Neural Engineering:
Fundamentals of interfacing with Brain

E SC 597D – Fall 2008

Lectures: Tuesday/Thursday 9:45-11:00 AM, 116 Earth Eng. Sciences Blg.

Instructor: Bruce Gluckman, 302B EES Building, 865-0178, BruceGluckman@psu.edu

Office Hours: By appointment

Text:

Neural Engineering, edited by Bin He (2005, Kluwer Academic Press);
BIOELECTROMAGNETISM: Principles and Applications of Bioelectric and Biomagnetic Fields. Jaakko Malmivuo and Robert Plonsey (1995, Oxford University Press).

Course Description: Brain is one of the most complex systems about which we know. Exciting advances have been made in methodologies for detecting neural signals, modeling neural dynamics, and constructing bidirectional interfaces for prosthetic applications such as restoring sensory input, providing neural control of devices, and controlling disease states. This course will give an overview of the field of neural engineering with a focus on the fundamentals of neural interfaces and their applications.

Course Objectives: The course objectives are to describe the biophysical basis of neural function, the origin of measurable signals, electrical interactions used for neural stimulation, and the fundamentals of hardware-brain interfaces. Special attention will be given to the electrochemical nature of the electrode tissue interface.

Prerequisites: Electromagnetism (ESC400H or equivalent), Partial Differential Equations (Math 251 or equivalent)

Topics:

- Biophysical Basis of Neural Signals and Function ~4 weeks
- Electrical Stimulation ~3 weeks
- Electrode-Tissue Interfaces ~2 weeks
- Measurement Distortion ~1 week
- Survey of Topics in Neural Engineering ~3 weeks
  Neurorobotics, Brain Computer Interfaces, Neuromuscular Stimulators, Neuroethics

Learning Objectives: Students will be introduced to the field of Neural Engineering, and instructed in the basic phenomena underlying interfaces between brain and machine. Through this course, students are expected to:

- Use biophysical models of neural function to interpret measured neural signals.
- Predict the efficacy of electrical stimulation based on models of neuronal function.
- Integrate electrical, electrochemical, physiological and mechanical phenomena into the design of neural interfaces for both recording and stimulation.
- Develop vocabulary and context for understanding current literature in Neural Engineering

Target Students: This course would be of interest in students wanting to work in the diverse fields contributing to the development and applications of neural interfaces and devices, including those interested in device, materials, and control systems development, electronics, and clinical research, as well as those interested in measuring and modeling neural processing and behavior.