

# ECE 5397: Medical imaging with Lasers

## General Information

Rohith Reddy, Assistant Professor  
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Room:  
Time: 8:30am – 10:00am, MW  
Office: 11:00am – 12:30pm, MW

## Description

Medical imaging is an important field of inquiry for both biological discovery and clinical diagnostics. Imaging the human body allows us to identify and diagnose diseases, and suggests modes of treatment. A study of cells and their interactions allows us to make fundamental discoveries in biology that have been used to improve medicine and human health. There are several technologies such as ultrasound, MRI, X-ray CT, optical imaging etc. that are capable of providing images from inside the body. However, optical imaging has the fundamental advantage that it provides significantly higher resolution images than other technologies in a minimally invasive manner. It is often possible to see cellular and tissue features at the microscopic scale using light and perform more accurate diagnosis at an earlier stage. This course presents a graduate level overview of optical technologies for medical imaging and illustrates the ideas behind these technologies using practical examples from clinical and biomedical applications. Topics covered will focus on three primary topics:

1. **Introduction to medical imaging and fundamentals of optics**
2. **Overview of different optical imaging techniques**
3. **Examples illustrating biomedical applications of various imaging techniques**

## Textbook

The field of optical imaging is rapidly evolving. The following two books will serve as useful guides to the course material:

“Fundamentals of photonics”, Bahaa EA Saleh, and Malvin Carl Teich, John Wiley & Sons, 2019

“Introduction to subsurface imaging” Bahaa E. A. Saleh, Cambridge University Press, 2011

## Course Topics

1. Overview of Medical Imaging
  - a. Ultrasound
  - b. MRI
  - c. X-ray CT
  - d. Optical imaging
  - e. PET
  - f. Other techniques
2. Fundamentals of Optics
  - a. Light
  - b. Lasers
  - c. Ray and wave optics
  - d. Fourier optics
3. Optical Imaging Techniques
  - a. Microscopy
  - b. Fluorescence and confocal
  - c. Quantitative phase imaging
  - d. Optical Coherence Tomography
  - e. Diffraction Tomography
  - f. Diffused optical imaging
  - g. Spectroscopic imaging
4. Biomedical Applications
  - a. Cancer diagnosis using spectroscopic imaging
  - b. Early Barrett’s esophagus detection using OCT
  - c. Histopathology using microscopy
  - d. Drug discovery using fluorescence and confocal



## Grading

5%	Homework Assignments
25%	Paper Presentation
20%	Exam 1
20%	Exam 2
30%	Final Project

## Grade Point Scale:

A = 93-100	A- = 90-92	
B+ = 87-89	B = 83-86	B- = 80-82
C+ = 77-79	C = 73-76	C- = 70-72
D+ = 67-69	D = 63-66	D- = 60-62
F < 60		

(Thresholds may be lowered at my discretion.)

## Homework

There will be regular homework assignments, which will be collected, checked for completion, and randomly graded. Failure to do the work will result in your assignments being selected for more frequent grading. These homework assignments will be based on material from the books or your own notes. Students are encouraged to work together on the homework assignments, however I expect you to turn in actual (not copied) work. **Answers to homework assignments must be legible (typing is preferred) and include your name and the date it was assigned in the upper-left corner. Some assignments will require drawing figures, which should be done neatly by hand. No late homework will be accepted, because we will generally discuss the assignment in class on the due date. You may hand it in before the due date if you expect to be absent.**

## Paper Presentation

Students will be required to read review papers on one of the imaging modalities discussed in class and present the latest research developments related to that modality. They will give a 12 minute presentation to the class followed by 3 minute for questions. The students can form teams of two as dictated by the breadth of the topic and number of students enrolled in class. The topics will be decided in consultation with the course instructor.

## Final Projects

Each student will select a final project after the first Mid-term Exam. The instructor will provide several suggested projects before the deadline, however students can propose their own. Projects proposed by students can be used as part of their ongoing research. Projects should be in the area of medical imaging. The students will give (1) a written report (2) a 10 minute presentation describing their research. **A final report is due the last day of class. Presentations will be given during the last week of class and overflow into the Final Exam date. Students who present during the last week of class will not be required to attend the final presentation date.**

## Examinations

**Exam Schedule: Mid-term 1: Oct 14 | Mid-term 2: Nov 4 | Final Exam: Presentations, Dec 4/9 8.30am – 10am**

Exams will be based on homework assignments, class notes, and my own notes. My slides and any relevant notes will be made available before the exam, providing at least one week for review.

Exams and quizzes are closed book, closed notes, unless otherwise announced. All work must be done on the examination forms provided for that purpose. The seats for exams will be randomly assigned. All of these regulations are designed to reduce the possibility of cheating, so that all students will be graded as fairly as possible. **No makeup examinations will be given.** **If you have a medical emergency you should call your instructor as soon as possible, preferably before the examination. Medical documentation will be required in all such cases.**

## Academic Honesty Policy

Students in this course are expected to follow the *Academic Honesty Policy* of the University of Houston. It is your responsibility to know and follow this policy.



## Religious Holy Days

Students whose religious beliefs prohibit class attendance on designated dates or attendance at scheduled exams may request an excused absence. To do this, you are **strongly encouraged** to request the excused absence, in writing, by Wednesday, February 11, 2015. Please submit this written request to your instructor to allow the instructor to make appropriate arrangements. For more information, see the *Student Handbook*.

## Students with Disabilities

Students with recognized disabilities will be provided reasonable accommodations, appropriate to the course, upon documentation of the disability with a *Student Accommodation Form* from the *Center for Students with Disabilities*. To receive these accommodations, you must request the specific accommodations, by submitting them to the instructor in writing, by Wednesday, February 11, 2015. Students who fail to submit a written request will not be considered for accommodations. For more information, see the *Student Handbook*.

