ILLINOIS
Bioengineering
GRAINGER COLLEGE OF ENGINEERING

NE 422: Introduction to Neuroimaging

Meeting time: T/TH 11:00-12:20
Location: 3117 Everitt Laboratory

Credit hours: 3 undergraduate hours
Semester: Spring 2026
Prerequisites: BIOE 210, BIOE 310, NE 330

Instructor Information Guillermo L Monroy, PhD
Office Location 4355 Beckman Institute

Office Hours Schedule TBD in Everitt
TA Kevin Tan

Class Website https://canvas.illinois.edu/courses/63961

Course Info https://courses.illinois.edu/schedule/2026/spring/NE/422

Course Description

Basic physics and physiology associated with imaging approaches that are unlocking the secrets of organization and function in both health and disease in the central (brain) and peripheral nervous systems at both the microscale and the macroscale. From cellular structure to metabolic signals to electrical signaling, this course will cover fundamental neuroimaging techniques and provide access to representative data sets to help the student understand the types of neuroscience questions that can be answered by the technologies. From the microscale, including multiphoton microscopy, neural circuit reconstruction, and brain clearing techniques to macroscale electrophysiology, hemodynamics, and molecular imaging approaches. Students will process data from these modalities using MATLAB or other specialized analysis software.

Course Objectives

At the end of the course, the student should be able to

- Explain the basics of imaging system physics for micro to macro neuroimaging and what types of signals can be measured
- Couple understanding of the underlying physiology with the measurements obtained in these systems
- Apply basic analysis tools to extract information from data sets from the various modalities
- Explain the forefront of the technology at the micro scale in neuroimaging up to the macro scale of visualizing brain systems

Course Format

- Two lectures that mix lecture delivery with interactive data analysis
- Students are expected to spend 3 hours in class per week and 8–10 hours outside of class.

Textbook and Reading Materials

Sections from these reference books:

- Basic Neuroimaging. A guide to the methods and their Applications. Bloomfield, Brigadoi, Rizzo, Veronese. 2017.
- Introduction to Biomedical Imaging. Andrew G. Webb. 2002.
- Analyzing Neural Time Series Data: Theory and Practice. Mike X. Cohen. 2014.
- Selected journal articles, such as: Buzsaki, Anastassiou, and Koch. The origin of extracellular fields and currents – EEG, ECoG, LFP, and spikes. Nat Rev Neurosci. 2012, 407-420. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4907333/

Grading

Homework	20%
Exam 1 (micro systems)	25%
Exam 2 (macro systems)	25%
Final project	20%
Class participation	10%

Homework assignments

Weekly homework assignments will be given that require some exercises on theoretical analysis on system behavior and performance (limits, point spread function, and detection limits) in addition to analysis exercises that use datasets in MATLAB to extract information about the underlying neurophysiological system being measured.

Final Project

For the final project, teams of 2 students will work on analyzing a publicly open neuroimaging data set using a modern approach from the literature. The students will be free to choose the neuroimaging system and dataset according to their interests. The students will submit a project proposal and gain approval from course staff, deliver a short presentation to the class, and a final, detailed report that explains how a system works, what is measured, the underlying physiology of the measurement, information about the underlying neural state based on the analysis that they performed, etc.

Additional Expectations:

1. The student will consider the readings as required material and may be tested on items not covered during lecture. Readings are important to provide well-rounded knowledge and alternate explanations, though lecture material is the main source of information as the course progresses.
2. Grading is left to the discretion of course staff. Students are expected to study the solution sets to ensure that they have understood all of the problems assigned.
3. *Ethics and Integrity*: Students are expected to uphold the highest ethical standards, be honest, and practice academic integrity. This includes doing original work and citing any sources used. Group discussions with classmates (only those currently enrolled in the course) about course content and homework is encouraged. However, all work submitted by you must be your own work. No discussion is allowed on exam problems (duh). Please see the academic integrity statement at the University's policy on academic integrity, found in the *Code of Policies and Regulations Applying to All Students* under Article 1, Part 4: Academic Integrity Policy and Procedure.
4. **Homework is due as noted in Canvas**, unless otherwise noted in class or via canvas announcement. Homework not turned in on time will not be accepted unless there is a significant circumstance or granted by various campus authorities.
5. Students will be expected to track their grades and verify its accuracy by frequently checking the grades in gradescope.com and the Canvas site, as appropriate.

Illness and absence policy – PLEASE READ

See: https://studentcode.illinois.edu/article1/part5/1-501
Any unexcused or missed homework / exam will result in a 0. Late homework may be accepted at 50% if approved. However, life does not schedule illness, emergencies, accidents, family events, etc. conveniently - Please contact the instructor *as soon as possible* to make accommodations. Any reasonable request will be considered and are at the discretion of course staff.

This course will not record attendance, and so written permission to miss class due to conflicts is not required. However, regular class attendance is expected, encouraged, and highly correlated with course performance. A quick note is always appreciated to help maintain class continuity. If you decide to come to class and may be sick – you are encouraged to wear a mask to support your fellow campus members.

To attain excused absences / accommodations: Other than contacting the instructor, follow campus policies outlined in the link above or in the following sections. If you are ill, please take some rest and notify your instructor within a reasonable time frame and ahead of time if possible. For exams, you must contact your instructor **immediately** / **as soon as possible**. Depending on the severity and length of time away, an excused absence form may need to be filed, or coordinate with official notice from DRES, BIOE/NE Department, Emergency Dean, etc.

Students are expected to remain current on campus COVID-19 policies, located at: https://covid19.illinois.edu/ and ask questions if a process is not clear. Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community.

Emergency response recommendations

These can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: https://studentcode.illinois.edu/.

Academic dishonesty will result in a sanction proportionate to the severity of the infraction, with possible sanctions described in 1-404 of the Student Code (https://studentcode.illinois.edu/article1/part4/1-404/). Every student is expected to review and abide by the Academic Integrity Policy as defined in the Student Code: https://studentcode.illinois.edu/article1/part4/1-401/. As a student it is your responsibility to refrain from infractions of academic integrity and from conduct that aids others in such infractions. A short guide to academic integrity issues may be found at https://provost.illinois.edu/policies/policies/academic-integrity/students-quick-reference-guide-to-academic-integrity/. Ignorance of these policies is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

In this course you are expected to produce your own work in all assignments. Written assignments will be submitted through SafeAssign, a software tool that compares your writing against a large database as well as to the work of your current classmates and previously submitted assignments. Assignments with close matches to other work will be flagged and investigated.

Anti-Racism and Inclusivity

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (https://bart.illinois.edu/). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

Community of Care

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050) or online at: http://odos.illinois.edu/community-of-care/referral/. Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe.

Furthermore, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at McKinley Health Center (https://mckinley.illinois.edu/) or the Counseling Center (https://counselingcenter.illinois.edu/). For urgent matters during business hours, no appointment is needed to contact the Counseling Center. For mental health emergencies, you can call 911.

Disruptive Behavior

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported to the Office for Student Conflict Resolution (https://conflictresolution.illinois.edu; conflictresolution@illinois.edu; 333-3680) for disciplinary action.

Campus approved accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the as soon as possible. To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class should contact Disability Resources and Educational Services (DRES) and see the instructor as soon as possible. If you need accommodations for any sort of disability, please speak to me after class, or make an appointment to see me or see me during my office hours. DRES provides students with academic accommodations, access, and support services. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TDD), or e-mail disability@illinois.edu. http://www.disability.illinois.edu/.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Mental Health and Counseling Services

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Student Health Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

Counseling Center (217) 333-3704
McKinley Health Center (217) 333-2700
National Suicide Prevention Lifeline (800) 273-8255
Rosecrance Crisis Line (217) 359-4141 (available 24/7, 365 days a year)

*This statement is approved by the University of Illinois Counseling Center.

You can always contact the instructor if you have any concerns or need any help.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: https://wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: https://wecare.illinois.edu/.

Schedule (Subject to change – kept up to date on class website)

Lectures will motivate different neuroimaging approaches by trying to build an understanding of the physiological basis of disease, such as Alzheimer's Disease (AD), with that modality, providing a consistent look at the information available across the multiple modalities:

Week	Date		Lecture topic
1	20-Jan		**Syllabus day and class intro**
	22-Jan		Nervos sys. Overview
2	27-Jan		NMR / Structural MRI
	29-Jan		Structural MRI + diff + perf
3	3-Feb		fMRI - Basic principles
	5-Feb		fMRI - Brain mapping
4	10-Feb		fMRI - Connectomics
	12-Feb		Neuroimaging Stats
5	17-Feb		Xray / CT
	19-Feb		PET/SPECT physics / imaging
6	24-Feb		functional PET/SPECT + ultrasound
	26-Feb		Ultrasound + **final proj info**
7	3-Mar		**No class**
	5-Mar		**Exam 1**
8	10-Mar		Neural ckt recon
	12-Mar		Electrophys
9	17-Mar	x	Spring break Mar 14-22
	19-Mar	x	Spring break Mar 14-22
10	24-Mar		Project feedback - OH
	26-Mar		Spikes-fields-potentials
11	31-Mar		EEG
	2-Apr		Microscopy
12	7-Apr		Fluorescence, Optogenetics
	9-Apr		Brain / Tissue clearing
13	14-Apr		OCT/PSOCT
	16-Apr		NIR + Diffuse imaging + EROS
14	21-Apr		Class recap + Final proj prep/OH
	23-Apr		**Exam 2**
15	28-Apr		**No Class**
	30-Apr		Final project pres 1
16	5-May		Final project pres 2