Syllabus for BME468/ELE568 Neural Engineering
Spring 2014

Course Contents:
Principles and technologies of neural engineering and clinical applications; basic human neurophysiology, brain stimulation, spinal cord stimulation, functional electrical stimulation, neural-machine interface for motor prosthesis control, artificial visual/auditory devices for augmented sensory perception.

Pre-requisite: BME 360 or permission from instructor;
Lecture: TTh 9:30 pm-10:45 am, Kelley Hall, Room 103;
Instructor: Prof. Oleksandr Makeyev
omakeyev@ele.uri.edu
Office hours TTh 3:00-4:00 pm. Other times by appointment. Send email.

Textbook: There is no required textbook for this course. I encourage you to read the following textbooks and journals. In addition, required reading materials will be posted on the course website.
"**Neuroengineering**" edited by D. J. Dilorenzo and J. D. Bronzino, CRC Press, 2007; ISBN 0849381746.
"**Neural Engineering (Bioelectric Engineering)**" by Bin He, Springer, 2005; ISBN 0306486091.
"**Neural Engineering: Computation, Representation, and Dynamics in Neurobiological Systems**" by Chris Eliasmith, C. H. Anderson, Bradford Book, 2004; ISBN 0262550601.

IEEE Transaction on Neural Systems and Rehabilitation Engineering
http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=7333
IEEE Transaction on Biomedical Engineering
http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10
Journal of Neuroengineering and Rehabilitation
http://www.jneuroengrehab.com/
Journal of Neural Engineering
http://iopscience.iop.org/1741-2552/

Course Topics
1. Introduction: neurophysiology; neural plasticity; neurological dysfunctions; history of neural engineering.
2. Neuromotor-machine interface: human voluntary motor control system; biomaterials, configurations, and characteristics of implantable multi-array electrodes.
3. Brain-machine interface: action potentials and local field potentials; cortical signal recording and decoding; clinical applications.
4. Brain-machine interface: ECoG-based brain-machine interface; brain-machine interface based on surface EEG/MEG recording; clinical applications.
5. Peripheral-nerve-machine interface: biomaterials, configurations, and characteristics of implantable recording electrodes; efferent neural signal recording and decoding.

6. Muscle-machine interface: biomaterial, configuration, and characteristics of implantable electrodes; intramuscular EMG recording and decoding;
7. Muscle-machine interface: targeted muscle reinnervation; targeted sensory reinnervation; surface EMG recording and decoding; clinical applications.
8. Technologies in prosthetics and orthotics: human-robot interaction and integration; clinical needs for advancing the bionic legs and arms; ethic issues in neural-machine interface.
9. Deep brain stimulation: implantable electrodes; brain pacemaker; surgery; applications to Parkinson's disease.
10. Spinal cord stimulation for pain management and gait improvement; clinical applications.
11. Functional electrical stimulation: peripheral nerve stimulation; type of stimulation electrodes; clinical applications.
12. Other technologies in neuromotor rehabilitations: mechanisms for neuromotor rehabilitation; robotics and virtual reality in physical therapy; transcranial magnetic stimulation.
13. Visual prostheses: human visual system; type of electrodes; surgery for electrode placement; clinical applications.
14. Cochlea implant: human auditory system; stimulation system and electrodes; surgery; clinical applications.

Evaluation, Grading and Exam Schedule
Participation (15%)
Homework (20%)
Midterm (tentative date March 13th) (25%)
Final Proposal and Presentation (25% for proposal and 15% for presentation)