ECE 441 Interfacing & Modulating the Nervous System

Fall 2023

Lecture 01 Introduction

Instructor Team

- **Instructors**
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Office Hours

- **Instructors**
  - After each lecture
  - Appointment by email

- **TAs**
  - TBD

Course Information

- The syllabus of this course has been posted on **Quercus** https://q.utoronto.ca/courses/324724

- We will use **Piazza** for the class discussion board

About This Course

Provides an overview of the fundamental principles and clinical applications of neuromodulation. Topics include (i) overview of the human nervous system & neural oscillations, (ii) introduction to electrical-neural interfaces, (iii) fundamentals of neural recording, neural stimulation & signal processing as well as (iv) instrumentation and clinical applications of commonly used neuromodalities including Electroencephalography (EEG), Deep brain stimulation (DBS), Transcranial magnetic stimulation (TMS) and Functional electrical stimulation (FES).

About This Course

This course provides an overview of the fundamental principles and clinical applications of neuromodulation.

Topics include:

(i) Overview of the human nervous system & neural oscillations,

(ii) Introduction to electrical-neural interfaces,

(iii) Fundamentals of neural recording, neural stimulation & signal processing

(iv) Instrumentation and clinical applications of commonly used neuromodalities including Electroencephalography (EEG), Deep brain stimulation (DBS), Transcranial magnetic stimulation (TMS) and Functional electrical stimulation (FES)

Lecture Outline

Date	Description
Sept 7	Overview of human nervous system and neural circuits
Sept 14	Introduction to clinical neuromodulation
Sept 21	Introduction to oscillations
Sept 28	Fundamentals of signal processing and control theory for neuromodulation-Part I
Oct 5	Fundamentals of signal processing and control theory for neuromodulation-Part II
Oct 12	Introduction to neural interfacing technologies
Oct 19	Circuit modelling and computational neuromodulation
Oct 26	Observation-only clinical lab sessions
Nov 2	Fundamentals of neural stimulation
Nov 6-10	Fall study break
Nov 16	Fundamentals of neural recording
Nov 23	Instrumentation and clinical application, Part I - Current and emerging modalities of non-invasive neurostimulation
Nov 30	Instrumentation and clinical application, Part II -FES
Dec 7	Instrumentation and clinical application, Part III -DBS

Lab Schedule

- Location: SF2201
- Sessions (only need to attend one session)
  - PRA 101: Mon 3-6pm
  - PRA 102: Mon 12-3pm
  - PRA 103: Wed 9-12pm

Lab Schedule

Lab	Date	Description
1	Sept 18	Introduction to OpenBCI system, device setup
2	Oct 2	Experiment: recording neural signal from visual cortex
3	Oct 16	Experiment: signal processing of visual cortex recordings
4	Oct 30	Experiment: frequency stimulus differentiation
5	Nov 13	Experiment: neuromodulation with band power (I)
6	Nov 27	Experiment: neuromodulation with band power (II)

Tutorial Schedule

- Time: Monday 9–11 am
- Location: WB219
- Schedule
  - First tutorial session: Sept 18
  - Last tutorial session: Dec 4 (final presentation)

Marking Scheme

Assessment	Percentage
Labs	30%
Group Project	30%
Final Assessment	40%
Total	100%

- **Final Exam date/time:** To be arranged by undergrad office

Academic Integrity

http://www.academicintegrity.utoronto.ca/
https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic- matters-july-1-2019

Final Exam

- **Final Exam date/time:** To be arranged by undergrad office
- **Exam Type:** Type D Notes permitted (specifics to be announced in advance of the examination)
- **Exam Coverage:** materials covered in all lectures (including guest lecturers)

Textbooks

- Bin He, “Neural Engineering”, 2020. Link: https://link.springer.com/book/10.1007/978-3-030-43395-6
- Pascal Wallisch “MATLAB for Neuroscientists”, 2014 https://www.sciencedirect.com/book/9780123838360/matlab-for-neuroscientists
- Intraoperative Neurophysiological Monitoring for Deep Brain Stimulation: Principles, Practice and Cases by Erwin B. Montgomery Jr., 2014 [Link]
- (Optional) J. G. Webster, “Medical Instrumentation: Application and Design” 5th edition, Wiley, 2020.

Note: in addition to the textbooks listed above, a selection of latest papers will be provided to students as references.