ECE 5206: Medical Imaging and Processing

Course Description

Introduction to medical imaging techniques (CT, MRI, PET, ultrasound), including data collection, image reconstruction, physics of tissue interactions, and digital processing of medical images.

Prior Course Number: 706
Transcript Abbreviation: Medical Img & Proc
Grading Plan: Letter Grade
Course Deliveries: Classroom, 100% at a distance
Course Levels: Undergrad, Graduate
Student Ranks: Junior, Senior, Masters, Doctoral
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 3050 (352). Prereq or concur: 3090 or 582, or Grad standing in ECE, BiomedE, or Biophys.
Exclusions: Not open to students with credit for 706.
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

Course Goals

Master the basic the physical & mathematical principles of medical imaging modalities commonly used in clinical & research applications, paricularly x-ray axial computed tomography, magnetic resonance imaging & ultrasound
Master the design of computer simulation experiments to demonstrate the mathematical principles of image reconstruction. Instruction for computer experiment design is given in lectures and feedback is provided with graded projects

Be competent at writing and presentation skills for the required written and oral report on a research topic selected by each student or student team and approved by the instructor
Be competent in demonstrating professional and ethical responsibility in appropriately citing references in their reports
Be familiar other imaging modalities and techniques for research projects, including but not limited to: x-ray angiography, single photon emission tomography, electron spin imaging, optical tomography and synthetic aperture radar

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Topical summary	1.0							
Digital image mathematics: multidimensional FTs, DFT, circular symmetry, Hankel & Abel transforms, sampling and interpolation	3.0							
Axial computed tomography: Radon transform, central slice theorem, filtered backprojection (parallel and fan beam), iterative reconstruction, direct Fourier reconstruction	5.0							
X-ray CT: Basic physics of generation, photon absorption, attenuation; system configurations	2.0							
Nuclear magnetic resonance: basic physics, relaxation times, Bloch equations, spin echos, gradient recalled echoes	3.0							
Magnetic resonance imaging: Fourier imaging, spin echo sequence, gradient echo sequence, T1 and T2 weighted imaging, high speed imaging, echo planar imaging, spiral imaging, FLASH, SSFP	6.0							
Acoustics: physics, wave types, reflection and transmission properties	3.0							
Ultrasound imaging: propagation in tissue, scattered signal, A-mode imaging, B-mode imaging, M-mode imaging, diffraction and focusing	6.0							
Image processing: zero-padding and spatial interpolation, scanning window spatial filters (moving average, median, range), edge detection, intensity thresholding, morphometric operations	5.0							
Multispectral image processing: image registration, PET-CT, PET-MRI, combination of T1-T2-density MRI imaging.	3.0							
Student research report presentations	5.0							

Representative Assignments

Computer simulation and calculation projects (5)
Library research project oral presentation
Library research project written report

Grades

Aspect	Percent
Computer simulation and calculation projects	60%
Research project oral presentation	15%
Research project written report	20%
Participation	5%

Representative Textbooks and Other Course Materials

Title	Author
Foundations of Medical Imaging	Z. H. Cho, J. P. Jones, M. SIngh
Digital Image Processing, 3rd Ed.	Gonzalez & Woods

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
***	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
**	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
***	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

CpE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
***	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
**	3	an ability to communicate effectively with a range of audiences
*	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
*	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
**	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
**	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

EE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
**	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Course Contribution		Program Outcome
**	3	an ability to communicate effectively with a range of audiences
*	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
*	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
**	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
*	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Additional Notes or Comments

Update prereqs, exclusions, goals and topics to match university format.
Corrected typo in text, 4/3/12.

Up date course goals 4/21/14 BLA

Change semester of offering to spring 3/25/16

New outcomes contributions. 6/5/2019 BLA

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