

Neural Signals, Systems and Technology

EEE 5283 Section 1G59/EEL 4930 Section 2308

Class Periods: Tu 3rd period, Th 3rd and 4th

Location: CHE 0237

Academic Term: Spring 2020

Instructor:

Prof. Karim Oweiss

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Office Phone Number: 352-294-1898

Office Hours: Tuesdays and Thursdays 2-3 pm

Teaching Assistant: Phillip Navarro (phillipnavarro@ufl.edu)

Course Description

(3 credits) Biophysical principles of neural signaling, characterization of neural circuits and systems, technology design principles for interfacing with biological neural systems, overview of clinical applications and industrial opportunities for neurotechnology and artificial intelligence.

Course Pre-Requisites / Co-Requisites

Graduate standing in engineering and/or neuroscience or related fields or undergraduate senior standing with consent of instructor.

Course Objectives

The student will be able to describe the techniques for characterization of neural circuits and systems, and explain the principles of neurotechnology for interfacing with biological neural systems.

Materials and Supply Fees

N/A

Required Textbooks and Software

a. Recommended Textbooks

- Title: Statistical Signal Processing for Neuroscience & Neurotechnology (SSPNT)
Editor: Karim Oweiss
Publication date and edition: 1st edition, 2010, Academic Press. ISBN number: 9780123750273
- Title: Principles of Neural Science (PNS)
Author: Kandel, Schwartz, Jessel, Siegelbaum, and Hudspeth
Publication date and edition: 5th edition, 2013, McGraw Hill. ISBN number: 9780071390118
- Title: Theoretical Neuroscience (TNS)
Author: Dayan Peter and Abbott, L.
Publication date: 2001. ISBN: 9780262318723
- Title: Neural Engineering (NE)
Editor: Bin He
Publication date: 2nd ed., 2013 Edition. ISBN: 978-1461452263

b. Software

1. **Matlab** with Simulink Student Edition

Course Schedule

Part I. Fundamentals of Neurophysiology and Neural Signaling

Week 1: Nerve cells, ion channels, synapses, neurotransmitters & receptors/PNS Ch 4-5

Week 2: Passive and Active Properties of Nerve Cells/PNS ch. 6-7/HW 1 due

- Week 3: *Neural Signal Processing*: Detection, Estimation and Classification of neural signals/SSPNT ch. 2; SSPNT ch.3 (or TNS ch 4)/HW 2 due
- Week 4: *Neural Encoding*: principles of linear and nonlinear regression/TNS ch. 1-2/HW 3 due
- Week 5: *Neural Decoding*: principles of machine learning/TNS ch. 3/mini project 1/essay 1
- Week 6: Neural systems for sensory processing and perception/PNS Part V
- Week 7: Neural systems for the control of movement/PNS Part VI/ Quiz 1

Part II. Fundamentals of Neural Systems Engineering

- Week 8: *Neural Sensing*: electrode recording of neural activity/in Class material/HW 4 due
--- Spring Break ---
- Week 9: *Neural Sensing*: Super resolution imaging of neural activity/in Class material/ mini project 2/essay 2
- Week 10: *Neural Control*: Neurostimulation and neuromodulation/in Class material
- Week 11: *Neural Control*: activity-dependent modulation of neural signals/in Class material/Quiz 2

Part III. Applications: Technology for interfacing with specific neural circuits and systems

- Week 12: Neural interface system design considerations/in Class material/NE select chapters
- Week 13: *Clinical applications*: open and closed-loop neuromodulation for sensory, (cognitive) and movement disorders/ project previews
- Week 14: *Consumer applications*: Artificial Intelligence and Neurotechnology Ventures/in Class material/
- Week 15: Final project presentation
- Week 16: Final exam week: Final project report due

Evaluation of Grades

Assignment	Percentage of Final Grade
In class activities/participation	5%
Homework (4)	20%
Quizzes (2)	15%
Mini projects/Essays (2)	25%
Final Project/Term Paper	35%
Total	100%

Guidelines and Format

1) Mini-projects, essay and homework guidelines

There will be 4 homework assignments testing your analytical skills. Mini-projects will test your analytical and basic programming skills. Essays will test your ability to comprehensively review a given topic in your own words. Each mini-project/essay is worth 12.5% of your grade. Data for these mini-projects/topics for essays will be provided by the instructor or simulated by the student. Quizzes will test your knowledge of the reading assignments.

2) Final Project Guidelines

a) The Pre-proposal:

Write a brief description of the research topic that you plan to pursue for your project/term paper, as well as the specific problems or questions you plan to address in your proposal. You will be provided with guidelines and resources on how to gain access to data to be used for your project.

Limit: 2 pages, 12-pt font size, 1.5-line spacing (no references), font type: Arial, one-inch margins.

b) The Proposal:

Based on the feedback I give you on your pre-proposal, write a proposal that should attract “funding” (aka a good grade) from your “sponsor” (instructor). Your proposal should include:

- a) Background and Significance
- b) Preliminary studies (if any) or relevant work
- c) Research Design and Methods
- d) Timeline

You should introduce the area of investigation, explain the “big picture” or significance of the specific problem that you will tackle, provide a list of the particular questions you intend to address in your experiments/simulation, and the methods you will use to conduct these experiments/simulation. It is very important to include all the details about how the data you will be working with has been/will be collected.

Limit: 4 pages (not including references), Single spacing, one-inch margins, 12-pt font size Arial font.

c) The Final report:

Based on the actual implementation of the proposal, write a concise, yet detailed summary of all your experimental findings in the form of a final report. A key element of this report is your discussion section and how it relates to topics learned in class and challenges specific to the problem you addressed in your project. **Limit: 10 pages** (not including references or figures), Single spacing, one-inch margins, 12-pt Arial font.

Task	Topic	Grade %	Date
1	Pre-proposal (written)	5%	February 28 th , 2020
2	Proposal (written)	10%	March 15 th , 2020
3	Final Project Report (Written)	15%	April 25 th , 2020
4	Final Presentation (Oral)	5%	April 30 th , 2020

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

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

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is required as a considerable portion of your grade depends on class participation and discussion. Because the class covers a multi-disciplinary topic, questions and discussions during class are strongly encouraged. I will record attendance throughout the semester. You need 75% attendance to PASS the class.

Cell phones and other electronic devices are to be silenced. No text messaging during class or exams.

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found in the online catalog at:

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

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://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 feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

Software Use

All faculty, staff and student 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.

Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

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 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/>.

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://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>.