Course title and number  ECEN 489: At the Interface of Engineering and Life Sciences  
Term  Spring 2015  
Meeting times and location  Tu/Th 12:45 – 2:00 PM, CHEN 104  

Course Description and Prerequisites

Course Description: This course aims to provide a broad overview of electrical and computer engineering principles that are being applied to various areas in life sciences and introduce recent trends in interfacing engineering and various life science disciplines to address emerging grand challenges.

Prerequisites: None (suitable for junior and senior students, but not limited to)

Learning Outcomes or Course Objectives

Engineering principles are revolutionizing our understanding in various life science disciplines, from biological sciences to medical sciences. The objective of this course is to provide a broad overview of electrical and computer engineering principles, and more broadly engineering principles, that are being applied to various areas of life sciences. Recent trends in interfacing engineering and life science to address emerging grand challenge problems in health, bioenergy, and biosecurity will be introduced. This will be a team-taught course by several faculties.

Instructor Information

Name  Profs. Arum Han and Xiaoning Qian  
Telephone number  979-845-9686  
Email address  arum.han@ece.tamu.edu, xqian@ece.tamu.edu  
Office hours  TBD  
Office location  WEB 309C  

Textbook and/or Resource Material

Handouts

Grading Policies

Homeworks: 80%  
Term Project: 20%  

Course Topics, Calendar of Activities, Major Assignment Dates

Week 1: Introduction - At the Interface of Electrical Engineering and Life Sciences

- Introduction to life science areas where electrical and computer engineering technologies have made - and will continue to make - impacts  
- Sensing techniques, imaging techniques (MRI/CT/PET/Ultrasound), brain-machine interfaces, implantable devices (e.g. pace makers), defibrillators, etc.  
- Bio-signal processing (EEG/ECG) and biomedical image processing  
- Bioinformatics
Week 2: Introduction to Biology and Medicine
- How biological systems function: DNA, RNA, Cell, Protein
- Conventional measurement technologies (DNA microchip, DNA sequencing devices, fluorescence technology, western blot, mass spectrometry, biosensors)

Week 3: Scientific Epistemology and Control in Biology
- On scientific knowledge
- History of science
- On translational science
- Biological pathways, robustness in biological systems, gene regulatory networks.
- Boolean network models
- Optimal and heuristic methods for network control

Week 4 - 6: Bioinformatics, Computational Biology, and Pattern Recognition in Genomics
- Sequencing techniques
- Sequence assembly, sequence alignment, gene prediction
- Predicting the structure and function of biomolecules
- Signal processing models and methods for biological signal & data analysis
- Introduction to classifier design
- Error estimation and validation of classification methods
- Application in disease diagnosis/prognosis, biomarker discovery

Week 7-9: Medical Imaging (MRI, CT, PET, Ultrasound)
- Introduction to cross-sectional imaging acquisition and reconstruction
- Overview of sensitivity, information sources and contrast in MRI, CT and PET
- Hardware overview of MRI, CT and PET.
- General notions on ultrasound imaging including ultrasound wave propagation and scattering of ultrasound in biological tissues
- Electronic transducers for ultrasound imaging
- Overview of state-of-the-art ultrasound techniques including harmonic imaging, elasticity imaging, 3D/4D imaging, high intensity focused ultrasound

Week 10: Biomedical Image Processing
- Image segmentation
- Image registration
- Parametric mapping

Week 11 - 12: Micro and Nano Technology
- Microfabrication and micro-electro-mechanical systems (MEMS)
- Microfluidics and lab-on-a-chip (point of care diagnosis, high throughput screening systems)
- Micro/nano sensors

Week 13-14: Recent Trends in Interfacing Electrical Engineering and Life Sciences
- Enabling technology for personalized medicine
- Computational prediction of drug response, computational toxicology
- Brain activity maps
- Next-generation prosthetics (e.g. brain-machine interface)
- Microphysiological systems
- Enabling technologies in global and remote healthcare

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**Academic Integrity**
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"An Aggie does not lie, cheat, or steal, or tolerate those who do."

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