

**Department of Bioengineering**  
**BioE 3700 Bioinstrumentation and Bioimaging**

3 credits

Lectures: MW, 11:15- 12:05 AM, Rhodes Annex 111

Labs: M, T, or W 3:30-6:00 PM, Rhodes Annex 316

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**Syllabus – Spring 2019**

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Instructor:

Jordon Gilmore, Ph.D.

Assistant Professor of Bioengineering; 201-1 Rhodes Hall

E-mail: [jagilmo@clermson.edu](mailto:jagilmo@clermson.edu)

Office Hours: Monday 12:15-1:15pm or by appointment (please email)

Lab Manager:

Melissa McCullough

Office: 103 Rhodes Research Center

Email: [mmccul4@clermson.edu](mailto:mmccul4@clermson.edu)

TAs:

Mohammed Jaradat

Email: [mjarada@clermson.edu](mailto:mjarada@clermson.edu)

Office Hours: Wednesday 1pm-3pm in Rhodes Annex 316

Zhanhe Kevin Liu

Email: [zhanhel@g.clemson.edu](mailto:zhanhel@g.clemson.edu)

Office Hours: Monday 9am-11am in Rhodes Annex 316

Hetal Maharaja

Email: [hetalm@g.clemson.edu](mailto:hetalm@g.clemson.edu)

Office Hours: Wednesday 1pm-3pm in Rhodes Annex 316

Margarita Portilla

Email: [mportil@g.clemson.edu](mailto:mportil@g.clemson.edu)

Office Hours: Thursday 3:30pm-5:30pm in Rhodes Annex 316

Lucas Schmidt

Email: [lschmidtytech@gmail.com](mailto:lschmidtytech@gmail.com)

Office Hours: Thursday 10am-12pm in Rhodes Annex 316

Prerequisite:

ECE2020 or ECE 2070, and MTHSC 2080

Recommended (not required) Textbooks:

John Semmlow, ***Circuits, Signals, and Systems for Bioengineers: A MATLAB-Based Introduction***, 3<sup>rd</sup> Ed., Academic Press – Elsevier, 2018

Andrew G. Webb, ***Principles of Biomedical Instrumentation***, Cambridge University Press, 2018

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

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

Required software: This class uses MATLAB by Mathworks. Homework problems and some lab assignments may require MATLAB. This software can be accessed through CCIT (<https://ccit.clemson.edu/support/faculty-staff/software/software-licenses/>). For assistance installing this software, please visit the CECAS CCIT Support Desk in Freeman Hall 142.

Additionally, course information will be facilitated through Canvas. Attendance, grading, and course documents can be found on the BioE 3700 001 page. Lab information will also be located on this page, *NOT on the respective lab Canvas pages.*

Course Objectives:

Bioinstrumentation is an interdisciplinary subject of applying physical principles and mechanical, electronic and chemical engineering technologies to acquire, analyze 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, 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 professor or guest lecturer does not come to class within the first 15 minutes, students are authorized to leave.

Laptops, tablets, and cell phones should be off and put away unless they are being used for specific class purposes. Students caught using laptops or electronics device for nonclass related activities during lectures will be counted as having an unexcused absence for that class.

**NO FOOD or DRINKS in the lab!**

#### Assignments and Due Dates

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). 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 in-class assignment, including tests 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). 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 intension of dropping the course.

Tentative Schedule of Important Dates: Dates are subject to change pending snow days, etc.

- Exam 1 - Feb. 4
- Exam 2 - Mar. 4
- Exam 3 - Apr. 24
- Midterm Lab Practical - Feb. 18-20
- Lab Write-up - Mar. 1 by 5:00pm
- Drop Date - Mar. 15
- Spring Break - Mar. 18-22
- Final Lab Proposals - Mar. 29 by 11:55pm
- Final Poster Due - Apr. 29
- Final Poster Presentation Tuesday – April 30, 8:00-10:30am (Final exam time)

#### Grading Policy Details:

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

1. Exams	45%
Exam 1: 15%	
Exam 2: 15 %	
Exam 3: 15 %	
2. Quizzes (3 total, 4 pts ea)	12%
3. Final Lab Project	15%
Written Proposal: 10%	
Group Final Poster: 5%	
4. Lab Reports	28%
Practical: 8%	
Midterm Report: 10%	
Weekly Reports: 10%	
5. Homework	0% (Used for Test Rework)

**Test Rework Policy:** Homework (out of 3 pts each) will be graded and used for test rework credit. Students will be eligible to rework missed test questions for replacement points up to the value of total homework points earned for that test period. For example, if there are three homework assignments before Exam 1, there are a maximum of 9 points available for test rework. A student may earn up to 9 points back on their test grade by reworking missed test questions. True/False and multiple-choice questions are not eligible for rework. Additionally, each reworked test question must include a corrected solution and accompanying explanation. Test reworks are due the class period after test are returned.

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).

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

- Late assignments will receive a 0.
- 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 the 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.

Unless otherwise stated, weekly lab write-ups are due on the following lab session before start of class. 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
Lecture 0 and 1	Jan 9	Introduction to Bioinstrumentation and Biosignals
Lecture 2	Jan 14	Linear System Analysis and First Order Circuits
Lecture 3	Jan 16	Second Order Circuits and Sinusoidal Sources
No Class	Jan 21	MLK Day
Lecture 4	Jan 23	Quiz #1 and Nonlinear Circuit Elements
Lecture 5	Jan 28	Op Amp Circuits
Lecture 6	Jan 30	Exam 1 Review
<b>Exam 1</b>	Feb 4	Exam 1
Lecture 7	Feb 6	Hearing
Lecture 8	Feb 11	Electrically Excitable Cells (Electrophysiology)

Lecture 9	Feb 13	Patch Clamp and Cardiac Cells
Lecture 10	Feb 18	Quiz #2 and ECG
Lecture 11	Feb 20	ECG Noise and Implantable Pacing
Lecture 12	Feb 25	EEG
Lecture 13	Feb 27	Electrical Safety
<b>Exam 2</b>	Mar 4	Exam 2
Lecture 14	Mar 6	Blood Pressure
Lecture 15	Mar 11	Lungs and Chemical Biosensors 1
Lecture 16	Mar 13	Blood Gas and Glucose and Chemical Biosensors 2
No Class	Mar 18	Spring Break
No Class	Mar 20	Spring Break
Lecture 17	Mar 25	Ultrasound
Lecture 18	Mar 27	Electron Microscopy
Lecture 19	Apr 1	Quiz #3 and Laser
Lecture 20	Apr 3	Radiation Therapy
Lecture 21	Apr 8	X-Ray
Lecture 22	Apr 10	Atomic Force Microscopy
Lecture 23	Apr 15	CT Scan
Lecture 24	Apr 17	NMR and MRI
Lecture 25	Apr 22	Imaging Facility Tour
<b>Exam 3</b>	Apr 24	Exam 3
<b>Final Exam</b>	Apr 29	Poster Presentation

<b>Lab</b>	<b>Date</b>	<b>Description</b>
No Lab	Jan 9	None
Lab 1	Jan 14	Linear Circuits (Bridge Circuits)
Lab 1	Jan 15	Linear Circuits (Bridge Circuits)
Lab 1	Jan 16	Linear Circuits (Bridge Circuits)
No Lab	Jan 21	MLK Day
Lab 1/Lab 2	Jan 22	Linear Circuits (RC filters) and Op-amp Circuits 1
Lab 1/Lab 2	Jan 23	Linear Circuits (RC filters) and Op-amp Circuits 1
Lab 1/Lab 2	Jan 28	Linear Circuits (RC filters) and Op-amp Circuits (all)
Lab 2	Jan 29	Op-amp Circuits 2
Lab 2	Jan 30	Op-amp Circuits 2
Lab 3 – Arduino	Feb 4	Arduino, Midterm Lab Hypothesis, Project Ideas Due
Lab 3 – Arduino	Feb 5	Arduino, Midterm Lab Hypothesis, Project Ideas Due
Lab 3 – Arduino	Feb 6	Arduino, Midterm Lab Hypothesis, Project Ideas Due
Lab 4	Feb 11	Patch Clamp and Electrophysiology
Lab 4	Feb 12	Patch Clamp and Electrophysiology
Lab 4	Feb 13	Patch Clamp and Electrophysiology
Lab Practical	Feb 18	Lab 4 Report, Lab Practical
Lab Practical	Feb 19	Lab Practical
Lab Practical	Feb 20	Lab Practical
Lab 5	Feb 25	EMG and ECG
Lab 5	Feb 26	EMG and ECG
Lab 5	Feb 27	EMG and ECG
Lab 6	Mar 4	EEG
Lab 6	Mar 5	EEG
Lab 6	Mar 6	EEG

Lab 7	Mar 11	Blood Pressure and Presentation of Proposal Aims
Lab 7	Mar 12	Blood Pressure and Presentation of Proposal Aims
Lab 7	Mar 13	Blood Pressure and Presentation of Proposal Aims
No Lab	Mar 18	Spring Break
No Lab	Mar 19	Spring Break
No Lab	Mar 20	Spring Break
Open Lab	Mar 25	TBA
Open Lab	Mar 26	TBA
Open Lab	Mar 27	TBA
Lab 8	Apr 1	Ultrasound
Lab 8	Apr 2	Ultrasound
Lab 8	Apr 3	Ultrasound
Open Lab	Apr 8	Project Workday
Open Lab	Apr 9	Project Workday
Open Lab	Apr 10	Project Workday
Open Lab	Apr 15	Project Workday
Open Lab	Apr 16	Project Workday
Open Lab	Apr 17	Project Workday
Open Lab	Apr 22	Project Workday
Open Lab	Apr 23	Project Workday
Open Lab	Apr 24	Project Workday