Biomedical Signals & Systems

BME3508 Section 034G
Class Periods: M, W, F | Period 7 (01:55 PM - 02:45 PM)
Location: FAB 0105
Academic Term: Fall 2022

Instructor:
Dr. May Mansy | mmansy@bme.ufl.edu |352-273-5305 | BMS-J289
Student Hours: W 3:30-4:30pm , R 1:00-2:00pm in BMS-J289.
One-on-one appointments will be available/scheduled via the Canvas calendar.

Teaching Assistant:
Lihan Cui | lihancui@ufl.edu *Student Hours:* TBD

Course Description
3 credit course – This course introduces the basic theory and concepts of signals and systems from a biomedical engineering perspective. The characterization and analysis of man-made as well as stochastic biological signals, in the time and frequency domains, are discussed and implemented using MATLAB.

Course Pre-Requisites / Co-Requisites
Pre-Requisites: EEL3003 or EEL3111C and MAC2313 with min grades of C. *Now would be a good time to review the material of those courses!*

Course Goal:
This course will introduce the student to the major concepts and methods for the characterization and analysis of deterministic as well as random signals in biological systems. Students will acquire tools and develop a mindset that enables them to apply signals & systems concepts to various biomedical applications, on the microscopic and macroscopic levels. Students will be able to mathematically describe and solve engineering problems.

Learning Objectives:
Students are expected to:
1. Recognize and identify components, parameters, and variables of biological systems.
2. Describe biological signals and systems using the appropriate terminology and mathematical representation.
3. Characterize systems using the appropriate terminology and mathematical representation.
4. Quantitatively and qualitatively explain and predict the functionality and performance of a system for a given signal.
5. Apply basic methods for the appraisal and analysis of biological signals using MATLAB.

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	Medium - Introduced
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 and inclusive 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	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Required Software

- MATLAB with Simulink – student edition

Recommended Textbooks and Material

- Linear Systems and Signals, by B.P. Lathi (Author), Roger Green, Oxford press, 3rd edition, ISBN-10: 0190200170
- Signals and Systems using MATLAB, by Chaparro and Allen, academic Press, 3rd edition ISBN-10: 0128142049
- The Intuitive Guide to Fourier Analysis & Spectral Estimation, by Charan Langton and Victor Green. E-copy will be provided with the author's permission

More resources and supplemental reading will be provided by the instructor on Canvas

Tentative Course Schedule

Week#	Week of	Topic
Module 1 - The Time Domain		
1	08/22	Introduction to biological signals & systems
2	08/29	Time-domain properties
3	09/05	Time-domain operations
Module 2 - The Frequency Domain		
4	09/12	Introduction to the frequency domain
5	09/19	Fourier series, Magnitude & Phase Spectra
6	09/26	Fourier transform, pairs & properties
7	10/03	Power Spectral Density (PSDs), Spectrograms and Noise
Module 3 - Intro to Systems		
8	10/10	System Topology & Properties
9	10/17	Response of an LTI system, Impulse response, convolution,
10	10/24	Frequency response & analog filters
11	10/31	Sampling theorem & Digital/Discrete systems
Module 4 - Random Variables		
12	11/07	Primer to random variables and stochastic processes
13	11/14	Similarity measures
14	11/21*	**** Thanksgiving Holiday ****
15	11/28	Similarity measures + Final Project
16	12/05	Final Project

Attendance Policy:
Attendance: This course is categorized as 100% in-person with no online options. Therefore, you are expected to attend all lectures.

Participation: Class participation will be assessed through low-stakes lecture quizzes via Canvas.

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.
- 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 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 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.

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.

Class expectations:
Class format: This is an **in-person class** and it will follow a classic lecture-based format using PowerPoint slides, MATLAB demonstrations and in-class activities. All lectures will be recorded and made available on Canvas for review and reinforcement purpose. Recorded lectures **do NOT replace attendance** and may not capture in-class activities and MATLAB Demos.

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).
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators:

- 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.
- Hand sanitizing stations will be located in every classroom.

Exams: Each exam will cover one module. Exams will be in-person during assembly exam periods (E1-E3) and their dates will be announced on Canvas.

Make-up Policy:
Lecture quizzes: No make-up allowed.

Exams: Make-up is allowed for only **one** exam and **under the following conditions**: 1) The student has informed the instructor of the absence at least 24hrs before the exam. 2) the student has provided adequate documentation for the absence. 3) the make-up exam must be conducted within one week of the original exam date unless the absence is due to COVID-19 illness. COVID-19 absences will be considered on a case-by-case basis. Make sure you communicate your situation to the instructor as soon as you can.

** Each student has **one** 'rain-check', which they can use to drop **one lecture quiz** or **one HW attempt** at the end of the semester **.

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**. All important dates, tips, and announcements will be made through Canvas. Students are fully responsible for every piece of information on Canvas and must check it regularly for updates (turn on notifications).

Class Material:
Lectures: Lecture notes will be provided in three forms to accommodate all types of learners:
1- Module content pdf[1]: All lectures of the module in a single pdf file.
2- pdf Lecture notes: clean, unmarked pdf of the lecture PowerPoint.
3- Annotated pdf Lecture notes: annotated pdf of the lecture PowerPoint.
4- Video lecture: Narrated and annotated video recording of each lecture (uploaded **after** class).

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 coming to class and should take their own notes during the lecture to complement the pdf. Be reminded that the lecture notes are meant to illustrate complex concepts and thus may not be fully comprehensive. As such, lecture notes do not substitute the supplemental readings. Students are responsible for covering lecture notes and supplemental reading material. Recorded lecture notes (video lecture) complement the pdf lecture notes and are not a sufficient study source.

Supplemental reading material: Supplemental material will be provided by the instructor and posted to Canvas. All material posted to Canvas is exam and homework relevant unless otherwise noted by the instructor.

[1] The Module pdf gives a good overview of the content that will be covered in a module. However, the most up-to-date material will be in the individual lecture note pdfs.

Homework: Homework will be assigned on Canvas and is always due at midnight. Get an early start on your homework to help you keep structure of your learning experience. *Homework submissions 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, extension, and format) is the responsibility of the student. Always view your submission after you submit it

Lecture Quizzes: lecture quizzes will be assigned on Canvas after class. The due date will be shown on Canvas and *late submission will not be considered*.

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

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.

Evaluation of Grades:
"You are not defined by your grade, but by your effort and morals" ~Dr. Mansy
Assignments are educational tools to evaluate and assess the desired 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-stake assignments rather than few high-stake assignments to reduce test-induced anxiety and stress.

Assignment	% of Final Grade	Objective
Participation – Lecture Quizzes	10%	Monitoring of participation & engagement Real-time evaluation of the comprehension and apprehensions of the material
Homework Sets	35%	Practice newly introduced concepts. Implement new concepts in MATLAB. Solve problems that reinforce the understanding of the theory Solve problems that extend the concepts taught in class
Test I (Module 1)	14%	Assess student comprehension of the theory and concepts introduced in module 1
Test II (Module 2)	14%	Assess student comprehension of the theory and concepts introduced in module 2
Test III (Module 3)	14%	Assess student comprehension of the theory and concepts introduced in module 3
Final Project	13%	Assess student comprehension of the theory and concepts introduced in modules 1-4
Total	100%	Overall class performance

Grading Policy

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
%	≥95	90-94	85-89	80-84	75-79	70-74	65-69	60-64	55-59	50-54	45-49	< 45

Percent grades will be rounded to the next point (92.5 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 and homework.
- 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.

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.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/.

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, 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.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.

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 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/.

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) 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 suppor*t*, 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.