

BME 4361: Neural Engineering

Spring 2022

Catalog Description: Applying engineering to neuroscience including such diverse areas as neural tissue engineering, models of neural function, and neural interface technology. Focuses mainly in the context of neural interfaces and prosthetics, from basic neural physiology and models of neural mechanisms to advanced neural interfaces currently in development or produced commercially.

Credits: 03

Prerequisites: BME3508-Biosignals and Systems, or equivalent Signals and Systems class

Instructor:

- Aysegul Gunduz, Ph.D. (agunduz@ufl.edu)
Biomedical Sciences Building J283 (352) 273-6877

Office Hours:

- Aysegul Gunduz: M 4PM Online Zoom Meeting ID: 942 947 5359

Class Meetings: **MWF, Period 3; 9:35-10:25am Communicore Lecture Hall C1-003**
Lectures can be joined in by zoom link posted on Canvas. Classes will be recorded to allow for absences related to the pandemic.

Class Homepage: [eLearning Canvas](#)

Required textbook and software:

No textbooks are required. Slides will be posted on the class website. Students are responsible for material presented on black board. MATLAB software will be used for some assignments and all projects.

Recommended reading:

- *Neural Engineering*, He
- *Neuroengineering*, DiLorenzo
- *Principles of Neural Science*, Kandel
- *Biological Psychology*, Kalat

Course Objectives:

- Understand the basic principles of brain anatomy, chemistry and function
- Learn about the principles of neurophysiologic recording and imaging technologies
- Learn about the applications of neural engineering in sensory, motor, neurological and mental disorders
- Understand the current challenges in neural engineering and the directions in which the area is headed

Course Outline:

- Basic principles of brain anatomy (~1 week) – Week 1
- Neurons and neural signaling (<1 week)
- Hodgkin-Huxley models (<1 week) – Week 2
- Spike sorting (PCA) (1 week)
 - Project I – Week 3
- The Motor System (~1 week) – Week 3
- The Motor System Engineering Application: Brain-Machine Interfaces (Firing rate estimation, Population vectors) (~1 week)
 - Project II – Week 5
- The Visual System (~1 week) – Week 6
- The Visual System Engineering Application: Retinal Implants (~1 week) – Week 7
- Recording from the Brain: Electroencephalogram (EEG) (~1 week) – Week 8
- Visual EEG Brain-Machine Interfaces (~1 week) – Week 9
 - Project III
- The Auditory System (<1 week)
- The Auditory System Engineering Application: Cochlear Implants (<1 week) – Week 10
- Sensorimotor EEG Brain-Machine Interfaces (~1 week) – Week 11
 - Project IV
- Functional Electrical Stimulation (Muscular FES, Peripheral FES, Electrocortical Stimulation) – Week 12
- Noninvasive Neuromodulation Methods and Functional Applications (TMS, rTMS, TDC) (~1 week) – Week 13
- Neuroimaging and Functional Applications (fMRI, fNIRS) – Week 14
- Neural Engineering Poster Day

Grade Determination:

14% Homeworks, 19% Project I, 19% Project II

19% Project III, 19% Project IV, 10% Poster Day Presentation

Poster presentation: 10% -- Students will present the results of one of the projects of their own choice. They will present their poster through video recordings on Zoom.

Grading Scale: All component grades will be on an A(4), B(3), C(2), D(1), F(0) basis (with + (0.33) and – (-0.33) modifiers. These will be assigned on a curve based on the raw numerical score (homeworks, projects and poster presentation) For information on current UF grading policies for assigning grade points, please visit:

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

Policies:

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

Students with Disabilities:

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate

documentation. Once registered, students will receive an accommodation letter, which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

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 Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Plagiarism

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>. Plagiarism on any of your assignments **will be reported to the Dean of Students as a UF Student Honor Code violation**. Also, note that **copying solutions for any assignment, regardless of the source (e.g. other students, pirated website solutions), will be treated as plagiarism**. If you have any questions or concerns, please consult with the instructor in this class. Note that failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures.

Commitment to a Safe and Inclusive Learning Environment

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 expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@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

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>

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

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>;<https://care.dso.ufl.edu>.

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