

# Course Syllabus

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## Course Description

**Course no.** BIOE 383      **Course title:** BIOMEDICAL ENGINEERING INSTRUMENTATION

**Course instructor(s):** Tomasz Tkaczyk (BRC 513, [ttkaczyk@rice.edu](mailto:ttkaczyk@rice.edu))

Required or Elective: Required

**Course description, including the overall purpose of the course—why the course exists, how it fits into the larger curriculum and for whom it is designed:**

The purpose of the course is to provide knowledge and skills essential for working in experimental sciences and engineering with the focus on biomedical and bioengineering instrumentation. It focuses on working expertise of instrumentation and their design. The course prepares to design independently performed experiments. Therefore, it allows improving knowledge and understanding useful in undergraduate laboratory projects and classes. It also builds a foundation to for further career development in a graduate school or industry.

**Course prerequisite(s):** MATH 211 (ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA), PHYS 126 (GENERAL PHYSICS II WITH LAB) OR PHYS 102 (ELECTRICITY AND MAGNETISM – WITH LAB), ELEC 243 (INTRODCUTION TO ELECTRONICS), AND BIOS 201 (INTRODUCTORY BIOLOGY)

**What are the concepts and critical skills these prerequisites imply that students must know to take this course?**

The course builds on principles of mathematics and physics to allow designing system models. In addition it requires knowledge of electronics, circuits and programming to implement practical detection and sensing solutions. It also provides connection between instrument design and biomedical applications.

**Course credit:** 3 hours

**Class/laboratory schedule:** TTh lectures (75 minutes each) –in person with occasional zoon depending on circumstances (updated weekly, depending on university announcements, travel, etc.)

**Textbook(s) and/or other required/recommended material:** Principles of Biomedical Instrumentation, Cambridge University Press 2018, Andrew G. Webb, ISBN 9781107113138

**Course objectives:** Students should learn:

1. To apply the principles of sensing, amplification, control and detection components to the design of biomedical devices
2. To identify the principles of bio signals and the methods that can be used for their detection and measurement
3. To perform signal conditioning/processing, such as filtration and amplification
4. To apply Fourier transforms to analyze signals.
5. To identify sources of error and challenges arising from the interaction between living and non-living systems.
6. To identify engineering principles used in a broad spectrum of biomedical instruments.

**Course outcomes:** Student completing the course should be able to:

1. Design strain, temperature, current/voltage, and photodetection sensors.
2. Design circuits that properly amplify and filter bio signals.
3. Calculate the signal-to-noise ratio of an instrument.
4. Design systems to detect and measure biological signals.
5. Perform analysis and design of medical monitoring equipment, including ECG, IV drip, and blood pressure measurements.
6. Perform Fourier analysis of signals.

**Topics covered:**

- Data acquisition and processing
- Principles of detection, sensors and transducers

- Amplifiers and signal processing
- Fourier analysis
- Bio signals, principles and detection
- Examples of biomedical devices: EKG, Blood pressure and IV Drip
- Safety requirements of biomedical devices

**Scheduling:** BIOE 383 is normally taken in the fall of the junior year

**Professional Component Content:** Engineering (3 hrs)

### Homework

There will be 6 homework assignments over the course of the semester. Handed out homework will generally be due the following week on the same weekday it was released. For example if homework is given on Thursday it will be due week later also on Thursday (unless other schedule is clearly specified – for example longer time frame). Homework will be due at the beginning of a lecture (9:25 a.m.) on the day it is due, unless stated otherwise in the assignment. No late homework will be accepted without permission of the instructor before the homework is due. Illness and family emergencies will be dealt with on an individual basis. Grades on other late homework will be reduced 25% per day (including weekends). Solutions to homework problems will be made available soon after the homework is due. Individuals turning in late homework are expected to not consult the posted homework solutions (Honor Code). Students may not consult homework from previous years (Honor Code).

### Exams

There will be two mid-term exams, tentatively scheduled (schedule will be adjusted to align with HW assignments) to last week of September / first week of October and last week of October / first week of November, and a final exam during the week of finals. Mid-term format will be in person. Final exams will be in a form of take-home exam. Late exams will not be accepted. The instructor retains the right to fail a student who does not turn in either exam or the final.

**Grading Policy** - The final grade will be based on the following.

- |              |      |
|--------------|------|
| • Homework   | 30 % |
| • Exam 1     | 20 % |
| • Exam 2     | 20 % |
| • Final Exam | 30 % |

Total: 100%

- Extra Credit –Participation, Attendance and Extra Credit Assignments 10%

### Office hours

Tue 11 am-12.00pm or by appointment

## Teaching Assistants

Yicheng Ma (ym37@rice.edu), BRC 503, Jinyun Liu (jl316@rice.edu), BRC 503

TAs will be available during consultations sessions—before homework due (exact hours will be announced before the HW due). They will also be available by appointment.

## Honor Code Policy

Students are encouraged to talk to each other, the teaching assistants, the instructors, or anyone else about any assignment in the course that is not specifically designated as pledged. This assistance is limited to the discussion of the problem and perhaps sketching of a solution. Students must complete their own work. Students are not allowed to look at homework problems or solutions or exams from the courses taught in past years.

## Title IX Responsible Employee Notification

Rice University cares about your wellbeing and safety. Rice encourages any student who has experienced an incident of harassment, pregnancy discrimination or gender discrimination or relationship, sexual, or other forms interpersonal violence to seek support from The SAFE Office.

At Rice University, unlawful discrimination in any form, including sexual misconduct, is prohibited under Rice Policy on Harassment and Sexual Harassment (Policy 830) and the Student Code of Conduct. As the instructor and a responsible employee, I am required by Title IX to disclose all incidents of non-consensual interpersonal behaviors to the Title IX Coordinator on campus. Although responsible employees are required to make this notification, it is the student's choice to pursue a formal complaint. The goal is to make sure that students are aware of the range of options available and have access to the resources when in need. For more information, please visit [safe.rice.edu](https://safe.rice.edu), [titleixrice.edu](https://titleixrice.edu), or email [titleixsupport@rice.edu](mailto:titleixsupport@rice.edu) (<mailto:titleixsupport@rice.edu>).

Any student with a documented disability needing academic adjustments or accommodations is requested to speak with me during the first two weeks of class.

All discussions will remain confidential.

Students with disabilities should also contact Disability Support Services in the Ley Student Center.

Tomasz Tkaczyk  
2023

21 August

Prepared by:

Date: