MEDICAL IMAGING
BME 4531 Section 7850
Class Periods: Tuesday (Period 4): 10:40 am – 11:30 am;
Thursday (Periods 4-5) 10:40 am – 12:35 pm
Location: Little Hall 0237
Academic Term: Spring 2024

Instructor:
Kuang Gong, PhD, kgong@bme.ufl.edu
Office Hours: Tuesday, 2:00 pm – 3:00 pm, Malachowsky Hall 3117
Email Correspondence: If emailing about class issues, please use the email facility within Canvas.

Teaching Assistant:
Miguel Contreras, PhD student at Biomedical Engineering, contreras.miguel@ufl.edu
Office Hours: TBA
Email Correspondence: If emailing about class issues, please use the email facility within Canvas.

Course Description
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.

Required Textbooks and Software
Required Textbook: The Essential Physics of Medical Imaging, Jerrold T. Bushberg, 4th Edition, Wolters Kluwer (2020)
Required Software: MATLAB (mathworks.com), ImageJ (imagej.nih.gov)

Course Schedule

Week	*Date*		*Lecture No. and Topic*	*Chapters*
1	***Jan.***	9	**M1** - Course Introduction / Review of Imaging Modalities	Chapter 1
		11	**M2** - Review of Photon Interactions	Chapter 3
		11	**M2** - Review of Photon Interactions	Chapter 3
2		16	**M3** – Review of Electron Interactions	Chapter 3
		18	**M4** - X-Ray Production and Generators	Chapter 6
		18	**M5.1** – Radiography Fundamentals	Chapter 7
3		23	**M5.2** – Radiography Imaging	Chapter 7
		25	**M6** - Mammography and Digital Tomosynthesis	Chapter 8
		25	**M6** - Mammography and Digital Tomosynthesis	Chapter 8
4		30	**A1** – Medical Imaging Informatics	Chapters 4-5
	Feb.	1	**M7** - Fluoroscopy – Diagnostic	Chapter 9
		1	**M8** - Fluoroscopy – Interventional	Chapters 9
5		6	**M9** - Computed Tomography	Chapter 10
		8	**Exam 1**	
6		13	**A2** – Image Display / **A3** – Image Processing	Chapters 4-5

		15	**M10** - X-ray Dosimetry in Projection Imaging and CT	Chapter 11
		15	**M10** - X-ray Dosimetry in Projection Imaging and CT	Chapter 11
7		20	**A4** – Frequency Domain and Image Convolution	Chapters 4-5
		22	**M11** - Magnetic Resonance Basics	Chapter 12
		22	**M11** - Magnetic Resonance Basics	Chapter 12
8		27	**A5** – Spatial Resolution / **A6** Contrast Resolution	Chapters 4-5
		29	**M12** - Magnetic Resonance Imaging	Chapter 13
		29	**M12** - Magnetic Resonance Imaging	Chapter 13
9	***Mar.***	5	**A7** – Detective Quantum Efficiency and ROC Curves	Chapters 4-5
		7	**M13** - Radioactivity and Nuclear Transformations	Chapter 15
		7	**M14** - Radionuclide Production and Radiopharmaceuticals	Chapter 16
10		12	***No classes - Spring break***	
		14	***No classes - Spring break***	
		14	***No classes - Spring break***	
11		19	**M15.1** - Radiation Detection and Measurement	Chapter 17
		21	**Exam 2**	
12		26	**M15.2** - Radiation Detection and Measurement	Chapter 17
		28	**Review Paper Proposal Review / Presentations**	
		28	**Review Paper Proposal Review / Presentations**	
13	***Apr.***	2	**A8** – Image Artifacts and Quality Control in CT	
		4	**M16** - Nuclear Imaging – The Scintillation Camera	Chapter 18
		4	**M16** - Nuclear Imaging – The Scintillation Camera	Chapter 18
14		9	**A9** – Image Artifacts and Quality Control in MR	
		11	**M17** - Nuclear Imaging – Emission Tomography	Chapter 19
		11	**M17** - Nuclear Imaging – Emission Tomography	Chapter 19
15		16	**A10** – Data Corrections and Image Reconstruction in PET	
		18	**M18** - Ultrasound Imaging	Chapter 14
		18	**M18** - Ultrasound Imaging	Chapter 14
16		23	**A11** – Field of Biomedical Imaging / Preclinical Applications	
	May	1	**Exam 3**	

Exams: Three exams will be given during the semester. 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 for assignment upload on **Sunday, April 14**. Reviewed manuscripts will be returned by **Sunday, April 21**. A resubmitted manuscript with a revised Cover Letter and Response to Comments will be due by **Sunday, April 28**. **All papers will be subject to plagiarism review using Turnitin.**

Attendance Policy and Class 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.

Evaluation of Grades

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	100	15%	**Thursday – February 8**
Exam 2	100	15%	**Thursday – March 21**
Exam 3	100	15%	**Wednesday – May 1**
Review Papers - Submitted	85	15%	**Sunday – April 14**
Review Papers - Returned			**Sunday – April 21**
Review Papers - Resubmitted	15		**Sunday – April 28**

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 Program Outcomes (ABET):

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	
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	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 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	Low – Reinforced

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

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student

participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive 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, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

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

- Your academic advisor or Graduate Program Coordinator
- HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*:* https://distance.ufl.edu/getting-help/; *https://distance.ufl.edu/state-authorization-status/#student-complaint*.