

***Electrical and Computer Engineering Department***

***Syllabus & Schedule – FALL 2019***

Course Name: **EEL 6836**

Title: **Computer Visualization of Brain Electrical Activity**

Semester: **FALL 2019**

Instructor: **Mercedes Cabrerizo**

*Classrooms:* ***Room #***

*Class Times:* ***Tuesday & Thursday***

***2:00 3:15 pm***

*Office:* ***Room EC 2221***

*Office Hours:* ***Tuesday & Thursday:***

***by Appt.***

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**Course Description**

Computer techniques for the visualization of brain electrical activity using EEG signals. Analysis of the origin of this activity as it relates to its measurement and visualization through computerized systems.

**Suggested Textbook:** "EEG Signal Processing" by Saeid Sanei and J.A. Chambers, 2007, Wiley, West Sussex, England, ISBN-13 978-0-470-02581-9.

**1. Anatomy of the Brain**

* Description of the different areas of the brain
* Defining the lobes of the brain
* MRI different types of views (coronal, axial, saggital)
* MRI/fMRI main differences
* Brain areas and its associated functions (i.e. visual cortex, language, motor)
* Brain modalities associated with these tasks
* Diseases related with the brain (epilepsy, tumors) and statistics
* Treatments, surgery, diagnosis

**2. EEG**

- EEG Montages (10-20, MCN)

- EEG Computer tools, XLTEK, Neuroscan, Nexstim

- Electrical activity in the brain interpretation

- EEG frequencies (Alpha, Beta, Delta, Gamma and Theta)

- Epileptiform activity: ictal, interictal, seizure (focal, generalized)

- Understanding of the spatiotemporal characteristics of the EEG electrodes

- Set of conditions to determine suitable biomarkers in the EEG signals

-Parameters extraction:

-EEG Sampling rate, SNR, filtering

* + EEG Fourier Transform (FT), Fast Fourier Transform (FFT)
  + EEG time and frequency features
  + Artifacts, noise reduction, notch filter
  + PCA/ICA

- ROC descriptors

**3. 3D Source Localization**

- Dipole and source analysis

- Moving dipole and rotating dipole models

- Current density reconstruction (CDR)

-Estimation of the expected measured voltage values following different EEG configurations.

- Signal to noise ratio (SNR)

- PCA/ICA applied to 3D source localization

- MRI image segmentation (using different software’s such as Curry and FreeSurfer)

- Integration of the different modalities using EKG, TMS and EEG

- Source Visualization

- HFO, ripples and fast ripples definition

- Ictal and pre-ictal EEG, definition and processing

- Detection of interictal spikes using the Walsh Transform

- Extraction of parameters to measure EGG patterns

- Classification of EEG electrodes

**4. Transcanial Magnetic Stimulation (TMS) and its Applications**

-Introduction to TMS

-Basic principles (TMS Physics)

-Protocol design (Input parameters)

-TMS/EEG and TMS/EKG applications to Epilepsy, ADHD/ADD, Parkinson among others neurological disorders.

-Modalities integration

-System designs for integration and validation of different neurological disorders

**Projects:**

**Must** include following sections:

Abstract (hypothesis); Introduction; Methods; Results; Conclusion (significance of the study); and References.

**1-** Detect interictal spikes in subdural EEG recordings in order to classify electrodes that lead to seizure from those that do not.

**2-** Study the spectral power of the frequencies higher than 46 Hz in subdural EEG recordings in order to detect a seizure with better accuracy.

**3-** Identify ripples and fast ripples from high frequency oscillations (HFO) in epileptic patients: HFO in pediatric patients; HFO in resection cases and correlate it with seizure outcome; HFO in different types of intractable seizure disorders; and HFO in pediatric patients in different states/during different tasks

**4-** Use the findings in projects 1-3 to develop seizure prediction algorithms by investigating coherence, spectral power, and time domain features.

**5-** Study somatosensory evoked potentials (posterior tibial nerve located at the ankle) analysis in order to detect ahead of time the response of this particular nerve during intraoperative monitoring and surgeries.

**Evaluation and Grading:**

Project: 40 %

Midterm Exam 30 %

Final 30 %

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| --- | --- |
| **Grade** | **% (Percentage)** |
| **A** | **90-100** |
| **B** | **80-89** |
| **C** | **70-79** |
| **D** | **60-69** |
| **F** | **59+ <** |
| **N/A or None** |  |

**Please read carefully the *Department Regulations for Incomplete Grades*:**

1. Must be unable to complete the course through documented circumstances beyond his/her control.

2. Must be passing the course prior to that part of the course that is not completed.

3. Must contact the instructor or the secretary immediately before or during the part missed, so the instructor will be aware of the circumstances causing the incomplete.

4. Must make up the incomplete work through the instructor of the course and should not be allowed to sit through another entire course to make up the incomplete.

5. Must make proper arrangements with the instructor to complete the course before the last two weeks of the second term.

**Exams and Exam Policies:**

Exams will be closed book and closed-notes. Each exam will consist of materials from lectures, material covered in your assigned projects, materials posted in the website used in this course, and the principal operation procedures and rules of the software packages being studied.

**Make-Up Exams:**

* Make-up exams are very rarely given and **ONLY** in cases of extreme emergencies. Please read the guidelines provided below very carefully for more information on this issue.

**Impact of Absences and Lateness on your grade:**

* ***Absences*:** If you are absent from class, it is *your responsibility* to find out the material covered during your absence and to catch up with the rest of this class.
* ***Late assignments/projects, make-up exams*:** No late assignments/projects will be accepted, or make-up exam given, unless there is an extreme circumstance and you have an authorized excuse. In addition, if the student has an authorized excuse for a late/missed project/assignment, the authorized excuse and project/assignment must be turned in the day the student returns to class.

ABSOLUTELY NO PROJECT/ASSIGNMENT WILL BE ACCEPTED, OR MAKE-UP EXAM GIVEN IF THE STUDENT DOES NOT PRESENT THE AUTHORIZED EXCUSE THE FIRST DAY THE STUDENT RETURNS TO CLASS.

**Assignments and Projects**:

You will be given a number of assignments and projects. Each assignment/project is due on the date designated. More information and detailed guidelines about each project will be provided when each project is assigned. *All projects are to be turned in at the start of the class period (or within the first five minutes).*

**Presentation of Work:**

Every project/assignment (printed or electronic submission) must include a **COVER PAGE** showing: name of individual (names of each member if a group); course name, number and section; project name/ title, date, and the instructor’s name. For printed submissions, your work must be properly organized, labeled and stapled.

It is your responsibility to keep a copy of every assignment you submit. In case there is a dispute, I will change my record only if you show me all your work with my original initials. “I never got my assignment back from you” type of argument will not serve any purpose.

**Prohibited Conduct in the Classroom/lab**

Prohibited conduct includes, but is not limited to, the use of wireless communication devices, bringing unregistered persons to class, smoking, persistently speaking without being called upon, refusing to be seated, or disruptions caused by leaving and entering without authorization from the instructor for this course. Students are instructed to refrain from such prohibited conduct. Depending on the nature of the disorderly conduct sanctions may include removal from the classroom or other educational setting.

* All cellular phones, beepers, etc must be **turned off before** entering the classroom/lab. Your cell phones must be put away at the start of the class.