BME 6350 Introduction to Neurotechnology
Fall 2024

Instructor: Alex Kwan <alex.kwan@cornell.edu>
Associate Professor

TA: Zuzanna Maria Mamczarz <zmm24@cornell.edu>

Lectures: Tuesday and Thursday, 1:25 – 2:40 pm
In-person, Malott Hall 251

Office hours: Time TBD (1 hour per week), led by Instructor, in-person, 111 Weill Hall
Time TBD (1 hour per week), led by TA, in-person or on Zoom

(Times to be decided by polling students at the start of semester; attendance requirement – see below*)

Credit hours: 3 credit hours, letter grade only

This course includes engagement of 2,250 minutes in the semester, including 28x 75-minute class time and *150 minutes of office hour discussion during the semester. Students are expected to spend 6 hours per week on this course outside of scheduled meetings.

Pre-requisites: CS 1112/1114 or equivalent in MATLAB or Python programming

Required text: Assigned readings are listed in the course schedule.

Optional text: *Principles of Neural Science 5th edition*
Kandel, Schwartz, Jessell, Siegelbaum, Hudspeth

Course website: Course schedule, slides, and problem sets will be posted on Canvas.

Course description:
This course provides a survey of the latest technologies for recording and controlling brain activity. The class consists of lectures to introduce the relevant concepts in neurobiology, then discuss approaches to read out neural signals, such as large-scale electrophysiology and optical imaging, followed by methods to modify neural dynamics, including electrical, optical, and viral strategies. Emphases will be placed on how the technologies may be integrated into brain machine interfaces, and what promise they have for treating brain disorders. The course assumes no background in neuroscience. It is intended for engineers who want to know more about neural engineering and neurobiologists who are interested in the latest methods. The course is open to Ph.D., M.Eng., and senior-year undergraduate students.

Learning objectives: To grasp the breadth of latest approaches to engineer the brain with emphases on the strengths and limitations of each method that inform their promise for science and commercialization.

Learning outcomes:

- Design strategies to characterize and drive brain activity at different spatial and temporal scales
- Compare recording and stimulation approaches given their strengths and limitations
- Explain the biological underpinnings behind the major methods in neurotechnology
- Execute a project to evaluate the use of neurotechnology for treating brain dysfunctions

For all students:

Exercises: At the end of each week's lectures, there will be a short in-class exercise. At the end of semester, the lowest 3 scores will be dropped and do not count towards the total.

Problem sets: There will be 2 problem sets. Problem sets are due at 5 pm on the due dates and submitted through Canvas. For late submissions, there will be a 25% deduction of points for each extra day. Re-grade requests must be made within one week after the assignment is returned. You may work together on the problem sets but please write your own code and answers to questions.

Prelim exams: There will be 2 in-class prelim exams. The exam will cover materials presented up to that point and since the last prelim exam. This is a closed book exam, and no digital device is allowed. Re-grade requests must be made within one week after the exam is returned.

For Ph.D. and undergraduate students:

Final report: At the end of the course, each student will prepare and write a short report of >300 words in length. The report will focus on a novel neurotechnology or application of neurotechnology to a clinical problem.

Grading rubric:

10% In-class exercises
25% Problem sets
30% Prelim exam 1
30% Prelim exam 2
5% Final report

Grading scale:

A+ (96.7 – 100%)	A (93.3 – 96.7%)	A- (90 – 93.3%)
B+ (86.7 – 90%)	B (83.3 – 86.7%)	B- (80 – 83.3%)
C+ (76.7 – 80%)	C (73.3 – 76.7%)	C- (70 – 73.3%)
D+ (66.7 – 70%)	D (63.3 – 66.7%)	D- (60 – 63.3%)
F (<60%)		

Scores will be tallied based on the grading rubric, may be curved, and convert to a letter grade at the end of the semester.

For M.Eng. students:

Final project: At the end of the course, each student will prepare and make a slide presentation. The presentation will focus on a novel neurotechnology or application of neurotechnology to a clinical problem.

Grading rubric:
10% In-class exercises
25% Problem sets
25% Prelim exam 1
25% Prelim exam 2
15% Final project

Grading scale:

A+ (96.7 – 100%)	A (93.3 – 96.7%)	A- (90 – 93.3%)
B+ (86.7 – 90%)	B (83.3 – 86.7%)	B- (80 – 83.3%)
C+ (76.7 – 80%)	C (73.3 – 76.7%)	C- (70 – 73.3%)
D+ (66.7 – 70%)	D (63.3 – 66.7%)	D- (60 – 63.3%)
F (<60%)		

Scores will be tallied based on the grading rubric, may be curved, and convert to a letter grade at the end of the semester.

Accommodations:
Accommodations may be made for the course, but you must register and make an official request at Cornell's Student Disability Services (SDS).

Academic integrity:
While you are encouraged to discuss content of the class with your peers, you must use your own words for any written assignments, problem sets, and exams. Do not copy or paraphrase from any source, either sources provided in the class or ones you find on your own. You should read the papers, listen to the lectures, and develop your own understanding of the material. You may discuss the questions with other people, but then answer the questions by describing your own understanding in your own words. You must adhere to Cornell University's Code of Academic Integrity. Violations of the Code of Academic Integrity will result in a 0 grade for all parties involved for the assignment or exam, and be referred to the Academic Integrity Hearing Board of the College of Engineering.

Inclusiveness in the Classroom:
Cornell is committed to creating an inclusive environment, see https://diversity.cornell.edu/. As your instructor, I will strive to create a classroom space where differences are respected and valued. Every student in the class is encouraged to speak up and participate in class

discussions. At the same time, you are expected to demonstrate diligence in understanding how your peers' perspectives and worldviews may be different from your own.