BME 599.003 Neural Engineering (3 credits)

Instructor:	Cynthia Chestek, Ph.D.	cchestek@umich.edu
Office Hours:	Mon, 9:00-10:00am	LBME 2220
Lecture:	Mon 10:00am-12:00pm	LBME 1123
Lab:	Thur 10:30am-12:30pm	LBME 1st floor CAEN Lab

Course Materials:

Principles of Neural Science (several chapters throughout)
Plonsey and Barr (for Parts 1,2 below)
Bishop (for Parts 5,6 below)
Most of the course will be taught from the scientific literature

Grading:		**Dates:**
Lab Reports	25%	1/26, 2/9,2/23 3/23, 4/6
Exam 1	20%	2/20
Exam 2	20%	4/17
Literature review notes	10%	3/6, 4/25
Final Project	25%	4/25 (1 pg proposal 3/6)

Pre-Requisites:

Previous coursework on circuits, signal processing, differential eqns
Experience using MATLAB

Final Project:

Students will work in groups of 2 or 3 to complete a research project involving 1 or more of the techniques used in this course. Neural data will be made available from several different sources. For example, this project could involve simulating a particular stimulation or recording paradigm with COMSOL or NEURON, processing field potentials recorded in epilepsy patients to decode motor or seizure related activity, or applying machine learning algorithms to single unit data previously recorded in animals. Projects that advance thesis research are encouraged, but students cannot use work previously completed outside of the course.

Literature Review Notes:

Most of this course will be taught using examples from the literature. Also, a literature review will be required for the Final Project Report. Throughout the semester, students will be assigned to read particular papers, and also identify other relevant papers on the same topic. Students will generate a database of these papers that they can use for future research projects. These can be in any preferred format as long at it includes bibliographic information and short notes for each paper. These databases will be verified twice during the semester.

Neural Engineering Syllabus

Date	Lecture	Date	Lab
		1/5	Class overview (lecture), biophysics review
1/9	Topic: Biophysics review, NEURON simulation models	1/12	Lab 1) Membrane potentials, Hodgkin-Huxley, Cable Equation (BME 417 review)
1/16	No class, MLK Day	1/19	Lab 2) NEURON simulation software
1/23	Topic: Volume conductor models, modeling neural recording	1/26	Lab 3) Volume conductor models of neural environment (COMSOL) *(Lab report **due** on 1,2)*
1/30	Topic: Modeling neural stimulation, electrode impedance models	2/2	Lab 4) Modeling of neural recording and stimulation (Cindy out)
2/6	Topic: Principal components, clustering algorithms	2/9	Lab 5) Complex impedance of electrodes, filtering neural signals *(Lab report **due** on 3,4)*
2/13	Topic: Machine learning classifiers	2/16	Lab 6) Spikesorting, clustering algorithms
2/20	**Exam 1**	2/23	Lab 7) Classification based brain machine interfaces (Naïve Bayes, LDA, logistic regression, SVM) *(Lab report **due** on 5,6)*
2/27	No class, Winter break	3/2	No Lab, Winter Break
3/6	Topic: Continuous control brain machine interfaces *(Project proposal, lit review **due**)*	3/9	Lab 8) Continuous brain machine interfaces (Linear regression, Kalman filters)
3/13	Topic: Continuous control brain machine interfaces	3/16	Lab 9) Brain machine interfaces continued
3/20	Topic: Neural networks for neural decoding	3/23	Lab 10) Neural networks and deep learning *(Lab report **due** on 7,8,9)*
3/27	Topic: Epilepsy, Prof. William Stacey, Neurologist-Engineer	3/30	Lab 11) Seizure detection
4/3	State of the art in electrode research	4/6	Class Project Lab Period *(Lab report **due** on 10,11)*
4/10	State of the art in neuroprosthetics research	4/13	Class Project Lab Period
4/17	**Exam 2**		
4/25	**Final Presentations, 1:30-3:30pm** *(lit review, report **due**)*		