Bioelectronic Devices
New materials and device architectures
System integration
Micro/nanofabrication

Large-scale data and systems
Systems neuroscience and behavior
Computational modeling
Neuromorphic computations
Genomics

Translational devices and analysis
Clinical electrophysiology and imaging
Brain machine interfaces
Drug discovery
Topical courses:

**ELEN E608X**

- ELEN E6080: Methods of Signal Processing in Comp. Neuroscience
- ELEN E6081: Compu. Methods for Biomolecular and Info Networks
- ELEN E6082: Global Brain Modeling
- ELEN E6083: The Origins & Implications for Large-scale Biological & Information Systems
- ELEN E6084: Proteomic Biomarker Discovery from Analysis of Mass-spectroscopic Data

**ELEN E609X**

- EEBM E6090 Topic: Global Brain Modeling
- EEBM E6090 Topic: Brain Comp. Interfaces
- EEBM E6091 Topic: Neuromorphic Engineering
- **EEBM E6091 Topic: Devices & Analysis for Neural Circuits**
- EEBM E6092 Topic: Big Data in Neuroscience Engineering
- EEBM E6099 Topic: Brain Computer Interfaces
Digital Signal Processing
Prof. John Wright

- Prerequisites: (ELEN E3801)

- Digital filtering in time and frequency domain, including properties of discrete-time signals and systems, sampling theory, transform analysis, system structures, IIR and FIR filter design techniques, the discrete Fourier transform, fast Fourier transforms.
Neural Networks and Deep Learning
Prof. Zoran Kostic

- Developing features & internal representations of the world, artificial neural networks, classifying handwritten digits with logistics regression, feedforward deep networks, back propagation in multilayer perceptrons, regularization of deep or distributed models, optimization for training deep models, convolutional neural networks, recurrent and recursive neural networks, deep learning in speech and object recognition.

- Analytical study and software design

- Team based projects

- Industry participation
Computational Neuroscience: Circuits in the Brain  
Prof. Aurel Lazar


Encoding with Neural Circuits: Stimulus Representation with Time Encoding Machines, Geometry of Time Encoding, Encoding with Neural Circuits with Feedback, Spatio-Temporal Receptive Fields, Population Audio and Video Time Encoding Machines.


Projects in Matlab or Python
Introduction to Genomic Information Science and Technology
Prof. Dimitris Anastassiou, W. Cheng

- Introduction to the information system paradigm of molecular biology.

- Representation, organization, structure, function and manipulation of the biomolecular sequences of nucleic acids and proteins.

- The role of enzymes and gene regulatory elements in natural biological functions as well as in biotechnology and genetic engineering.
Brain Computer Interface Laboratory

Prof. Nima Mesgarani

- Hands on experience with neural signal recording and analysis
- Gaining experience with electroencephalography (EEG)
- Exploring the applications in scientific, engineering and medical fields
Data in Biology and Information Systems: Ongoing advancements in information systems as well as the emerging revolution in microbiology and neuroscience are creating a deluge of data, whose mining, inference and prediction will have an enormous economic, social, scientific and medical/therapeutic impact.

Biology: For example, in biology, microarray technology is creating vast amounts of gene expression data, whose understanding could lead to better diagnostics and potential cure of cancer.

Information Systems: Similarly, in information systems, companies like Google, Amazon, Facebook, etc., are facing various problems on massive data sets, e.g., ranking and community detection.
Tools and analysis for neural circuits
Prof. Dion Khodagholy

A comprehensive overview of devices and analytical techniques that enable investigation and decoding of neural circuits.

- Introduction to brain, brain states and neural networks
- Neural devices and their spatiotemporal resolution
- Time domain neural analysis
- Frequency domain neural representation
- Phase, traveling waves and wave propagation
- Closed-loop real time processing
- Template matching for event detection
- Clustering and sorting
Faculty

- **Dimitris Anastassiou** – Computational biology and genomics
- **Christine Hendon** – Optical imaging for cardiovascular and oncology applications
- ** Predrag Jelenkovic** – Mathematical modeling of biological systems
- **Aurel Lazar** – computing with neural circuits
- **Nima Mesgarani** – Reverse-engineering the auditory system
- **Dion Khodagholy** – Neuroelectronics, bioelectronics, systems neuroscience
- **Ken Shepard** – Bioelectronics and neural interfaces
- **Paul Sajda** – Neural engineering, neuro-computation
- **Joshua Jacobs** – Electrophysiology of navigation and memory, brain stimulation, direct human brain recordings
- **Qi Wang** – Neural coding, brain machine interfaces
Thank You!