

Department of Bioengineering
BioE 3700 Bioinstrumentation and Bioimaging

3 credits

Lectures: M-F, 11am-12:30pm via Zoom

Lab: Rhodes Annex 316

Syllabus – Summer 2023

Instructor:

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Lab Manager:

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Prerequisite:

ECE2020 or ECE 2070, and MTHSC 2080

Recommended (not required) Textbooks:

John G. Webster, Ed. *Bioinstrumentation*, John Wiley & Sons, Inc., 2004

John G. Webster, Ed. *Medical Instrumentation: Application and Design*, 4th Ed., John Wiley & Sons, Inc., 2010

Course Objectives:

Bioinstrumentation is an interdisciplinary subject of applying physical principles and mechanical, electronic and chemical engineering technologies to acquire, analysis and display information from cells, tissues, organs and entire organisms including the human body. It has emerged from research conducted at the interface of the physical and biological sciences, engineering and medicine. This course is designed for junior and senior undergraduates, aiming to introduce fundamentals and frontier topics of bioinstrumentation to familiarize students with basic principles to acquire and analyze physiological signals. Through the course work, students will learn how to explore the connections between different fields and the ways of integrating those fields together to select and properly use the optimal instrument for solving biomedical problems.

An emphasis will be placed on the physics behind various phenomena that is employed to transduce physiological events into electronic signals. Through the lectures, the students will be provided with a basic knowledge of a broad range of topics in bioinstrumentation so that each of them in different engineering or other related disciplines can rapidly acquire the minimal necessary background for the operation and development of bioinstrumentation.

Course Learning Objectives:

Students will be able to:

1. State the fundamentals of bioinstrumentation and bioimaging
2. Understand physics behind various phenomena that are employed to convert physiological events into electronic signals
3. Appreciate frontier topics in bioinstrumentation and bioimaging
4. Develop the ability to acquire and analyze physiological signals including images
5. Select and operate optimal instrument for solving biomedical problems
6. Design, in a team-based setting, an experiment to measure and analyze biological/physiological sample properties

Attendance Policy:

Since this is a lab class, students are expected to attend all classes (lectures and labs). Students are allowed 1 unexcused absence; all other absences will be reflected in the final grade (see Grading Section). Absences are excused only with a valid, written, medical or university excuse. Non-medical excuses need to be cleared more than 24 hours before class and will only be granted for a valid university excuse. Students are also expected to be on time to class and labs; 2 tardies is equivalent to one unexcused absence. If the lecturer does not come to class within the first 15 minutes, students are authorized to leave.

Assignments, Due Dates, Missed Work/Exam Policy

Assignments are due before the time and date given as the due date for that assignment. Assignments received after the due date will not receive any credit (i.e. you will get a 0 for that assignment). Similarly, any in-class assignment, including exams and lab assignments, that is missed due to an unexcused absence will not get any credit (i.e. you will get a 0 and the assignment will count as a missing assignment). In addition, any student missing more than 2 assignments at the end of the semester will fail the class (see details in Grading Policy section). Any extensions of deadlines must be requested more than 24 hours before the assignment is due and will only be granted for a valid, written, medical or university excuse (see Attendance Policy for definition of valid excuse).

Disability Access:

It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services to discuss their individual needs for accommodation. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Clemson University Title IX statement:

“Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran’s status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the

Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix>. Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).”

Emergency Procedures

Emergency procedures have been posted in all buildings and on all elevators. Students should review these procedures for their own safety. Please ask the instructor if you have any questions on what constitutes plagiarism or academic integrity in general.

Academic Integrity

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately and expeditiously to charges of violations of academic integrity.

Mid-Term Grade Policy

Student grades shall be entered in Canvas for students to keep track of their performance in the course. Once, near mid-term, but no later than five days before the last day students can drop courses (Drop day in the important dates listed below) without receiving final grades, instructors of every undergraduate course shall make available for each student (a) that student's numerical course grade or (b) that student's letter ranking to date in that course (A-F or P/F). Please see instructor before drop day to discuss progress and mid-term evaluation.

Drop and Withdrawal: Notify the instructor either by email or verbally of your intention of dropping the course.

Grading Policy Details: The final grade is calculated from the following components and then adjusted for attendance and missing assignment penalties:

1. Exams	55%
Exam 1: 15%	
Exam 2: 20 %	
Exam 3: 20 %	
2. Final Lab Project	20%
Written Proposal: 14%	
Group Final Poster: 6 %	
3. Midterm Lab	15%
Practical: 5%	
Written Report: 10%	
4. Weekly Lab Reports	5%
5. Homework	5%

Unless otherwise specified in lecture, grade cut-offs are as follows:

- A: 90% and up
- B: 80-89.99%
- C: 70-79.99%
- D: 60-69.99%
- F: less than 60%

Note: in canvas, the “current final grade” is calculated from the above formula but does not include attendance and missing work deduction (see below). These will be taken into account at the end of the semester and affect the final overall grade in the class.

Missing assignment grading: Assignments are anything that is collected by the professor or TAs (e.g., lab reports, homework, exams, lab practicals, final and midterm lab reports) The assigned work policy for your final grade is as follows:

- Late assignments will receive a 0.
- Missing homeworks will be marked at -3 points in the final grade calculation. All other missing work will be counted as 0s.
- In addition, students who are **missing 2 or more assignments will receive an F** as their final overall grade in the class (i.e. they will fail the class). Students have until 3pm on Wednesday of the last day of lecture to turn in any missing assignments late so as not to fail the class.

Attendance Grading: (2 tardies = 1 unexcused absence)

2 unexcused absences will result in your final overall class grade being lowered by half a letter grade (for example, an A will drop to an A-)

3 unexcused absences will result in your final overall class grade being lowered by a whole letter grade (for example, an A will drop to a B)

4 unexcused absences will result in your final overall class grade being lowered by 2 letter grades (for example, an A will drop to a C)

5 or more unexcused absences will result in automatically failing the class. (i.e. get an F)

Unless otherwise stated, weekly Lab write-ups are due on the following lab session before start of class and homework is due before the start of lecture one week after it is assigned.

Tentative course outline (all dates subject to change pending scheduling issues):

Lecture	Date	Description	Assignments Due
L01	T May 16	Introduction & Circuit Review	
L02	W May 17	2 nd Order Circuits, Transforms	
Lab 1	R May 18	Circuits LAB	Homework 1: 1 st Order Circuits
L03	F May 19	Nonlinear Circuits and Amplification	
Lab 2	M May 22	Circuits II LAB	Homework 2: 2 nd Order Circuits
L04	T May 23	A/D Conversion	
Lab 3	W May 24	Arduino LAB	Homework 3: Matlab
Exam 1	R May 25	Exam 1	
L05	F May 26	Electrically excitable cells/Patch clamp	
Lab 4	M May 29	Electrophysiology LAB	Homework 4: Electrophysiology
L06	T May 30	Cardiac conduction/EKG	
Lab 5	W May 31	EMG/EKG LAB	Homework 5: EKG
L07	R June 1	Noise and electrodes/EEG	
Lab 6	F June 2	EEG LAB	
L08	M June 5	Blood Pressure	
	T June 6	Lab Report Workday and Lab Practical	Midterm Lab Report & Practical
L09	W June 7	Chemical biosensors/ Glucose Sensing	

Exam 2	R June 8	Exam 2	Homework 6: Biosensors
L10	F June 9	Microscopy	
L11	M June 12	Ultrasound	
L12	T June 13	X-Ray & Computed Tomography (CT)	
	W June 14	Project Workday	Project Proposal
	R June 15	Project Workday	Homework 7: Imaging
L13	F June 16	NMR and MRI	
	M June 19	Project Workday	
Exam 3	T June 20	Exam 3	
	F June 23	Final Project Presentation	Final Project