BME I3000. INTRODUCTION TO NEURAL ENGINEERING AND APPLIED BIOELECTRICITY
FALL 2009

Instructor:
Prof. Marom Bikson, T-403B
bikson@ccny.cuny.edu
Class hours: Monday 6:00-8:00 PM
Office hours: Open (if my door is open) / By appointment.
bme.engr.ccny.cuny.edu/faculty/mbikson/Courses/BMENeuralEngr/index.html

Course TA:
Davide Reato, T-459 (Neural Engineering)
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Overview:
This course is a survey course of key topics, issues, and applications in Neural Engineering. This course also covers the basics of neurophysiology and electrophysiology. How cells in the brain work and they communicate with each-other is introduced. A basic electrical circuit’s background but minimal Biology/Neuroscience background is assumed. The course centers on developing a quantitative understanding of the effect of electricity on the body.

A level of critical thinking is required to pass this course. The course works towards critically analyzing current papers/topics in neural engineering; this will include debates about current medical technology. Students in the course will also work on critical paper/legal document analysis in the area of neural engineering. In this last regard, will consider the engineering to electrical safety including legal standards and case reports of electrocution.

Design aspects of neural engineering devices will be introduced, specifically in brain electrical recording and brain electrical stimulation. Basic principles and current “state-of-the-art” technology will be presented. Students’ assignments will include design components.

In addition to dealing with established basic mechanisms and theories, we will address specific tools and developing applications in Neural Engineering – including with outside speakers.

Students are highly encouraged to attend BME Seminar Lectures (Wednesday at 3 PM) which deal with Neural Engineering Topics. The Neural Engineering lab Friday morning meetings and other lectures/events are open to students enrolled in BME3000. Details at http://bme.ccny.cuny.edu/faculty/lparra/neuroengineering/upcoming.html

Textbook:
There is no required text-book for the course. Additional course material will be made available through class hand-outs and the class web-site. The course is based largely on class lectures/notes. Attendance of all classes is required and students are responsible for all material lectured on.

As needed, text-books may be made available for short-term loan through the Department of Biomedical Engineering.

**Topics Covered:** *(topics may not be covered serially)*

**Neural-engineering what?**
What’s that brain thing for anyways?
What are engineers doing messing with the brain?

**How the brain works**
How do brain cells work: Basics of ‘excitable cells’: the resting membrane potential, action potentials, action potential conduction
How do brain cells talk to each-other: Basics of excitatory cell communication: chemical synaptic and ‘non-synaptic transmission’ (including field/ephaptic effects, ionic waves, gap junctions)
How do brain cells organize themselves: Basics of neuronal networks – ‘coherent’ network activity and field potentials

**How to stimulate the brain (and why)**
Fields generated by mono-polar sources: a tool to interpret ‘field recordings’ and EEG
Basic analog circuit for electrophysiology
Applications of functional electrical stimulation (Deep Brain Stimulation): Overview
Overview: But what mechanisms can electricity effect cells?
Cable theory
Electrical ‘activation’/excitation with a mono-polar stimulating source
‘Uniform field’ and multi-polar electrical stimulation
Practical Issues in Electricity Safety / Regulations – Analysis of legal reports
Measurement of ion concentration and extracellular resistivity
Joule heating of the brain: bio-heat transfer model
Functional electrical stimulation: Current papers/topics

**Grading**
- Quizzes 10%
- Homework / Projects 60%
- Attendance / Participation 30%

**Homework:** Unless otherwise stated, homework is due at the beginning of the next class. No extensions will be given. Homework will not be accepted after the lecture begins (including late e-mails). If you are tardy for class your homework will not be accepted. Un-submitted homework (or equivalently homework that are not accepted because they are submitted late or not within given guidelines) are scored as 0 – under
not conditions it there is not late acceptance or late penalty. This, especially for large projects, students are encouraged to submit early/arrive to class early.

Collaboration with other students on homework is allowed. If you work with another student directly on a home-work problem and receive or provide information directly related to a home-work problem you must list the names of any collaborators on your home-work. Failure to do so (even if it was a “slip-up”) will be automatically considered cheating – so when in doubt list collaborators since there is no penalty for listing collaborators. Students may be asked questions about handed in home-work during or after class.

Collaboration can include exchanging of ideas on how to approach solving a problem or how to solve a specific step in a given problem. Collaboration does not allow direct copying of (even a portion) of someone else’s work. You must derive all equations and run all numerical calculations yourself.

Each home-work and project will be given a ‘point’ value. Unless otherwise stated, a single home-work is worth one point. In calculating your homework grade, each assignment will be weighted by its point value (i.e. a 3-point assignment counts as much as a three 1-point assignments). One homework will involves analysis/debate of a legal document/issue. The final home-work/project will involve individual presentations to the class.

**Quizzes:** There may be a (surprise) quiz at the beginning of a class. A quiz will be based on material directly covered in previous lectures, homework (including homework due that day), or any assigned reading material. If you arrive late, you will not be allowed to take the quiz.

**Attendance:** An absence is an automatic 3% deduction from the final course grade.

However, attendance is required and simply attending does not give you any attendance points. Rather, students are expected to be involved in the course discussion and lecture. This involvement will not be possible unless students are on top of all course readings, review lectures notes, and are constantly working on assignments ahead of time. This PhD level course is based on a dialogue between the students and communication skills are required. To be clear, a student who does not speak during the course will receive an automatic 0% on attendance. While there are no stupid questions and students are highly encouraged to ask any question on unclear material (if it’s unclear to you, it’s usually unclear to the rest of the class) – it is equally obvious when someone has not been engaged in the entire course process. On this last note, start “at run” to position yourself to enjoy the course.

Because the course material is largely lecture (rather than text-book) based, students are discouraged from missing any classes. If a student cannot attend a lecture they are responsible for obtaining the lecture notes/homework assignments from another student – the student will still receive full penalties for not attending and missed
quizzes/homework. Homework may be handed in by another student or dropped at my office or mail-box before it is due.

You may use a computer to take notes. You may not use the internet for any purpose (including checking e-mail) during class. Cell phones: If your phone rings (including for a text) during class (including vibrate) you final grade may be reduced by as much as 4% each incident. If it is absolutely necessary to answer a call during class (e.g. an emergency), do so at a distance down the hallway. Do not send/check text messages under any conditions in class – if it is an emergency leave the class.

If you are 1 second late, then it is the same as if you did not attend the class from the perspective of handing in homework, taking quizzes, and other penalties. There are no exemptions for this rule and no excuses will be accepted (even acts of god and subways). So it is strongly recommended, that you plan on arriving early – as being late a single day can have a substantial and irreversible impact on your final grade.

Course TA
The TA is not responsible for proof-reading