications, click the dots next to the channel name and select **Channel notifications**. You can also customize your notifications by going to **Settings > Notifications** (in desktop/browser, click your initials in the upper right-hand corner to find the Settings menu). Teams has many different notifications on its different platforms so [make sure you have them configured](#) so you get the communications you need.

For more information, check out the [Microsoft Support information](#) for getting started with Microsoft Teams. If you have difficulty logging in or accessing Microsoft Teams, please contact the Help Desk at [ep-help-desk@jhu.edu](mailto:ep-help-desk@jhu.edu).

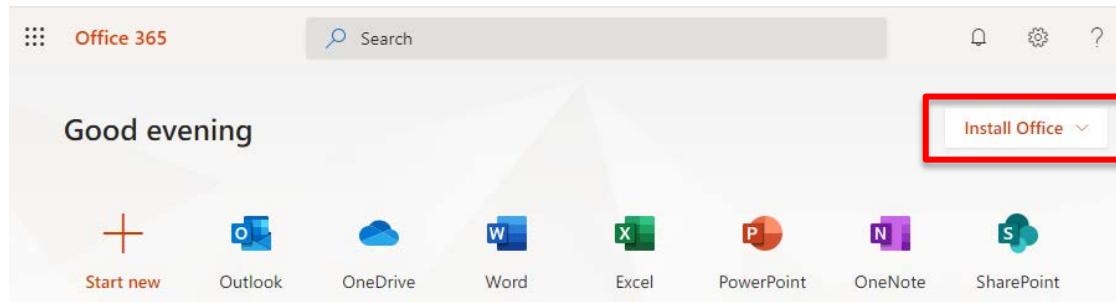
## Microsoft Office 365 Software

While you are enrolled in BMEI, you will have access to the software included in the Microsoft Office 365 Suite such as Microsoft Word, PowerPoint, and Excel. You will need your JHED to download the software to your device.

1. Go to <https://www.office.com/> and click **Sign In**.
2. Sign in using [JHEDID@jh.edu](mailto:JHEDID@jh.edu) and your password



3. When you land on the Office.com home screen, you can click **Install Office** in the upper right corner.



# Communication

## Course Announcements

Important announcements will be posted to Microsoft Teams in the **General** channel. They may also be cross posted in the relevant Module channel. You should check for new announcements each day.

## Public Questions via Teams Channels

The quickest way to get an answer to your question is to post in the **Microsoft Teams** channels for the course and include the **@Question tag**. When you are typing your message, include the text @Question and you should see a pop-up window you can select. The text @Question should then turn purple. Including this tag will alert your teachers about your post and will help distinguish your post from the Discussions posts.

While your teachers will not be “on call” for the course, they will make every effort to respond to your questions and reply in a timely fashion. Please refrain from sending private messages to your teachers—instead, ask questions in **Microsoft Teams** channels as much as possible so that the entire class can benefit from reading the answer. Your classmates might even know the answer to your question and respond to you before an instructor or TA does!

Students can post replies to questions from their peers, and this behavior is encouraged! In addition to written replies, it's also helpful to “like” posts by clicking on a post then selecting the thumbs-up icon.

## Personal Questions via Teams Chat

Direct chat messaging should generally be reserved for conversations about late assignments or Final Projects, which specific to you and are not relevant to the whole class. To send an Instructor or TA a direct message in Microsoft Teams, select **Chat** on the left-hand menu of Teams and click the **New Chat** icon (✉) above the chat list pane. Then type in the name of the teacher(s) you would like to send a message to.

## Study Sessions

Study sessions will be held multiple times a week as Microsoft Teams Meetings. Study sessions are a good opportunity for you to interact live with the teaching staff and with your peers. If there's content from the video lectures that you don't understand, send your questions to the teachers so they can prepare to cover that topic.

To join an in-progress meeting or view upcoming meetings, go to the **Study Sessions** channel in Microsoft Teams. If you need additional assistance, you can make an appointment with an Instructor or TA.

## Interacting with your Peers

You are encouraged to discuss the course content with your peers. In addition to posting and replying to messages in the public Microsoft Teams channels, you can also use Microsoft Teams to chat with individual students or groups of students. Select **Chat** on the left-hand menu of Teams and click the **New Chat** icon (✉) above the chat list pane. Then type in the name of the student(s) you would like to send a message to. Within a chat you also can share files, make video or audio calls, and share your screen.

Be respectful and reach out to a teacher if you believe someone is behaving inappropriately. Recall that you are bound by the Academic Integrity policy for the duration of this course.

# Grading

Engineers regularly encounter problems that are **open-ended** and which require them to **make assumptions**. For this reason, assignments in this course will require you to do some outside research and make assumptions rather than simply enter data into an equation and solve for an answer. **Don't be afraid to ask questions** – these assignments are meant to challenge you and help you grow.

## **Submission Format**

Documents should be submitted in PDF format. Videos should be created as .mp4 or .mov format, uploaded to [Microsoft Stream](#), and shared via a link to the video.

Typed submissions are preferred, but handwritten work can be scanned or photographed and included within a Word document. One option is to use a program like CamScanner to digitize handwritten work. Please take the time to ensure scans are not blurry, handwriting is legible, pictures are not sideways, and text and photos are not too small.

## **Late Policy**

Do not wait until the last minute to upload your work to Blackboard or Microsoft Stream. Large video files may take an hour or more to upload.

Because this course moves at a fast pace, in general, late work will not be accepted. However, you will receive partial credit for the portion of the assignment you do submit. For this reason, **submitting something on time is better than submitting nothing**. There are a few exceptions to this rule:

- All students will be able to submit one assignment or activity late (up to 12 hours late) with no penalty.
- The second late assignment (up to 12 hours late) will be penalized at 50% credit
- Exceptions will be made for genuine hardships experienced during the course.

Please contact your instructor as soon as possible to let them know why an assignment is late.

## **Grade Questions and Regrade Policy**

You may submit work to be regraded if you feel there is an error or if you have questions about how it was graded. You must do this within 48 hours of the grade being posted in Blackboard. Send a Microsoft Teams chat to the teachers in which you clearly indicate what portion of the work you would like to have regraded and explain the rationale for your request. The new grade may be higher, the same, or lower than the original grade. Once work is regraded, it may not be submitted for another regrading analysis.

## **Final Grade Letters**

Final grades will be awarded as follows:

- Above 90% A
- 80% - 90% B
- Below 80% No credit - Audit

A grade of A indicates achievement of consistent excellence and distinction throughout the course—that is, conspicuous excellence in all aspects of the course assignments. A grade of B indicates work that meets all course requirements on a level appropriate for undergraduate academic work. Students who do not earn an A or a B will be marked as “audit”; they will not receive a final grade and the course will not appear on their transcript.

Students who earn an A or B grade in the course receive 3 credits from Johns Hopkins University. If you are accepted to and matriculate as an undergraduate student at JHU, the credits awarded by JHU for this BMEI course are available to count towards your undergraduate degree at JHU. Credits may be applied towards your total required credits to graduate.

Students who complete the course (turn in all lab reports, design projects, and the final project) will receive a Certificate of Completion regardless of the grade they achieved (A, B, or Audit). Certificates will be sent by email from [ei-biomed@jhu.edu](mailto:ei-biomed@jhu.edu) approximately two weeks after the last day of class.

## **Grade Calculation**

Final grades will be determined by the following weighting:

Item	# Points	% of Grade
Final Project	210	21%
Assignments	160	16%
Human Efficiency Lab (Lab 1)	130	13%
Cardiovascular System Lab (Lab 2)	130	13%
Arduino Design Project	100	10%
Transport Design Project	100	10%
Discussions	60	6%
Quizzes	50	5%
Asking Questions	30	3%
Surveys	30	3%

## Major Deliverables

### Final Project

The Final Project is a chance for you to investigate an area of biomedical engineering and design an experiment related to the topic of your choice. Your Project may be a completely new idea, or it can be an extension of a previous project in the course. You will create a scientific poster summarizing the work you did for your Final Project and then record a video Presentation of the poster.

Item	# Points	% of Grade
Final Project Research	20	2%
Design Review 1	10	1%
Final Project Proposal	20	2%
Design Review 2	10	1%
Final Project Draft	20	2%
Design Review 3	10	1%
Final Project Final Submission	100	10%
Final Project Peer Review	10	1%
Final Project Reflection	10	1%
<b>TOTAL</b>	210	21%

Refer to the **Final Project Guidelines** for more information. The document can be found in the **Syllabus & Course Information** area of the Blackboard course menu, within a folder titled **Project and Lab Report Information**.

### Assignments

There are one or two assignments in each module to give you practice with the course content. Each of the following assignments is worth 20 points:

- Pre-Course Assignment
- Assignment 1-1
- Assignment 1-2
- Assignment 2
- Assignment 3
- Assignment 4
- Assignment 5-1
- Assignment 5-2
- Assignment 6
- Assignment 7

**The lowest two Assignment grades will be dropped.** So, the highest eight Assignment grades will count toward your final grade for a total of 160 possible points (16% of your final grade).

You can access the Assignments using the links provided in the Blackboard module. You are required to submit your answers to Blackboard as a PDF file. All work must be shown and legible to earn full credit. Solutions without justification will not be considered complete and the grade will be adjusted down accordingly.

### **Human Efficiency Lab (Lab 1) and Cardiovascular System Lab (Lab 2)**

The labs are an opportunity for you to design and conduct your own experiment. Prior to conducting the lab, you will submit a lab plan that describes your hypothesis, your method, and the data you plan to collect.

Item	# Points	% of Grade
Lab Plan	10	1%
Lab Report	100	10%
Lab Peer Review	10	1%
Lab Reflection	10	1%
TOTAL (each lab)	130	13%

Refer to the **Lab Guidelines, Lab 1 Guide, and Lab 2 Guide** documents for more information. They can be found in the **Syllabus & Course Information** area of the Blackboard course menu, within a folder titled **Project and Lab Report Information**.

### **Arduino Design Project**

The Arduino Design Project is worth up to 100 points. For this project, you will design a prototype of a biomedical sensor using one of the sensors in your lab kits and an Arduino microcontroller. This introduces you to biomedical sensors, Arduino coding, and measuring uncertainty. Projects will include a 1-minute video demonstration of your sensor in action.

Refer to the **Arduino Design Project Guidelines** for more information about grading. This document can be found in the **Syllabus & Course Information** area of the Blackboard course menu, within a folder titled **Project and Lab Report Information**.

### **Transport Design Project**

The Transport Design Project is worth up to 100 points. For this project, you will design and build two ping-pong mover devices, using limited supplies, that move a ping-pong 1.5 meters in the horizontal direction and then 1.5 meters horizontally in another direction. This introduces you to the engineering design process in which you identify and define a need, determine constraints to the problem, brainstorm and implement a solution, and evaluate the success of the design to meet the desired need.

Projects will be presented and judged in two ways: a 1-minute video “elevator pitch” presentation and a 2-minute video demonstration of the ball moving.

Refer to the **Transport Design Project Guidelines** for more information about grading. This document can be found in the **Syllabus & Course Information** area of the Blackboard course menu, within a folder titled **Project and Lab Report Information**.

## Discussions

In each module of the course you will respond to a Discussion prompt. The instructions for the prompt are in Blackboard, but you will post your work in Microsoft Teams so your peers can view your work and respond. This is an excellent opportunity to seek constructive feedback from your peers and to relate the BMEI coursework to your personal experiences. Each discussion is worth 10 points:

- Microsoft Teams Practice Meeting
- Module 1 Discussion
- Module 2 Discussion
- Module 3 Discussion
- Module 4 Discussion
- Module 5 Discussion
- Module 6 Discussion
- Module 7 Discussion

**The lowest two Discussion grades will be dropped.** So, the highest six Discussion grades will count toward your final grade for a total of 60 possible points (6% of your final grade).

## Quizzes

Each module includes a quiz composed of multiple choice and fill-in-the blank style questions. The quizzes are designed to test the concepts and skills covered in the module lectures, so you should plan to complete all lecture videos and readings before attempting the Quiz. Each of the following is worth 10 points:

- Module 1 Quiz
- Module 2 Quiz
- Module 3 Quiz
- Module 4 Quiz
- Module 5 Quiz
- Module 6 Quiz
- Module 7 Quiz

**The lowest two Quiz grades will be dropped.** So, the highest five Quiz grades will count toward your final grade for a total of 50 possible points (5% of your final grade).

Quizzes are untimed, and you will be allowed to attempt each quiz up to 2 times. Feedback on the quiz will be available after the quiz due date.

## Asking Questions

Due to the online nature of the course, it is difficult for the instructor to know whether students have questions about the material. Students should not hesitate to ask questions during Study Sessions or by posting to MS Teams. Other students likely have the same questions! If a question arises while completing your course work, please post a question to Microsoft Teams. We will respond to posting and other students can answer postings as well. If you correctly answer a question posed by a peer, you will receive credit towards your Asking Questions module total.

Students are encouraged to ask and answer questions in each module of the course and can earn up to 5 points in each module for asking or answering questions:

- Module 1 Asking Questions
- Module 2 Asking Questions
- Module 3 Asking Questions
- Module 4 Asking Questions
- Module 5 Asking Questions
- Module 6 Asking Questions
- Module 7 Asking Questions

**The lowest one Asking Questions grade will be dropped.** So, the highest six Asking Questions grades will count toward your final grade for a total of 30 possible points (3% of your final grade).

## Surveys

There is an anonymous survey at the end of each module where we encourage you to share your thoughts and opinions about the module content and assignments. In a constant effort to improve the course, we want to make sure that the content and assignments are as clear as possible and that you have enough time to complete the requirements. Please share your thoughts with us. There will be a more comprehensive evaluation at the end of the course as well:

- Module 1 Course Improvement Survey
- Module 2 Course Improvement Survey
- Module 3 Course Improvement Survey
- Module 4 Course Improvement Survey
- Module 5 Course Improvement Survey
- Module 6 Course Improvement Survey
- Module 7 Course Improvement Survey
- BMEI Course Evaluation

Completing the module and end of course surveys is worth up to 30 points (3% of your final grade).

## Academic Integrity

All students are required to read, know, and comply with the **Procedures for Dealing with Issues of Academic Misconduct**, as outlined in your Admission and Enrollment information packet and the corresponding form you signed.

This policy prohibits academic misconduct, including but not limited to the following: cheating, plagiarism, submitting the same or substantially similar work to satisfy the requirements of more than one course without permission, submitting as one's own the same or substantially similar work of another, knowingly furnishing false information to any agent of the University for inclusion in academic record, falsification, forgery, alteration, destruction or misuse of official University documents or seal.

While we encourage you to collaborate with your fellow students on Microsoft Teams, all work submitted must be fully your own. Lab reports, assignments, quizzes, and projects must be done on your own. Direct copying of written work or computer code is considered cheating and will result in a grade of zero on the assignment and could result in failing the course.

Plagiarism is defined as taking the words, ideas, or thoughts of another and representing them as one's own. If you use the ideas of another, provide a complete citation in the source work; if you use the words of another, present the words in the correct quotation notation (indentation or enclosed in quotation marks, as appropriate) and include a complete citation to the source.

## Policy on Disability Services

The Johns Hopkins University and the Engineering Innovation program are committed to making all courses, support services, and facilities accessible to students with disabilities.

To receive accommodations for a disability, students must register with the JHU Office for Student Disability Services (SDS) at <https://studentaffairs.jhu.edu/disabilities/>. Students are highly encouraged to do so as soon as possible after admission and no later than two weeks prior to the start of class. Although requests can be made at any time, there may be a delay in implementation depending on the nature of the request.

Part of the registration process is the submission of documentation of the disability. Please refer to the university documentation guidelines at <https://studentaffairs.jhu.edu/disabilities/newly-admitted-students/documentation-guidelines/> for more information.

You are encouraged to share this link with your provider (e.g. physician, psychologist, teacher/counselor, etc.) to help guide his or her writing, if necessary. Please know that IEPs and 504 Plans, although helpful, do not constitute comprehensive documentation. However, when combined with other documentation from a qualified evaluator, can provide adequate support for accommodations during your Engineering Innovation experience.

## Registration Procedure

To begin the registration process with Student Disability Services and to establish eligibility for disability related accommodations and services, please complete and submit [the SDS Online Registration Form](#) and upload supporting documentation. You can also find this form by visiting the Student Disability Services website at <https://studentaffairs.jhu.edu/disabilities/> and clicking on the link on the left hand side labeled '[SDS Homewood Online Registration for New Students.](#)'

Once your form and documentation are received, the next step in the process will be a phone call or virtual meeting with an SDS professional staff member, when needed, to complete your requested accommodations. If you have any difficulty providing documentation or need more information about any aspect of the process, please contact SDS staff at [studentdisabilityservices@jhu.edu](mailto:studentdisabilityservices@jhu.edu).

## Student Disability Services Office

- **Director of Student Disability Services:** Dr. Terri Massie-Burrell
- **Phone:** 410-516-4720; Fax: 443-529-1543; Email: [studentdisabilityservices@jhu.edu](mailto:studentdisabilityservices@jhu.edu)
- **Mailing address:** The Johns Hopkins University; Student Disability Services; 3400 N Charles Street; Shaffer Hall Suite 101; Baltimore, MD 21218
- **Website:** <https://studentaffairs.jhu.edu/disabilities>

## For More Information

For more information, please contact: [ei-biomed@jhu.edu](mailto:ei-biomed@jhu.edu) or visit our website at <https://ei.jhu.edu>.