

San Francisco State University

School of Engineering

## **ENGR 845: Neural-Machine Interfaces: Design and Applications (3 units)**

### **Course Objective:**

The primary objectives of this course are

- To introduce students to the concepts, designs, trends, and challenges of neural machine interfaces (muscle machine interfaces, brain computer interfaces, etc.) and their applications (e.g. neuroprosthetics, gesture-controlled devices) from an engineering perspective.
- For students to develop the ability to design real-time neural machine interfaces and neural controlled applications by combining principles of neural signal processing, machine learning and pattern recognition, and real-time computer system design.

### **Specific Learning Outcomes:**

Students completing the course successfully will demonstrate

- an in-depth knowledge of the concepts of neural machine interfaces as well as their design and applications
- an ability to apply signal processing, machine learning, and pattern recognition methods to analyze and interpret biosignals for human state recognition
- an ability to apply embedded system design and various computing technologies to design real-time neural machine interfaces and applications
- an ability to design neural machine interfaces and applications to meet desired needs with realistic constraints including economic, health and safety, and sustainability
- an ability to work in a team and communicate effectively
- an understanding of emerging neural machine interface research and development trends and challenges

### **Prerequisites:**

- For undergraduate students, ENGR 478 or equivalent with a grade of B or better, or consent of instructor.
- Familiarity with MATLAB and C programming

### **ENGR 844 Spring 2019**

Instructor: Xiaorong Zhang, Ph.D.  
Office: SCI 213D  
Office Hours: Tuesday, 2-3 pm, and Thursday, 2-4 pm  
E-mail: [xrzhang@sfsu.edu](mailto:xrzhang@sfsu.edu)  
Course Website: <https://ilearn.sfsu.edu>

(All lecture slides, supplementary materials, and assignments will be posted on iLearn.)

### **Class Schedule**

ENGR 845-01: Wednesday, 6:00 – 8:45 pm  
Location: TH 425

**Reference Materials:**

1. Roberto Merletti and Dario Farina, "Surface Electromyography: Physiology, Engineering, and Applications", 2016. ISBN: 978-1118987025 (full book can downloaded from <https://onlinelibrary-wiley-com.jpllnet.sfsu.edu/doi/book/10.1002/9781119082934> using your SFSU login credential)
2. Susanne D. Coates, "Neural Interfacing: Forging the Human-Machine Connection (1<sup>st</sup> Edition)", 2008. ISBN: 978-1598296808.
3. Desney S. Tan and Anton Nijholt, " Brain-Computer Interfaces: Applying our Minds to Human-Computer Interaction", 2010. ISBN: 978-1849962711.
4. Yangsheng Xu, Wen Jung Li, and Ka Keung Lee, "Intelligent Wearable Interfaces", 2007. ISBN: 978-0470179277.

**(Other reading assignments and reference materials will be posted on the course iLearn page)**

**Topics:**

- Introduction to neural machine interfaces, and more broadly, human computer interaction
- Applications and examples
- Scientific requirements and challenges
- Research areas and trends
- Human neuromuscular control system and EMG basics
- Signal Processing and machine learning in neural machine interfaces
- Real-Time processing schemes for neural machine interfaces
- Design and implementation of real-time computer systems for neural machine interfaces

**Important Dates**

Instruction starts	Jan. 28 (M)
<b>ADD/DROP/AUDIT</b> deadline (for students) (ADD with permission numbers)	Feb. 15 (F)
<b>Withdrawal</b> (serious & compelling reasons)	Feb. 16 (Sa) – Apr. 29 (M)
<b>Withdrawal</b> (serious & compelling/plus documentation)	Apr. 30 (T) – May 14 (T)
Instruction ends	May 16 (Th)
Fall Recess (no classes/offices open)	Mar. 25 (M) – Mar. 30 (Sa)

**Grading Policy:**

Grades will be based on total points earned through the following activities:

Homework Assignments	10%	
Research Topic Presentation	25%	
Project	Phase I	10%
	Phase II	15%
	Phase III	20%
Attendance and class participation	10%	
Out-of-class activity	5%	
Total	100%	

### **Important Dates:**

- Research topic presentation:
  - First Submission: Sunday, Feb. 17
  - Second Submission: TBD
- Final project presentation: Wednesday, May 22
- Final project submission due: Sunday, May 26
- Out-of-class activity submission due: Sunday, May 19

### Notes on grading:

- Generally, no late submission is allowed. If you miss an assignment submission deadline, you must notify the instructor before the deadline or, if physically impossible, soon after. If you have an acceptable, documented excuse, you may be given an extension. If you do not have an acceptable reason for missing the deadline, you will receive zero point for the assignment.
- Though you can collaborate during homework assignments, **direct copying of solutions, in part or in whole, is not permitted. All code and report required for the homework assignments should be individually designed and written. Students may not allow other students to copy from their work during any type of assignments.** Please read the **Policies on Plagiarism** section for more details.
- The research topic presentation is to be done individually.
- A term project will be published in the class. The project is to be done in student groups of no more than two. You will be evaluated as a group as well as individually.
- **Attendance will be taken randomly.** Students missing two lectures or more without justified excuses will receive zero attendance credit. You must come to class if you plan to pass the course. The information covered in class is essential for you to complete homework assignments as well as to prepare for project. Students late for over 10 minutes will be considered “absent” from that class.

### **Research Topic Presentation:**

In this class, each student will be asked to study a recent topic of choice in the fields of neural machine interfaces and human computer interaction. The student must search and pick at least one research paper on the chosen topic. The papers must be high-quality journal or conference papers. Once the selected topic and paper has been approved by the instructor, the student must do a presentation on the paper(s) in front of the class. More information will be provided later in the semester.

### **Term Project:**

The goal of the term project is to design a neural machine interface which may integrate data sensing and acquisition, signal processing and machine learning, as well as control of an external application using the knowledge and techniques taught in class. The project is to be done in student groups of no more than two. More information will be provided later in the semester.

### **Grading**

Grading for the project will be based on:

- Originality of the project

- Quality and complexity of the design and coding
- Quality of project presentations in both oral and written format

### **Out-of-class activity:**

The purpose of this out-of-class activity is to further the student's knowledge and experience in the neural machine interface (NMI) and human computer interaction (HCI) fields. There are two options to fulfill the requirement of this assignment:

**Option 1.** You can participate as a human subject in one experimental session of research projects on related topics conducted in the School of Engineering or other departments on campus. Conducting experiments on human subjects is an important part of NMI and HCI research to evaluate the effectiveness and usability of the developed projects.

By being in these studies, you are engaging in an important intellectual task with the faculty and advanced students in the university. It is our hope that you will gain an appreciation that will help you better evaluate other research that you read or hear about. We also hope that you might be inspired to get involved in a research project of your own. Because the experience is meant to be educational, the background and purpose of the study will be explained to you before or after the experimental session.

A list of ongoing research projects and the contact information will be provided to you later in the semester. You can contact the researcher directly to schedule an experimental session. All of the research projects have been approved by a review committee of the university's Institutional Review Board (IRB). Every procedure must guarantee your safety and confidentiality. Your responses will not be permanently associated with any identifying information, and in no case will personal or identifying information be disclosed.

#### **To receive full credit, you will need to provide copies of the following:**

- Official documentation regarding the length of experiment
- Recruitment Material (flyer, email, etc)
- Informed consent or debrief form signed by the experimenter

**Option 2.** You can attend at least one seminar/workshop/event in related fields organized by academic institutions, companies, or professional societies. By attending these events, you will learn from others and improve your own skills and knowledge about the field. It also provides opportunities to connect with the community, network with people in related fields, and advance your career. You can search for these events through platforms such as Eventbrite, Meetup. The instructor will also recommend some events in the class.

#### **To receive full credit, you will need to provide copies of the following:**

- Evidence of your attendance at the event
- A report including the title of the seminar/workshop/event, speaker/organizer information, and one paragraph summarizing the content of the seminar/workshop/event, and your thoughts and experience.

For both options, all required submissions must be completed by Sunday, May 19. Late submissions are not allowed.

### **Policies on Plagiarism**

Plagiarism is defined as using someone else's ideas or work as one's own without giving proper credit to the source. The source include public (books, journals, magazines, newspapers, internet, etc.) as well as private (unpublished reports, internal documents, personal work, etc.) materials. The instructor will not accept excuses such as "I forgot to give credit to ...," "It's an oversight," or "It's a clerical error."

Students are solely responsible for materials submitted for the course so “My roommate must have done that without my knowledge” is not an acceptable excuse either. That is, no excuses will be accepted if plagiarism is discovered. If a submitted work is found to contain plagiarized material, the work will receive zero credit and the student may be reported to the Student Judiciary Affairs for disciplinary actions. Disciplinary actions may include disqualification from the university.

### **Disability Policy Statement**

Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC is located in the Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email (dprc@sfsu.edu).

(<http://www.sfsu.edu/~dprc>)

### **Student disclosures of sexual violence**

SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the **Dean of Students**. To disclose any such violence confidentially, contact:

**The SAFE Place** - (415) 338-2208; [http://www.sfsu.edu/~safe\\_plc/](http://www.sfsu.edu/~safe_plc/)

**Counseling and Psychological Services Center** - (415) 338-2208; <http://psyservs.sfsu.edu/>

For more information on your rights and available resources: <http://titleix.sfsu.edu>

### **Policy on observance of religious holidays**

If a student wishes to observe religious holidays and such observances require the student to be absent from class activities, it is the responsibility of the student to inform the instructor, in writing, about such holidays during the first two weeks of the class each semester. If such holidays occur during the first two weeks of the semester, the student must notify the instructor, in writing, at least three days before the date that he/she will be absent.