

BME 4531 – MEDICAL IMAGING – FALL 2025

Instructor:

Wesley Bolch, PhD, (352) 273-0303, wbolch@ufl.edu

Office Hours: By appointment

Email Correspondence: If emailing about class issues, please use the email facility within Canvas.

Supervised Teaching Students:

Ziqian Huang, PhD Student in Biomedical Engineering, ziqian.huang@ufl.edu, Office Hours: By appointment

Julia Withrow, PhD Student in Medical Physics, juliawithrow@ufl.edu, Office Hours: By appointment

Email Correspondence: If emailing about class issues, please use the email facility within Canvas.

Course Description (3 Credits)

This course covers medical imaging from a biomedical engineering perspective. Topics include fundamental physics, mathematics, instrumentation, and clinical applications of imaging modalities to include x-ray radiography, fluoroscopy, computed tomography, ultrasound, magnetic resonance imaging, and nuclear medicine imaging.

Course Pre-Requisites / Co-Requisites: MAC 2313, MAP 2302, and PHY 2049 with minimum grades of C

Course Objectives:

Learn the principles of operation of medical imaging modalities used clinically – including x-ray imaging, CT, ultrasound, magnetic resonance imaging, and nuclear medicine; Develop understanding of analytical methods and theory that have general application across medical imaging modalities; Develop competence in analytical software tools useful in medical imaging.

Meeting Times: Tuesday, Period 5-6, 11:45 am – 1:40 pm, Little Hall 0113

Thursday, Period 6, 12:50 pm – 1:40 pm, Little Hall 0121

Meeting Location: All lectures will be delivered face-to-face in these classrooms.

Required Textbook:

The Essential Physics of Medical Imaging

Jerrold T. Bushberg, 4th Ed. Wolters-Kluwer (2020)

Required Software

MATLAB ([mathworks.com](https://www.mathworks.com))

ImageJ (imagej.nih.gov)

Attendance and Expectations:

Students are expected to attend all classes in person. Students must notify the instructor of expected absence in advance and make arrangements to make up missed material. Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>) and require appropriate documentation. Attendance will be monitored through periodic verification in class. During class, all students must put away all cell phones. Students are encouraged to bring laptops to class for class note taking. Professionalism standards will be enforced on reviewer papers and are subject to plagiarism checks.

Grading Policy	Total Points	% of Final Grade	Evening Exams / Due Dates
Homework Assignments (6)	100 each	20%	
Discussion Assignments (6)	100 each	10%	
Attendance and Quizzes	30 each	10%	
Exam 1 – Parts 1 and 2	100	15%	Thursday – September 25
Exam 2 – Parts 1 and 2	100	15%	Thursday – October 30
Exam 3 – Parts 1 and 2	100	15%	Friday – December 12
Review Papers - Submitted	85	15%	Sunday – November 16
Review Papers - Returned			Sunday – November 23
Review Papers - Resubmitted	15		Sunday – November 30

Lecture Schedule

<i>Week</i>	<i>Date</i>	<i>Lecture No. and Topic</i>	<i>Chapters</i>	<i>Lecturer</i>
1	Aug 21	M1 - Course Introduction / Review of Imaging Modalities	Chapter 1	Bolch
2	26	M2 - Review of Photon Interactions	Chapter 3	Bolch
	26	M2 - Review of Photon Interactions	Chapter 3	Bolch
	28	M3 – Review of Electron Interactions	Chapter 3	Bolch
3	Sep 2	M4 - X-Ray Production and Generators	Chapter 6	Bolch
	2	M5.1 – Radiography Fundamentals	Chapter 7	Bolch
	4	M5.2 – Radiography Imaging	Chapter 7	Bolch
4	9	M6 - Mammography and Digital Tomosynthesis	Chapter 8	Bolch
	9	M6 - Mammography and Digital Tomosynthesis	Chapter 8	Bolch
	11	A1 – Medical Imaging Informatics	Chapters 4-5	Withrow
5	16	M7 - Fluoroscopy – Diagnostic	Chapter 9	Bolch
	16	M8 - Fluoroscopy – Interventional	Chapter 9	Bolch
	18	UF Library Resources - Amy Buhler		Buhler
6	A 23	M9 - Computed Tomography	Chapter 10	Bolch (Recorded)
	23	M9 - Computed Tomography	Chapter 10	Bolch (Recorded)
	25	Exam 1 – Part 1 (closed notes) and Part 2 (open notes)		
7	30	M10 - X-ray Dosimetry in Projection Imaging and CT	Chapter 11	Bolch
	30	M10 - X-ray Dosimetry in Projection Imaging and CT	Chapter 11	Bolch
	Oct 2	A2 – Image Display / A3 – Image Processing	Chapters 4-5	Withrow
8	7	M11 - Magnetic Resonance Basics	Chapter 12	Withrow
	7	M11 - Magnetic Resonance Basics	Chapter 12	Withrow
	9	A4 – Frequency Domain and Image Convolution	Chapters 4-5	Withrow
9	14	M12 - Magnetic Resonance Imaging	Chapter 13	Bolch
	14	M12 - Magnetic Resonance Imaging	Chapter 13	Bolch
	16	A5 – Spatial Resolution / A6 – Contrast Resolution	Chapters 4-5	Withrow
10	21	M13 - Radioactivity and Nuclear Transformations	Chapter 15	Bolch
	21	M14 - Radionuclide Production and Radiopharmaceuticals	Chapter 16	Bolch
	23	A7 – Detective Quantum Efficiency and ROC Curves	Chapters 4-5	Withrow
11	28	Review Paper Proposal Review / Presentations		
	28	Review Paper Proposal Review / Presentations		
	30	Exam 2 – Part 1 (closed notes) and Part 2 (open notes)		
12	Nov 4	M15 - Radiation Detection and Measurement	Chapter 17	Withrow
	4	M15 - Radiation Detection and Measurement	Chapter 17	Withrow
	6	A8 – Image Artifacts and Quality Control in CT Imaging	Chapters 4-5	Withrow
13	B 11	M16 - Nuclear Imaging – The Scintillation Camera	Chapter 18	Bolch (Recorded)
	11	M16 - Nuclear Imaging – The Scintillation Camera	Chapter 18	Bolch (Recorded)
	13	A9 – Image Artifacts and Quality Control in MR Imaging		Withrow
14	18	M17 - Nuclear Imaging – Emission Tomography	Chapter 19	Bolch
	18	M17 - Nuclear Imaging – Emission Tomography	Chapter 19	Bolch
	20	A10 – Field of Biomedical Imaging / Preclinical Applications		Withrow
15	25	No Classes – Thanksgiving Holiday		
	25	No Classes – Thanksgiving Holiday		
	27	No Classes – Thanksgiving Holiday		
16	Dec 2	M18 - Ultrasound Imaging	Chapter 14	Bolch
	2	M18 - Ultrasound Imaging	Chapter 14	Bolch

Note A – Radiation Research Society Annual Meeting

Note B – No Classes – Veteran's Day Holiday

Exams: Three exams will be given during the semester. Each exam will be given in two parts. Part 1 of each exam will be closed notes / multiple-choice and will be given during the Thursday class period. Part 2 of each exam will be given later that same evening typically between 6 pm and 9 pm with an additional 30 minutes for scanning and uploading to the exam assignment. More information will be given prior to the first exam. Make-up exams will only be considered for exceptional circumstances and will be implemented by the instructor on a case-by-case basis. Notice of absence must be given to the instructor prior to each exam.

Review Papers: Student groups (4 students) are asked to select a topic related to a given set of imaging modalities and specific clinical imaging applications and will include a detailed literature review of that topic. The review article will follow the *Instructions to Contributors* for the journal *Physics in Medicine and Biology*. A list of suggested topics will be discussed in class. Grades for the final manuscripts will be based upon (1) technical content, (2) writing style, and (3) adherence to journal article submission guidelines.

Students are asked to follow the author instructions, except for the following:

- Limit your total number of pages of text (Abstract to Conclusions) to no more than 15 pages and no fewer than 10 pages.
- Submit both a Cover Letter and a Manuscript (with embedded tables and figures) all in MS Word format.
- Use the following file names:
 - Cover Letter – Group#.docx,
 - Paper – Group#.docx.
- Each paper must have at least two tables and two figures.
- Each paper must have cited a minimum of 10 peer-reviewed journal article citations (beyond textbooks or conference proceedings) and should have no more than 3 website citations.

Each manuscript will be submitted with a cover letter to the appropriate Editor-in-Chief noting why you think your work is worthy of publication. Final manuscripts are due assignment upload on **Sunday, November 16**. Reviewed manuscripts will be returned by **Sunday, November 23**. A resubmitted manuscript with a revised Cover Letter and Response to Comments will be due by **Sunday, November 30**. **All papers will be subject to plagiarism review using Turnitin.**

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Relation to ABET Program Outcomes

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	High - Emphasized
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	Medium - Emphasized
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informal judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	Low - Reinforced
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 meeting objectives.	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	Low – Reinforced

* Coverage is given as high, medium, or low. An empty box indicates that this outcome is not part of the course.

Required Computer

Recommended Computer Specifications: <https://it.ufl.edu/get-help/student-computer-recommendations/>
HWCOE Computer Requirements: <https://www.eng.ufl.edu/students/advising/fall-semester-checklist/computer-requirements/>

Academic Policies & Resources

To support consistent and accessible communication of university-wide student resources, instructors must include this link to academic policies and campus resources: <https://go.ufl.edu/syllabuspolicies>. Instructor-specific guidelines for courses must accommodate these policies.

Commitment to a Positive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.

If you feel like your performance in class is being impacted, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu