

**EECE4649 Biomedical Imaging Instrumentation**  
**Dialogues of Civilization**  
**May/June 2023**

**Course Description:**

Explores a wide variety of modalities for biomedical imaging in the pathology laboratory and *in vivo*. After an introductory discussion of tissue properties, waves used in imaging, and contrast mechanisms, the course discusses modalities such as microscopy, endoscopy, x-ray, computed tomography, ultrasound, and MRI. With each modality, instrument parameters, contrast mechanisms, resolution, and depth of penetration are considered. Offers students an opportunity to work in groups to complete a project in which they examine one modality in detail and either generate synthetic data using a computational model or process available image data.

**Overview:**

Students will work in teams on homework and projects, with each team including students from Northeastern and UAndes.

The instruction will be in English.

This course will require considerable collaboration among students beyond the class time. The total workload will be comparable to that of a typical 4-semester-hour course at Northeastern, with 45 hours of class time and 90 hours of homework, reading, programming, and preparing presentation material, spread over 5 weeks. Mandatory weekly workshops will provide some opportunity for outside work but students will need to find additional time for collaboration.

Because of the short schedule the 45 hours of lecture are presented in less than 20 sessions. Therefore, attendance is mandatory for all students at every session. Because of the unusual schedule, students from UAndes will be given alternatives in their other courses so that they may participate fully in this course.

**Syllabus for EECE-4649**  
**Biomedical Imaging Instrumentation**  
**Dialogues of Civilization**  
**Revised 17 February 2023**

Date	Day		Topic
1:	Tue		Wave Theory. Tissue Properties.
2:	Wed		Absorption, Scattering, and Reflection
3:	Thu		Contrast, Resolution, and penetration
	Fri		Workshop
	Mon	HW 1	Waves and Tissues
4:	Mon		X-Ray 1
5:	Tue		X-Ray 2
6:	Wed		X-Ray CT and MRI 1
7:	Thu		MRI 2
	Fri		Workshop
			Project Proposals
	Mon	HW 2	Radon Transform
8:	Wed		MRI 3
9:	Thu	JD	Inverse Problems
10:	Fri		Ultrasound 1
	Fri		Workshop
	Mon	HW 3	Inverse Problems
11:	Mon		Ultrasound 2
12:	Tue		Microscopy in the laboratory
			Project Interim Reports
13:	Thu		<i>In-vivo</i> Microscopy
14:	Fri		Optical Coherence Tomography
	Fri		Workshop
15:	Mon		Endoscopy
	Mon	HW4	Microscopy
16:	Tue		TBD
17:	Wed		Experimental Techniques
18:	Thu		Review and Summary
19:	Fri	Students	Student Final Presentations

**Prerequisites:**

[MATH 1242 (Calculus 2) OR Math 1342 (Calculus 2)]

AND

[PHYS 1145 (Physics for Live Sciences 1) OR

PHYS 1151 (Physics for Engineers 1) OR

PHYS 1171 (Physics for Bioscience and Bioengineering 1)]

**Grading:**

- Homework 30%
- Attendance and Participation 20%
- Teamwork and Peer Evaluation 25%
- Final Projects 25%

**Course Objectives:** Students will be able to

- Apply some of the concepts of waves,— including absorption, scattering, and diffraction,— to different medical imaging systems.
- Understand how the tissue properties generate contrast in normal and diseased tissue.
- Be able to select appropriate imaging modalities for different imaging applications.
- Apply computational techniques to predict sensor response.
- Understand and explain the different analytical techniques for solving simple inverse problems.