FLORIDA ATLANTIC UNIVERSITY

NEW COURSE PROPOSAL
Graduate Programs

UGPC Approval _____
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner _____
Catalog _____

Department Biomedical engineering

College COECS

(*To obtain a course number, contact* ***erudolph@fau.edu***)

Prefix BME **Number** 5521	*(L = Lab Course; C = Combined Lecture/Lab; add if appropriate)* **Lab Code**	**Type of Course** Lecture	**Course Title** Biosignal Processing

Credits *(See Definition of a Credit Hour)*
3

Effective Date *(TERM & YEAR)*
Spring 2026

Grading *(Select One Option)*
Regular (●)
Sat/UnSat ( )

Course Description *(Syllabus must be attached; see Template and Guidelines)*
The Advanced Biorobotics course explores the exciting field where biology meets robotics. Students will learn how biological systems inspire the creation of innovative robotic technologies that mimic natural movements and functions. The course covers key topics including robot design, motion analysis, sensor technology, and simulation tools. Through lectures, hands-on labs, and projects, students will design and build robots that are inspired by biological systems. This course equips students with the skills to advance in robotics and bioengineering, using nature's designs to solve technical challenges in creative and efficient ways

Prerequisites
EEL 3502 or equivalent.

Prerequisites, Corequisites and Registration Controls are enforced for all sections of course.

Academic Service Learning (ASL) course ☐
Academic Service Learning statement must be indicated in syllabus and approval attached to this form.

Corequisites
NA.

Registration Controls *(For example, Major, College, Level)*
BME, COECS, Graduate

Minimum qualifications needed to teach course:
Member of the FAU graduate faculty and has a terminal degree in the subject area (or a closely related field).

List textbook information in syllabus or here
Lecture notes.

Faculty Contact/Email/Phone
Dr. Bhenaz Ghoraani ; bghoraani@fau.edu

List/Attach comments from departments affected by new course
There is no other course affected.

Approved by		***Date***
Department Chair	Javad Hashemi	3/27/25
College Curriculum Chair	Francisco Presuel-Moreno	4/8/2025
College Dean	Raquel Assis	4/8/2025
UGPC Chair		
UGC Chair		
Graduate College Dean		
UFS President		
Provost		

Email this form and syllabus to UGPC@fau.edu 10 days before the UGPC meeting.

BME 5521

Biosignal Processing

3 credits

Fall, 2025

Prof. Behnaz Ghoraani
Office: Building EE 96, Office: 319
Office hours: with appointment
Classroom: TBD
Telephone: 561-297-4031
Email: bghoraani@fau.edu

TA name	TBD
Office	TBD
Office hours	TBD
Email	bghoraani@fau.edu

Course Description

This course covers the generation of bioelectrical signals, their acquisition, modeling, and analysis. Modeling and analysis tools cover adaptive filtering, time-frequency analysis, model-based spectral analysis, stochastic signals, and signal representation in orthogonal bases: wavelet transforms. The physiology of electrical signal generation covers ionic transport in cellular membranes and propagation of electrical signals in cells and tissues. The range of biomedical signals covered includes such common signals as the electroencephalograms, evoked potentials, electromyograms, electrocardiograms. The students write MATLAB or Python codes to perform common signal analysis such as filtering, autocorrelation and covariance, Fourier-based spectral analysis, the short-time Fourier transform, and noise reduction.

Instructional Method

In-Person and Distance learning sections. The lectures will be recorded in zoom. There will be no live streaming of the lectures.

Prerequisites/Corequisites

EEL 3502 Signals and Digital Filter Design or equivalent.

Course Objectives/Student Learning Outcomes

This course provides a comprehensive overview of techniques of processing bioelectrical signals. It is problem-based and programming oriented. Students are expected to code in MATLAB or Python at a level where they can use programming to verify and demonstrate concepts. Demonstration of work will be done with synthetically generated waveforms and real data.

Course Evaluation Method

Program-based assignments 70%
Project 30%

For the project, the students will identify a scientific article for review and implementation. The students will prepare a 10-page technical report to discuss the problem in the paper, the methods applied, implementation of the method in the paper, and their results. Also, the students will propose a new approach to address the problem and compare their results with the methods found in the paper. The students will deliver a 15-minutes presentation and present their final work to the class for further discussions with their peers.

Course Grading Scale

Letter Grade	Total (%)
A	94 - 100%
A-	90 - 93%
B+	87 - 89%
B	83 - 86%
B-	80 - 82%
C+	77 - 79%
C	73 - 76%
C-	70 - 72%
D+	67 - 69%
D	63 - 66%
D-	60 - 62%

Policy on Makeup Tests, Late Work, and Incompletes (if applicable)

Incomplete grades are assigned only if there is solid evidence of medical or otherwise serious emergency situation incomplete grades will not be given.

Late assignment submissions will not be graded, and the student will receive a zero for that assignment. There are no make ups for the assignments.

The following applies to the project: after 1 day, the students will lose 25% and after 2 days, 50% of marks. The student will receive a zero after the 2nd day of due date.

Special Course Requirements (if applicable)

All assignments are due by 11:59 PM on the due date. However, it is recommended that you submit your work by 9:00 pm in case you encounter any technical difficulties.

1. Canvas registration is required.
2. The instructor will regularly post materials/announcements on Canvas. It is student's responsibility to regularly check Canvas and their FAU email for the most recent information.
3. Participation in University-approved activities or religious observances, with prior notice, will not be penalized.
4. Students should have an operational computer system equipped with Windows 10 or macOS Sierra (or higher), Microsoft Office, web browser, etc.

5. All assignments will be submitted to Canvas. You must be able to scan answers, combine and upload them to Canvas as needed.
6. All questions must be sent publicly through Canvas, on the FAQ Discussion Board, so other students also benefit from the answers. Only personal or confidential matters should be sent via email to the professor, all others will be ignored.

More details will be announced throughout the semester. It is students' responsibility to review and follow communications posted by the instructor.

HARDWARE & SOFTWARE REQUIREMENTS

Hardware

- Dependable computer
- Computer speakers
- Headset with microphone
- Webcam
- Printer
- Printer paper
- Ink
- Scanner

Software

- Microsoft 365 Suite
- MATLAB or Python programing software
- Reliable web browser (recommended Chrome)
- Canvas mobile app: Download instructions for iOS device or Android device
- Adobe Reader
- Adobe Flash Player

Classroom Etiquette Policy (if applicable)

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001. If your college has particular policies relating to cheating and plagiarism, state so here or provide a link to the full policy—but be sure the college policy does not conflict with the University Regulation.

Due to the casual communication common in the online environment, students are sometimes tempted to relax their grammar, spelling, and/or professionalism; however, please remember you are adult students and professionals—your communication should be appropriate. You are expected to use correct spelling and grammar and write in complete sentences. Also, please note that in the online environment you do not have the advantage of voice inflection or gestures. As a result, sarcasm can come across very negative, so this form of communication should be

avoided. When writing on the discussion board or responding to classmates' posts, please remember that you are responding to the ideas of the writer: keep your communication professional and on-topic.

Policy on the Recording of Lectures

Students enrolled in this course may record video or audio of class lectures for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach students about a particular subject. Recording class activities other than class lectures, including but not limited to student presentations (whether individually or as part of a group), class discussion (except when incidental to and incorporated within a class lecture), labs, clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, and private conversations between students in the class or between a student and the lecturer, is prohibited. Recordings may not be used as a substitute for class participation or class attendance and may not be published or shared without the written consent of the faculty member. Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct and/or the Code of Academic Integrity.

Attendance Policy

Students are expected to attend all of their scheduled University classes and to satisfy all academic objectives as outlined by the instructor. The effect of absences upon grades is determined by the instructor, and the University reserves the right to deal at any time with individual cases of non-attendance. Students are responsible for arranging to make up work missed because of legitimate class absence, such as illness, family emergencies, military obligation, court-imposed legal obligations or participation in University-approved activities. Examples of University-approved reasons for absences include participating on an athletic or scholastic team, musical and theatrical performances and debate activities. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting. Instructors must allow each student who is absent for a University-approved reason the opportunity to make up work missed without any reduction in the student's final course grade as a direct result of such absence.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being. For more information, go to http://www.fau.edu/counseling/

Disability Policy

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses – Boca Raton, Davie and Jupiter – however disability services

are available for students on all campuses. For more information, please visit the SAS website at www.fau.edu/sas/.

Code of Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high-quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001.

If your college has particular policies relating to cheating and plagiarism, state so here or provide a link to the full policy—but be sure the college policy does not conflict with the University Regulation.

Required Texts/Readings

N/A.

Supplementary/Recommended Readings

Bioelectrical Signal Processing in Cardiac and Neurological Applications by Leif Sornmo and Pablo Laguna. Elsevier Academic Press, ISBN: 978-0-12-437552-9, 2005

R.M. Rangayyan, Biomedical Signal Analysis: A Case-Study Approach, 1st Edition IEEE and Wiley, 2002

A.V. Oppenheim and A.S. Willsky with S. Hamid, Signals and Systems, 2nd Edition, Prentice Hall, 1996.

A.V. Oppenheim and R.W. Schafer with J. Buck, Discrete-Time Signal Processing, 3rd Edition, Prentice Hall, 2010.

Yossi Farjoun. *18.S997 Introduction To MATLAB Programming.* Fall 2011. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

Guttag, J., 2016. Introduction to computation and programming using Python: With application to understanding data. MIT Press.

Course Topical Outline

Introduction to course
Basics of Bioelectrical Signals – Chapter 1* – Bioelectrical signals – Signal acquisition and analysis
Introduction to MATLAB programing Introduction to datasets
The Electrocardiogram Signal Processing – Chapter 6 – Electrical activity of the heart – Generation and recording of an ECG (Depolarization/repolarization, recording techniques, ECG waves and time intervals) – Noise and artifacts – Clinical applications (resting ECG, Intensive care monitoring, ambulatory monitoring, stress test, high-resolution ECG)
ECG Signal Processing – Chapter 7 – Baseline wander filtering (linear filtering, time-varying/time, Polynomial fitting) – Powerline interface (linear/non-linear filtering, estimation subtraction) – Muscle noise filtering – QRS detection – Wave delineation – Data compression
Evoked Potentials – Chapter 4 – Evoke potential modalities – Noise characteristics & noise reduction methods (ensemble averaging, linear filtering) – Single trial analysis by Basis functions (orthogonal expansion, Karhunen-Loeve expansion, modeling with damped sinusoids) – Adaptive filtering using Basis functions – Instantaneous LMS algorithm, block LSM algorithm – Wavelets transform – Multi-resolution signal analysis – Denoising using wavelet filtering

***** From book: Bioelectrical Signal Processing in Cardiac and Neurological Applications by Leif Sornmo and Pablo Laguna. Elsevier Academic Press, ISBN: 978-0-12-437552-9, 2005

The Electroencephalogram (EEG) – Chapter 2 – The nervous system (neurons, the cerebral cortex) – The EEG signals (Rhythms and waveforms, categorization of EEG activity) – Recording techniques – Applications of EEG (epilepsy, sleep disorder, brain-computer interface)
EEG Signal Processing- Chapter 3 – Modeling the EEG signals (deterministic and stochastic signals, stochastic models, nonlinear modeling of the EEG) – Artifacts in EEG (characteristics, processing, cancellation) – Non-parametric spectral analysis (Fourier-based power spectrum analysis/ spectral parameters) – Model-based spectral analysis – EEG segmentation – Spectral measure error – The Periodogram approach – The whitening approach – Joint time-frequency analysis – The short-time Fourier transform – The ambiguity function – The Wigner-Ville distribution – Cohen's class time-frequency distributions
The Electromyogram -Chapter 5 – The electrical activity of muscles (action potentials and motor units) – Recording of myoelectric signals – EMG applications – Amplitude estimation using signal model and ML estimation – Spectral analysis of the EMG signal – Conduction velocity estimation (two-channel and multi-channel time delay estimation) – Modeling and intramuscular EMG (the MUAP train amplitude and power spectrum) – Intramuscular EMG signal decomposition (feature extraction and clustering)
Students' project presentations