NJIT | DEPARTMENT OF BIOMEDICAL ENGINEERING

Medical Imaging Systems: (BME 471)

Bharat Biswal, PhD Email- biswal@njit.edu

Class: 6:00 – 8:50 PM Thursday

Office Hours: Thursday 3:00 – 6:00 PM, by appointment

Text Book:

The Essential Physics of Medical Imaging,

by Jerrold T. Bushberg and J. Anthony Seibert

Course Description:

Introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound, magnetic resonance imaging modalities are included.

Learning objectives:

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

1. Demonstrate a strong grasp of the basic physical principles underlying several medical imaging modalities.

2. Demonstrate a solid understanding of the concepts of medical image acquisition, image formation, image quality and display methods.

3. Apply the concepts learnt in class to solve real-world problems in medical image reconstruction, image processing and analysis.

4. Demonstrate an appreciation for the strengths and weaknesses of various imaging modalities and what kind of

anatomical and physiological information can be obtained from them.

Course Schedule:

Lecture 1	Introduction and overview, MATLAB Training -Matrix operations
Lecture 2	MATLAB Training -Matrix operations - Image display - Image Manipulation Radiation and the Atom Interaction of Radiation with Matter
Lecture 3	X-ray Production Interaction with Matter X-Ray Projection Techniques X-Ray Detectors
Lecture 4	Computed Tomography Data Acquisition Projection Radon Transform Sinogram Creation 2DImage Creation Back projection
Lecture 5:	Circular CT MultiSlice CT Cardiac CT Dual-Energy CT Image Artifacts -Beam Hardening -Scatter Midterm Review
Lecture 6:	Midterm Discussion of Project Topics
Lecture 7:	Nuclear imaging Radio-nuclides Detectors Planar Imaging SPECT
Lecture 8:	Positron Emission Tomography

Lecture 9:	Ultrasound imaging: physics, data acquisition, modes Ultrasound imaging: Doppler, advanced topics
Lecture 10:	Magnetic Resonance Imaging
Lecture 11:	Functional MRI
Lecture 13/14	Project Presentations
Lecture 15:	Finals

Course Structure:

The course will consist of weekly lectures, homework assignments, two exams and
a course project (details below).

20% Homework
25% Midterm
25% Final
30% Project

Course Project:

The course will involve a research project. At the end of the semester, all students
will be expected to make a 15-min presentation (with slides) on a particular topic in medical imaging. Students should select a topic, discuss with the instructor, and get approval within the **first five weeks of class**. Students with similar interests can choose to work together and present a joint in-depth project (the contribution of each student should be clearly noted). A list of literature sources should be submitted to the instructor for approval by **the ninth week of class**. Students are expected to submit a written report on their project topic in addition to the presentation.

Your classmates will grade the final presentation based on following criteria.

Category	Description	Weighting	Grade
Slide Preparation/Timing	Were the slides nicely prepared with font size/ heading. Did speaker use time wisely?	10%	
Oral Communication	Eye Contact/ Did speaker engage the audience and answer questions properly?	15%	
Organization	Do the slides convey the main idea? Did the speaker provide an outline and follow it?	25%	
Level of understanding	Did the speaker comprehend and enlighten us about the subject and cover all the important aspects of the paper	30%	
Enthusiasm	Can the speaker tell us the big picture and relevance?	20%	

The report should follow the guidelines for an IEEE conference paper, with sections for Introduction, Materials and Methods, Results, Discussion and Conclusion. Grades will be based on: knowledge of the subject and quality of background research, depth of critical analysis, clarity of explanation, and presentation style. For the project, students can select one of the following approaches:

1) Review a specific algorithm or technology for medical image formation, processing or analysis, demonstrate its uses, compare against alternative approaches, discuss the strengths and weaknesses, and suggest avenues for improvement.

2) Explore medical imaging applications for a specific organ or disease by identifying the clinical need, comparing the applicability of various imaging methods, an critically
reviewing the latest research directions.

3) Review an emerging medical imaging modality, discuss the physics, instrumentation and image processing involved, describe potential applications, and discuss the strengths and weaknesses compared to existing imaging modalities.