Biomedical Instrumentation

BME4503 Section 0713
***Class Periods:*** M, W, F | Period 6 (12:50 PM – 01:40 PM)
***Location:*** LAR 0310
***Academic Term:*** Fall 2025

### *Instructor:*
Dr. May Mansy | mmansy@bme.ufl.edu |352-273-5305 | BMS-J289 | mmansy
Student Hours: F 10:30 am - 11:30 am or Book a Meeting with Me
Request A Letter of Recommendation

### *Teaching Assistant:*
Chance Fleeting | cfleeting@ufl.edu
Student Hours: T & F 5:00 pm - 6:00 pm

### *Learning Assistant:*
Miranda Torres Garcia | mtorresgarcia@ufl.edu
Kadin El Bakkouri | kelbakkouri@ufl.edu

### *Syllabus Policy:*
It is your responsibility to read and adhere to the instructions, guidelines, and schedules outlined in this syllabus, as well as to check the Canvas site regularly for updates or announcements about any changes. Failing to review the syllabus or announcements will not be accepted as a valid excuse for missing assignments or deadlines.

### *Course Description:*
3 credits – Provides engineering and clinical fundamentals involved in acquiring, measuring, and processing physiological signals. Covers operational amplifier (op-amp) circuits for signal conditioning, amplification, and spectral filtering relevant to physiological signals. Explores biosensors and bioelectrodes used in biomedical applications such as photoplethysmography (PPG), electrocardiography (EKG), electrophoresis, and TENS. There is a hidden easter egg in this syllabus. Continue reading to find it and earn a prize. Introduces digital systems and Boolean logic to enable the prototyping of clinical devices.

### *Course Pre-Requisites:*
MAC 2313, MAP 2302, PHY 2049, and EEL 3003 with minimum grades of C

### *Co-Requisites:*
BME 4503L – you must be enrolled in the lab to attend the lecture class

***Now is a good time to review the material from previous courses!***

### *Course Objectives:*

Upon completion of the course, students are expected to:

- Identify the basic building blocks of a biomedical instrument/measuring device.
- Design operational amplifier circuits to meet specific design requirements.
- Analyze the functionality and performance of a given circuit design.
- Recognize and describe the underlying bio-physical principle of biosensors and bioelectrodes.
- Characterize bio-sensor properties.
- Analyze and design simple digital logic circuits.
- Recognize discussed concepts and theories in commercial medical devices.

***Materials and Supply Fees:*** None

### *Relation to Program Outcomes (ABET):*

| ABET Outcome | Coverage* |
|---|---|
| 1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics | High - Reinforced |
| 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 | |
| 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, environmental, and societal contexts | |
| 5. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives | |
| 6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | High - Introduced |
| 7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies | |

### *Recommended Textbook and Software*

- Webster, John G. Medical Instrumentation: Application and Design, 4th Edition, John Wiley & Sons.
- R. J. Tocci, N. S. Widmer, and G. L. Moss, Digital systems: principles and applications, 10th ed., International ed. Upper Saddle River, NJ: Pearson/Prentice Hall, 2007.

### *Recommended Material*

Resources and supplemental reading will be provided by the instructor on Canvas

## *Tentative Course Schedule*

| Week# | Week of | Topic |
|---|---|---|
| **Module 1: Analog Circuits and Operational Amplifiers** | | |
| 1 | 08/25 | Basics of medical instrumentation & circuits primer |
| 2 | 09/01* | Op-amps: Follower, Inverting, Summing |
| 3 | 09/08 | Op-amps: Noninverting, Difference, Instrumentation |
| 4 | 09/15 | Op-amps: Active Filters |
| **Module 2: Basics of Biopotentials and Sensors** | | |
| 5 | 09/22 | Sensor Properties, Wheatstone bridge, Thermal Sensors |
| 6 | 09/29 | Resistive, Capacitive Sensors |
| 7 | 10/06 | Origins of Biopotentials |
| 8 | 10/13* | Case Study: EKG & the cardiac vector |
| 9 | 10/20 | Biopotential Electrodes |
| **Module 3: Digital Circuits and Safety** | | |
| 10 | 10/27 | Comparators, Digital Logic |
| 11 | 11/03 | Boolean Logic & Logic Gates |
| 12 | 11/10 | Final Project - Build Your Own Design |
| 13 | 11/17 | Final Project - Build Your Own Design |
| 14 | 11/24* | *Thanksgiving break* |
| 15 | 12/01* | Last Lecture |

* Indicates a holiday during this week.

## *Important Dates (subject to change)*

*September 24, 2025 Exam #1 (6 pm in **TBD**)*
*October 29, 2025 Exam #2 (6 pm in **TBD**)*
*** There is no scheduled final exam; the designated timeframe is only for make-up exams. See Make-up section.*

## *Attendance Policy:*

Attendance: This course is conducted entirely in person with no online options. As such, you are expected to attend all lectures. While attendance does not count towards the course grade, it is essential for ensuring solid comprehension of the course material.

Participation: Class participation will be assessed through low-stakes lecture quizzes on Canvas. Lecture quizzes are open for one week.

*Absence:*

- Requirements for class attendance are consistent with university policies. Click here to read UF 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.
- 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 holy day of their faith, upon prior notification to their instructors. 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 religious observance.

## *Class expectations:*

Class format: The class is in person and will follow a classic lecture-based format using PowerPoint slides and in-class activities and discussions.

In-class attitude:
Class will be interactive and heavily relies 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, notify the instructor immediately. If you are having a bad day in general, drop me a Canvas note (see Health and Rest section).

Exams: There are two exams, each covering one module. The exams are untimed and will be in person during assembly exam periods, usually starting at 6 pm. *The exams are designed to be completed in one hour, and their final dates will be announced on Canvas*.

## *Make-up Policy:*

Exams: Since we don't have a final exam, we will use that time frame to make up for missed exams. If you miss one of the two exams, you may make it up on December 11, 2025, in LAR 310, 12:30 - 02:30 pm, which is the timeframe designated for the final exam. You must coordinate the makeup exam with the teaching team.

## *Communication Policy:*

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

## *Class Material:*

Lectures: Lecture notes will be provided in two forms to accommodate all types of learners:

1- pdf lecture notes: clean, unmarked pdf of the lecture's PowerPoint.
2- Annotated pdf lecture notes: annotated pdf of the lecture's PowerPoint.

All lecture resources will be uploaded to Canvas by the instructor on the day of the class meeting. Students are strongly encouraged to read the notes before attending class and should take their own notes during the lecture to complement the pdf. Be reminded that the class notes are meant to illustrate complex concepts and thus may not be fully comprehensive. As such, lecture notes do not substitute for the supplemental readings. Students are responsible for covering lecture notes and supplemental reading material.

Supplemental reading material: Supplemental material will be provided by the instructor and posted to Canvas. All material posted to Canvas is eligible for inclusion and assessment in exams and homework unless otherwise noted by the instructor.

Homework: Homework will be assigned on Canvas and is always due at midnight. Get an early start on your homework using the preview pdf to help you keep the structure of your learning experience. The hunT continues. Keep going for more info. Submission integrity (correct file, file extension, and format) is the responsibility of the student when a file upload is required. Always view your submission after you submit it.

Lecture Quizzes: Lecture quizzes serve as quick checkpoints for your content knowledge and will be assigned on Canvas after class.

## *Evaluation of Grades:*

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

Assignments are pedagogical tools to evaluate and assess learning objectives. 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-stakes assignments rather than a few high-stakes assignments to reduce test-induced anxiety and stress.

| Assignment | % of Final Grade | Objectives | Submission | Grading |
|---|---|---|---|---|
| Participation (Lecture Quizzes) | 10% | • Identify key concepts and terminology introduced in the lecture.<br>• Demonstrate comprehension of foundational ideas through formative (real-time) assessments. | Individual on Canvas | Percentage |
| Homework | 30% | • Practice & apply newly introduced concepts.<br>• Extend classroom concepts by solving problems that require the synthesis of multiple ideas. | Individual on Canvas | Percentage |
| Exam I (Module 1) | 20% | • Demonstrate understanding of operational amplifier principles and basic analog circuit design.<br>• Solve quantitative problems to verify comprehension of core instrumentation theory.<br>• Evaluate circuit behavior based on input-output relationships | Individual on Canvas | Percentage |
| Exam II (Module 2) | 20% | • Characterize biopotential signals and biosensor characteristics in a biomedical context.<br>• Apply circuit modelling techniques to design sensing circuits.<br>• Differentiate among biosensor types based on signal sources and desired system behavior. | Individual on Canvas | Percentage |
| Final Project (Video & Presentation) | 20% | • Design a functional biomedical circuit system that integrates analog and digital subsystems.<br>• Collaborate effectively to prototype, troubleshoot, and document a working design.<br>• Justify design decisions based on theoretical knowledge, simulations, and experimental outcomes. | Group in OneNote & Canvas | Specifications |
| **Total** | **100%** | | | |

## *Grading Policy*

*Percentage Grading:* Lecture quizzes, Homework, & Exams will be graded according to UF's percentage 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

*Complete / Incomplete Marking Scale*

The Final Project Demo video and Group Presentation will be evaluated using the following marks:

- **C - Complete**: The submission meets all major criteria, demonstrates meaningful effort and engagement, and follows the required format.
- **I - Incomplete/Revise:** The submission is missing key components, lacks sufficient depth, or does not follow expectations. An "Incomplete" may be revised and resubmitted within 1 week of receiving feedback. Each revision will require **1 token per student** in the group. Revisions are expected to be thoughtful and substantive. Quick, superficial edits may be returned without further re-evaluation and revisions.

## *Token System Policy:*

Each student begins the semester with **5 tokens**, which can be used across both BME 4503L and BME 4503. Tokens offer flexibility while encouraging responsibility and planning. It's a system that encourages you to focus on doing the work well, not just "getting it done." You may use tokens as follows:

- **1 token per student** – to revise and resubmit the final project.
- **3 tokens** – to revise one (1) exam question. To qualify, they must notify the instructor and submit evidence of further practice, namely, two fully worked-out and explained problems, before retaking the question during the next exam period
- **1–2 tokens** – to excuse a late submission (see Late Submission Policy for details).

Tokens are non-transferable and cannot be shared between students. Use them wisely! Use your tokens strategically, as they are a limited but flexible resource intended to support your learning. Carefully review the feedback you receive and revise your work thoughtfully within the designated timeframe to demonstrate mastery. If you anticipate any challenges in meeting deadlines or assignment expectations, communicate with the instructor early, as effective planning and timely communication are essential skills for your future career.

## *Late Submission Policy*

- **Delays < 1 day (grace window):** Accepted without penalty if accompanied by a brief written reflection (approximately 200 words) explaining what caused the delay, and what might help you stay on track in future submissions. The reason for the delay must be meaningful. For example, "I forgot; it won't happen again" won't suffice and will **cost 1 token**.
- **Delays > 1 day:** Excused for **1 token**, unless a UF-approved excuse is provided. Without a token or valid excuse, the assignment will receive a maximum of **80% credit**.
- **Delays > 2 days:** Excused for **2 tokens**, unless a UF-approved excuse is provided. Without a token or valid excuse, the assignment will receive a maximum of **50% credit**.

### *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 and homework.
- 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 of the UF Honor Code. If you are confused as to what constitutes plagiarism, see here: https://guides.uflib.ufl.edu/c.php?g=147797&p=967443 . Also, note that copying solutions for any assignment, regardless of the source (e.g. Canvas, other students, AI, pirated website solutions), will be treated as plagiarism. You are very close to reaching the final instruction of the hƯnt. Turnitin will be enabled randomly, and students will be notified of any detected plagiarism. Own your choices, produce your own work, and take pride in it!

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

### *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 Student Success Section).

***Student Privacy***
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. Don't share the hᴜnT with others. Let everyone have their own fun. For more information, please see: https://registrar.ufl.edu/ferpa.html

***UF Student Success:***
For improving study skills, connecting with a peer tutor, peer mentor, success coach, academic advisor, and wellness resources, go to http://studentsuccess.ufl.edu.
To support consistent and accessible communication of university-wide student resources, please follow this link to academic policies and campus resources: https://go.ufl.edu/syllabuspolicies. Instructor-specific guidelines for courses must accommodate these policies.

***Commitment to a Safe and Brave Learning Environment***
I, personally, strive for a supportive, safe, and brave classroom that welcomes every student. It is, therefore, expected that every person in this class will treat one another with dignity and respect. You read the syllabus and completed the quest. To collect your prɪz€, find a picture of a baby panda and send it to me for one extra point towards participation before 08/22 11:59pm. Also, add the word panda after your signature in the syllabus assignment. Don't share this with others so they can have their own fun. The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.
If you feel like your performance in class is being impacted, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@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.uf.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.