

# Biomedical Instrumentation Laboratory

## BME4503L

### Fall 2024

<i>Section</i>	<i>Class Period</i>	<i>Time</i>	<i>Location</i>
11314	T   Period 3 - 5	9:35 AM - 12:35 PM	NSC 407
11330	W   Period 3 - 5	9:35 AM - 12:35 PM	NSC 407
11315	R   Period 3 - 5	9:35 AM - 12:35 PM	NSC 407

#### ***Instructor:***

Dr. May Mansy | [mmansy@bme.ufl.edu](mailto:mmansy@bme.ufl.edu) | 352-273-5305 | BMS-JG289 |  mmansy  
[Book a Meeting with Me](#) | [Request A Letter of Recommendation](#)

#### ***Supervised Teaching Student / Teaching Assistant***

Joseph Cox | [cox.j@ufl.edu](mailto:cox.j@ufl.edu)

Miguel Contreras | [contreras.miguel@ufl.edu](mailto:contreras.miguel@ufl.edu)

Lu Chen | [clu1@ufl.edu](mailto:clu1@ufl.edu)

#### ***Learning Assistant:***

TBD

#### ***Course Description***

1 credit lab course – The laboratory will introduce the student to the basic building blocks of biomedical instrumentation using simplified electric and electronic circuits that allow the acquisition, measurement, and conditioning of physiological signals. Students will gain a foundational understanding of amplifiers and the instrumental role they play in biomedical devices by designing, building, and characterizing different circuit configurations on a breadboard and in the circuit simulation platform KiCad. Students will explore the basic principles of sensors and transducers while constructing clinically-relevant temperature and strain measurement circuits. They will also learn about the limitations and safety considerations pertinent to medical devices. Toward the end of the lab, students will be able to build a complete, mixed-signal EKG acquisition system and design a simple PCB. This laboratory course complements BME 4503 Biomedical Instrumentation (lecture) and provides hands-on experience of the topics discussed in the lecture via circuit construction, circuit simulation, and foundational PCB design.

#### ***Course Pre-requisites***

MAC2313, MAP2302, PHY2049, and EEL3003 or  
EEL3111C with min grades of C. **Now is a good time  
to review the material of those courses!**

#### ***Course Co-requisites:***

BME 4503 and BME3508

### ***Course Objectives***

- 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

- 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

### 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, 4<sup>th</sup> edition  
ISBN-13: 978-0471676003 ISBN-10: 0471676004

### Tentative Course Schedule

Wk#	Wk of	Lab	Topic	Pre-Lab		Post-Lab
				Read	Assg.	Assg.
MODULE 1 - Operational Amplifiers (Op-Amps)						
1	08/26	--	Syllabus + Intro to KiCad (pre-Lab 0)	---	---	---
2	09/02*	L0	Intro to circuit measurements + safety	L0	---	L0Q
3	09/09	L1	Op-Amps: Follower and INV. amps	pL1, L1	pL1Q	L1Q
4	09/16	L2	Op-Amps: Non-INV and Diff. amps	pL2, L2	pL2Q	L2Q
5	09/23	L3	Op-Amps: Active Filters	pL3, L3	pL3Q	L3Q + Module 1 Report
MODULE 2 - Intro to PCB design						
6	09/30	L6a	PCB design	pL6, L6	---	L6Q
MODULE 3 - Basics of Sensors						
7	10/07	L4	Sensors: Wheatstone bridge + Thermistor	pL4, L4	pL4Q	L4Q
8	10/14*	L5	Sensors: Flex sensor + Potentiometer	pL5, L5	pL5Q	Module 3 Report
9	10/21	L7	Build Your Own Design (BYOD)	TBA	TBA	
MODULE 4 - Cardiac Pacemaker						
10	10/28	L8a	ECG amplifier	pL8a, L8a	pL8aQ	No L8aQ
11	11/04	L8b	Cardiac Pacemaker (1)	pL8b, L8b	pL8bQ	L8bQ is a pdf submission
12	11/11	L8c	Cardiac Pacemaker (2)	pL8c, L8b	pL8cQ	Module 4 report
13	11/18	L6b	PCB Soldering			
14	11/25*		*Thanksgiving break* - No Lab			
15	12/02*		*Reading Days* - No Lab			

### Attendance Policy:

The biomedical instrumentation laboratory is a BME core course that offers unique hands-on training that helps you develop a skillset essential for your junior and senior design projects in the short run and your BME career in the long run. Therefore, attendance of all labs is **mandatory** and will be tracked by the participation assignment.

**Punctuality:** Lab will start promptly at 9:35am. Students are expected to arrive on time (9:30am). Unexcused late arrivals of 10 minutes or more will affect your grade by-2pts from the lab's participation assignment for every 10 minutes, up to 30 minutes. Late arrivals, after 30 minutes, are not permitted into the lab. Excused late arrivals must be consistent with university policy.

**Course completion:** Students must complete 75% of the assignments to qualify for a passing grade.

### Absence:

- Requirements for class attendance are consistent with university policies. Click here to read the university attendance policies: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>
- 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. 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.
- 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](#).
- Unexcused absence will void the participation assignment of the corresponding lab.

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:***

Class format: This is a 100% **in-person** lab. 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, collect data/results (images from the oscilloscope or numerical data) during the lab period, and leave when they have completed the lab. Students must submit their participation assignment **\*\*before\*\*** they leave the lab.

### 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](#)).

Electronics devices: The usage of electronic devices should be limited to taking digital notes and viewing the lab instructions document. Avoid distractions by social media, texts, and/or chats.

Food/Drinks: Food and drinks are **not allowed** inside the lab.

### ***Make-Up Policy***

- You can only make up for **one** missed lab during one of the three lab sections the **following week**.

- Each student has one “rain-check”, which they can use to drop one attempt of one prelab quiz at the end of the semester (**must have submitted both of the quiz attempts**).

***The Learning Assistant (LA) – a new resource for academic success:***

The LA is a fellow undergraduate BME student who successfully completed this course and is trained in pedagogical methods and learning techniques. The LA will help you navigate the content of the course and create more efficient study habits. They have learned how to become a better learner and will help you become a better learner too! Reach out to your LA, when you feel stuck, overwhelmed, or need guidance as to where to start or how to approach course-relevant problems.

***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 essential background information that complements the lecture material (BME4503) 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 (Lab doc): The instructions document for every lab will be uploaded to Canvas a week before the actual lab (along with the pre-lab). The lab doc will lay out 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 advised to read the lab doc before arriving to the lab.

Lab intro: Each lab will start with a brief (10-15min) PowerPoint presentation to ensure we are well prepared for the lab and to announce any critical considerations regarding the lab.

Lab quiz: The lab quiz is a Canvas assignment you must 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 due one week after the lab.**

Participation: The participation assignment is a semester-long assignment that tracks attendance and engagement. Each lab will have a set of practice questions and/or design exercises that you must complete before leaving the lab. Answers are submitted **individually** via Canvas to the Participation assignment, and your grade will accumulate every week. The participation assignment is due **\*\*BEFORE\*\*** you leave the lab.

**Module reports:** Module reports are submitted **as a group assignment** and cover one lab module. The module report follows the format of an application note and will be graded/monitored weekly through partial submissions due one week after each lab. Partial credit will be given and will count toward the final report grade. The module report template will be released on Canvas at the beginning of every Module.

**Late submissions:** Late submission of the quizzes and Module reports within 48 hours of the deadline will be allowed **80%** of the full points. Submissions received 48 hours past the deadline will be allowed **50%** of the full points. Submission integrity (correct file type, extension, and format) is the responsibility of the student. ***Always view your submission after you submit it to avoid losing points! Late submissions of the participation assignment will not be accepted.***

### ***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. Module reports are group assignments. 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-lab Quizzes	25%	Prepare and practice the theoretical concepts of the lab. Identify gaps in understanding of lecture material. Practice newly implemented design concepts.
Lab Quizzes	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	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%	Monitor weekly attendance and engagement. Assess student comprehension of the circuit they built before leaving the lab.
<b>Total</b>	<b>100%</b>	<b>Overall class performance</b>

### ***Grading Policy***

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
%	≥94.5	90.0 - 94.4	86.7 - 89.9	83.4 - 86.6	80.0 - 83.3	76.7 - 79.9	73.4 - 76.6	70.0 - 73.3	66.7 - 69.	63.4 - 66.6	60.0 - 63.3	0 - 59.9

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.
- You are encouraged to leverage AI tools to enhance your understanding of the class material and topics, but copy-pasting AI-generated output is prohibited; this is plagiarism. All student submissions will be checked for AI usage.
- 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 of the answers to 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/](http://www.dso.ufl.edu/drc/) ) by providing appropriate documentation.
2. Email [mmansy@bme.ufl.edu](mailto: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).

### ***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.

### ***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.aa.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.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.



### ***In-Class Recording***

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### ***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 and Inclusive 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](mailto: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](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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>

### ***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](mailto: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](mailto: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/>.

**COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

**Academic Resources**

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto: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](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

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