

BME-452: Introduction to Biomimetic Neural Engineering (3 units)

Main Instructor:

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Office Hours: Tu & Th 1:00-2:00 pm DRB-176

Meeting Time & Location: 2 – 4:50 pm Thursdays, GFS-223

Course Description

Engineering principles, biology, technological challenges and state-of-the-art developments in the design of implantable biomimetic microelectronic devices that interface with the nervous system.

Prerequisites EE-202L; basic knowledge of biology recommended.

Reading Materials

- (1) Chapters from: Weiland J, Humayun M. (eds.) Towards Biomimetic MicroElectronic Systems as Neural Prostheses. *Engineering in Medicine and Biology Magazine* (Special Theme Issue), 2005 (in press).
- (2) Journal papers will be given for selected topics.

Grading

Homework will consist of weekly reading assignments.

Final Grade will be based on:

- (a) 1st Term Paper (6 pages max; 30%)
- (b) 2nd Term Paper (10 pages max; 40%)
- (c) Final Presentation (20%)
- (d) Class Participation/Attendance (10%)

Course Objectives

BME-452 provides a comprehensive overview of the scientific principles, basic biology and technical difficulties involved in the design of biomimetic microelectronic devices that are to be implanted into the human body for the restoration of neural function in a variety of disorders that include deafness, blindness, paralysis and memory loss. Guest lectures will be given largely by faculty who conduct research in this area of work under the auspices of the Biomimetic Microelectronic Systems Engineering Research Center. The course will provide the basic background for students who wish to undertake directed research projects with the BMES-ERC faculty or to pursue graduate work in neuroengineering.

Lecture schedule:

- 8/25: Introduction; Overview of the Biomimetic Microelectronic Systems ERC;
Basic engineering design issues in biomedical microelectronic devices
(*Michael Khoo, BME & Howard Phillips, BMES-ERC*)
- 9/01: Cochlear Implants: Normal and abnormal auditory physiology; Psychophysics
of hearing (*Robert Shannon, House Ear Institute*)
- 9/08: Cochlear Implants: State of the art developments
(*Leonid Litvak, Advanced Bionics*)
- 9/15: Physiology & pathophysiology of the Eye; Retinal Surgery; Biomimetic Image
Processing)
(*Mark Humayun, Ophthalmology & BME; Wolfgang Fink, Caltech*)
- 9/22: Visual Electrophysiology; Retinal implants – current and future designs.
(*Jim Weiland, Ophthalmology & BME*)
- 9/29: Functional electrical stimulation of muscles: state of the art
(*Rahman Davoodi, BME & AMI; Lucinda Baker, Biokinesiology*)
- 10/06: Existing and new neuromuscular prostheses (*Jerry Loeb, BME/AMI*)
- 10/13: Ethics and Regulatory Issues in Neuroprosthetics R & D [**MID-TERM EXAM**]
(*Frances Richmond, Molecular Pharmacology/Regulatory Science*)
- 10/20: Hippocampal memory & prostheses (*Ted Berger, BME*)
- 10/27: Modeling of hippocampal neural networks; nonlinear signal processing
(*Spiros Courellis, BME*)
- 11/03: Mixed-signal systems on chip & sources of implant power
(*John Granacki, EE & Information Sciences Institute*)
- 11/10: Design of conformal electrode arrays; Stem Cells in Neuroengineering
(*Armand Tanguay, EE-EP; Roberta Brinton, Molecular Pharmacology*)
- 11/17: Surface Modification for biotic-abiotic interfaces; Cell Adhesion
(*Mark Thompson, Chemistry; Anupam Madhukar, Materials Science*)
- 11/24: **THANKSGIVING**
- 12/01: Microelectrode technology; Microfluidic Circuits
(*YC Tai, Caltech; Ellis Meng, BME*)
- 12/08: **FINAL EXAM**