

Biomedical Instrumentation Laboratory

BME4503L

Spring 2021

<u>Section</u>	<u>Class Period</u>	<u>Time</u>	<u>Location</u>
0733	M Period 6-8	12:50pm - 03:50pm	NSC 407
0734	M Period 3-5	09:35am - 12:35pm	NSC 407
0735	W Period 7-9	01:55pm - 04:55pm	NSC 407
0736	F Period 7-9	01:55pm - 04:55pm	NSC 407
0738	T Period 2-4	08:30am - 11:30am	NSC 407
0739	R Period 2-4	08:30am - 11:10am	NSC 407
0740	T Period 2-4	08:30am - 11:30am	online
0741	R Period 2-4	08:30am - 11:30am	online
1734	M Period 6-8	12:50pm - 03:50pm	online

Instructor:

Dr. May Mansy | mmansy@bme.ufl.edu | 352-273-5305 | BMS-JG289 |  mmansy
Student Hours: one-on-one appointments are available via Canvas calendar

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Please contact via the Canvas

- Carlos Cruz | cruzcarlos@ufl.edu
- David Hall | david.hall@ufl.edu
- Kalyn Kearney | kalynkearney@ufl.edu
- Jacob Salminen | jsalminen@ufl.edu

Course Description

1 credit lab course – introduces key components of a biomedical instrumentation system and its functionality. The lab uses fundamental electric and electronic circuits to demonstrate standard practices of the acquisition and conditioning of biosignals, basic principles of sensors and transducers, and standard electrical safety precautions required in medical applications. This laboratory course goes with BME 4503 Biomedical Instrumentation (lecture) and provides hands-on experience of topics discussed in the lecture via circuit construction, circuit simulation, and basic PCB design.

Course Pre-requisites

MAC 2313, MAP 2302 and PHY 2049

Course Co-requisites:

BME 4503

Course Goal:

This laboratory will introduce the student to the basic building blocks of biomedical instrumentation and the acquisition, measurement, and conditioning of physiological signals. Students will gain a fundamental understanding of amplifiers and the instrumental role they play in biomedical measurement devices by implementing different configurations and circuit designs and by characterizing the circuits' behavior in a circuit simulation platform. Students will explore the basic principles of temperature and stress transducers and learn about the issues, limitations, and safety considerations pertinent to medical devices. Towards the end of this lab, students will be able to build a complete, mixed-signal, ECG acquisition system and design a simple PCB.

Course Objectives

- Follow a set of instructions using logic and common sense.
- Identify, design, and construct simplified building blocks of a biomedical instrumentation system.
- Simulate and characterize the functionality and performance of a given circuit design using LTSpice or KiCad.
- Troubleshoot the interconnected blocks (subsystems) of a larger pipeline (system).
- Acquire measurements and interpret data from physiological systems.
- Appraise and evaluate the practical limitations of physiological measurements.
- Write a technical lab report in the form of an application note.
- Design a PCB in KiCad.

Materials and Supply Fees

\$26.25

Professional Component (ABET):

This course covers 1 credit of engineering topics

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	Medium
3. An ability to communicate effectively with a range of audiences	
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	High
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	High
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Required Textbooks

No textbook is required.

Required Software

- Preferred S/W:
 - KiCad. KiCad is free a one-stop-shop for circuit schematic creation, simulation, and PCB design. It is PC and Mac compatible and has a user-friendly GUI on both platforms.
 - MATLAB - student edition
- Allowed S/W:
 - LTSpice. If you have previous experience with LTSpice, you may use it for circuit schematic creation and simulation. You will still need KiCad when it comes to PCB design. LTSpice is PC and Mac compatible but has a strongly reduced GUI on Mac.
 - GNU Octave

Required technology:

- A windows compatible USB drive is required to capture results from the oscilloscope.
- A laptop, tablet, or iPad to view the lab instructions and for note-taking.
- A laptop or desktop for circuit simulation, MATLAB and Arduino programming, and PCB design. See UF-HWCOE [Computer Requirements](#) for more information.

Recommended Materials

- Medical Instrumentation Application and Design - John G. Webster, 4th edition
ISBN-13: 978-0471676003 ISBN-10: 0471676004

Tentative Course Schedule

Wk#	Wk of	Lab	Topic	Pre-Lab		Post-Lab
				Read	Asgg.	Asgg.
MODULE 1 - Operational Amplifiers (Op-Amps)						
1	01/11	--	Syllabus + Safety Rules + pre-Lab0	---	---	---
2	01/18*	L0	Introduction to circuit measurements	L0	---	L0Q
3	01/25	L1	Op-Amps: Follower and INV. amps	pL1, L1	pL1Q	L1Q
4	02/01	L2	Op-Amps: Non-INV and Diff. amps	pL2, L2	pL2Q	L2Q
5	02/08	L3	Op-Amps: Active Filters	pL3, L3	pL3Q	L3Q + Module 1 Report
MODULE 2 - Basics of Sensors						
6	02/15	L4	Sensors: Wheatstone bridge + Thermistor	pL4, L4	pL4Q	L4Q
7	02/22*		RECHARGE DAY - NO LAB			
8	03/01	L5	Sensors: Flex sensor + Potentiometer	pL5, L5	pL5Q	Module 2 Report
MODULE 3 - Intro to PCB design & Biopotentials						
9	03/08	L6	PCB design	pL6, L6	---	L6Q
10	03/15	L7	Neural recording and stimulation	TBA	TBA	TBA
11	03/22*		RECHARGE DAY - NO LAB [Optional] PCB soldering			Video-Upload
MODULE 4 - Cardiac Pacemaker						
12	03/29	L8a	ECG amplifier	pL8a, L8a	pL8aQ	No L8aQ
13	04/05	L8b	Cardiac Pacemaker (1)	pL8b, L8b	pL8bQ	L8bQ is a pdf submission
14	04/12	L8c	Cardiac Pacemaker (2)	pL8c, L8b	pL8cQ	Module 4 report

* = a day of that week is a holiday or a UF assigned recharge day; pLx = pre-Lab x; Lx = Lab x; pLxQ = pre-Lab x Quiz; LxQ = Lab x Quiz

Safety measures against COVID-19:

Following the college and CDC guidelines, the number of students present in the lab will be reduced, and a mask or other facial covering will be mandatory at all times. Students will no longer search for and gather the components/equipment from the cabinets. Instead, all components and necessary equipment will be provided at every station before your arrival. This is to minimize flow, repeated touching of general surfaces, and the spread of germs. Equipment and workstation surfaces will be sanitized before and after each use. Hand sanitizer and disinfecting wipes will be available on all workstations.

Attendance Policy in the times of COVID-19:

I designed the F2F offering of this lab to comply with CDC and HWCOE safety measures and guidelines to maintain the health and safety of my students and to minimize the spread of COVID-19 (see [UF's COVID policies section](#)). However, this laboratory offers unique hands-on training that helps you develop a skill set that is essential for your senior design project, in the short-run, and your engineering career in the long-run.

F2F attendance: You are advised to attend all labs, but it is not mandatory. Please stay home if you don't feel well. Seek medical attention if you experience cold or flu symptoms (even if mild) and notify your instructor. You are responsible for making up the labs covered in your absence and must complete 75% of the assignments to qualify for a passing grade.

Online attendance: If you don't feel comfortable to attend the lab F2F, you may choose to take the lab online. The online version of the lab will offer pre-recorded videos of the circuit building process and a live zoom session during each section's period. You will submit your work individually (or with another student) and must complete 75% of the assignments to qualify for a passing grade.

**** All students will have access to the pre-recorded videos and the live zoom session ****

Punctuality: Students are expected to arrive on time for class. Late arrivals (beyond 10 minutes) will affect your grade. Classes will start on time.

Course completion: Students must complete 75% of the assignments to qualify for a passing grade. In case that you have contracted COVID-19 and find your performance strongly affected to the extent that a 75% completion becomes questionable, then I strongly encourage you to withdraw from the course for medical reasons. [For more information on medical withdrawal, please follow UF's undergraduate catalog guidelines.](#)

Absence: Non-COVID19 or health-related excused absences must be consistent with university policies in the undergraduate catalog and [require appropriate documentation](#). Students are responsible for making up the material or activities covered in their absence. After due warning, the instructor has the right to prohibit further attendance and subsequently assign a failing grade for excessive absences. More information can be found in the [undergraduate catalog](#).

Absence due to religious observances: Students are excused from class or other scheduled academic activity to observe a religious holiday of their faith upon prior notification of their instructor. Students will be permitted a reasonable amount of time to make up the material or activities covered in their absence and will not be penalized because of the religious observances. I will do my best to keep religious holidays in mind while scheduling major academic events. Please notify me if you think I have overseen a religious holiday. No documentation is required to prove the religious observance. Furthermore, a student who believes that he or she has been unreasonably denied an education benefit due to religious beliefs or practices may seek redress through the student grievance procedure.

Class expectations in the times of COVID-19:

Arriving to class: Students are encouraged to wear a personal cloth mask with a filter insert when arriving to class. Disposable face masks will be provided as well. Some form of face covering is mandatory at all times. Make sure to clean your hands and any personal belongings (cell phone, laptop) you intend to use during the lab using the hand sanitizing stations.

Class format: Class will start with a brief PowerPoint presentation to introduce the lab topic. Then students will split into groups of two to perform the lab. The students will take notes and collect their results (images from the oscilloscope or numerical data) during the lab period and leave when they are finished.

In-class attitude: Class will be very interactive and relies heavily on your participation. So, bring your best self to class to ensure a great learning experience. Keep up with the pace, and always ask questions. If you feel like you are falling behind, raise your hand, and notify the instructor immediately. Having a bad day in general, drop me a Canvas note (see [Health and Rest section](#)). Always maintain 6 ft between you and your partner and try to minimize touching equipment or tools if you don't need to.

Electronics devices: Usage of electronic devices should be limited to take digital notes and to view the lab instructions document. Avoid distractions by social media, texts, and/or unnecessary chats with others.

Food/Drinks: Food and drinks are not allowed inside the lab. You will need to step outside if you need a drink or a quick snack and must clean your hands before and after.

Make-Up Policy

F2F Labs: You can make-up for **one** missed lab during your lab period in the following week **only**.

F2F & online students: Each student has **one** 'rain-check', which they can use to drop **one** assignment (a prelab quiz, a lab quiz).

Communication Policy:

Communication is a cornerstone of the success of the students' learning experience. Hence, to ensure a message doesn't get lost and receive a timely response, all correspondence to/from the instructor and TA should be made via Canvas messages. All important dates, announcements, and tips will be posted on Canvas. Students are fully responsible for every piece of information on Canvas and must check it regularly for updates (turn the notifications ON).

Class Material:

Pre-Lab document: The pre-lab document will be uploaded to Canvas a week before the actual lab. The pre-lab provides you with essential background information that complements the lecture material and helps you prepare for the pre-lab quiz. You must read the pre-lab document thoroughly and be familiar with the lecture topics before attempting the pre-lab quiz.

Pre-Lab quiz: the prelab quiz must be completed, **individually**, on Canvas before you arrive at the lab to ensure you are prepared for the lab and have a good idea of what it entails. **You are allowed two attempts on the pre-lab quiz, and the quiz grade is the average of both attempts.**

Lab instructions: The instructions document of every lab will be uploaded to Canvas a week before the actual lab (along with the pre-lab). The lab doc will layout the steps you need to perform in the lab. It will also include design, troubleshooting, and analysis questions (Qs) that will help prepare

you for the lab quiz and lab report. You are strongly encouraged to read the lab document before arriving at the lab.

Lab introductory notes: Each lab will start with a brief (<5min) PowerPoint presentation to ensure we are all on the same page and to announce any important considerations regarding the lab.

Lab quiz: The lab quiz is a Canvas assignment that you have to complete, **individually**, after the lab. The lab quiz ensures you have a solid understanding of the concepts and theories of the lab. **There will be only one attempt for the lab quiz.**

Module reports: Module reports are submitted, **as a group-assignment**, after completing each lab module (not each lab) and must follow the technical lab report format and guidelines provided on Canvas.

** Late submissions within 48 hours of the deadline will be allowed 90% of the full points. Submissions received 48 hours past the deadline will be allowed 60% of the full points. Submission integrity (correct file, extension, and format) is the responsibility of the student. Always view your submission after you submit!

Resolving Technical Issues:

Feel free to share any technical issues in the dedicated FAQs discussion board on Canvas. For more elaborate technical problems, visit the helpdesk website or call 352-392-4357.

Evaluation of Grades:

“You are not defined by your grade, but by your effort and morals” ~Dr. Mansy

Assignments are pedagogical tools that evaluate and assess the learning objectives listed above. This happens to result in a grade. As such, asking questions and seeking help early on can significantly improve the outcome. Evaluation is designed to allow for frequent low-stake assignments rather than a few high-stake assignments to reduce test-induced anxiety and stress.

Students will receive individual grades for pre-lab quizzes, lab quizzes, and participation. Lab reports can be a group or individual assignment. Self-assignments to groups (team of 2 students) is available on Canvas and must be within the same day’s section.

Assignment	% of Final Grade	Objective
Pre-labs - Canvas Quiz	25%	Prepare and practice theoretical concepts of the lab. Identify gaps in understanding of lecture material. Practice newly implemented design concepts.
Lab Quiz - Canvas Quiz	40%	Assess student comprehension of the design concepts. Expand the design by varying certain parameters. Identify the effect of design changes on circuit performance and functionality.
Module Reports - Canvas submission	25%	Summarize the lessons learned from a set of related labs Assess student comprehension of the theory and concepts introduced in each lab module
Participation	10%	F2F labs: this is your lab attendance and engagement. (participation in Canvas discussion board is still encouraged) Online -labs: this is your participation in Canvas discussion boards.
Total	100%	Overall class performance

Grading Policy

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
%	≥95	94-90	89-87	86-83	82-80	79-77	76-73	72-70	69-67	66-63	62-60	< 60

Percentage grades will always be rounded to the next point (92.23 will become 93%). More information on UF grading policy may be found at

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Class Ethics:

- Collaboration or teamwork in assignments is allowed and encouraged, but each student must make individual submissions of their own work for the quizzes.
- Plagiarism, the act of verbatim copying of text, figures, and/or images (essentially anything) from the web or from Canvas resources without proper citation or paraphrasing, is strictly prohibited. Plagiarism is a common infraction to the UF Honor Code. If you are confused as to what constitutes plagiarism, see here: <https://guides.uflib.ufl.edu/copyright/plagiarism> . Also, note that copying solutions for any assignment, regardless of the source (e.g., other students, pirated website solutions), will be treated as plagiarism. Turnitin will be enabled randomly, and students will be notified of any detected plagiarism.
- Team-work and discussions in lab and prelab quizzes are strictly prohibited.

Any violations of the above, or attempts thereof, will be immediately reported to the Dean of Students as a UF Student Honor Code violation

Students Requiring Accommodations

No one is perfect, and we all have something we struggle with. If you are aware of a particular difficulty, please do the following:

1. Register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation.
2. Email mmansy@bme.ufl.edu your accommodation letter, along with any additional information and set up an appointment to discuss your needs with the instructor.
3. Register for the tests through the DRC to ensure testing accommodations are met.

***** This should be done as early as possible in the semester *****

Should you, however, feel the need for accommodation at any other point in the semester, please do not hesitate to contact the instructor immediately. This can manifest in various forms, so inform the instructor of any sudden changes you experience regarding the class (see Communication Policy).

Course Evaluation

I'm personally committed to improving your learning experience. I, therefore, value and appreciate all forms of constructive feedback (positive and negative) at ANY time during the semester. Help me help you!

End of the term course evaluations are mandatory. Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.a.ufl.edu/students/>. Students will be notified when the evaluation

period opens and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge, which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe, Inclusive and Anti-racist Learning Environment

I, personally, strive for an anti-racist, inclusive and supportive classroom that welcomes every student. The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is, therefore, expected that every person in this class will treat one another with dignity and respect regardless of race, ethnicity, religion, gender, sexuality, disability, age, socioeconomic status, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind (implicit or explicit), please contact your instructor (mmansy@bme.ufl.edu) or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Furthermore, you are allowed to change your “Display Name” on Canvas to match your personal preference. To update your display name, you must go to one.ufl.edu. Click the dropdown arrow next to your profile icon in the top right corner then click Directory profile. There you can edit your Display name. It may take a business day for the update to reflect in Canvas.

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Health and Rest:

Your academic success relies on your combined physical, mental, and emotional health. Take care of your health by dedicating at least (bare minimum) 1 hour per week to exercise and 6-8 hours per day to sleep. Please speak to the instructor if you feel drained or exhausted or reach out to the many resources available on campus (see Resources section).

UF Student Success:

For improving study skills to connecting with a peer tutor, peer mentor, success coach, academic advisor, and wellness resources, go to <http://studentsuccess.ufl.edu>

UF COVID-19 policies:

1. For face to face courses a statement informing students of COVID related practices such as: We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms ([Click here for guidance from the CDC on symptoms of coronavirus](#)), please use the UF Health screening system and follow the instructions on whether you are able to attend class. [Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms](#).
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. [Find more information in the university attendance policies](#).

2. For an online course with recorded materials, a statement informing students of privacy-related issues such as:

Our class sessions may be audio-visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilized a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials are prohibited.

Campus Resources:
Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling.
<https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.