

Summer 2023

Diagnostic Radiological Physics III

BME 6505; Section 7402; 3 Credits

CLASS MEETING INFO

10:30^{AM} -12:10^{AM} Tue/Thu

C2-33

INSTRUCTOR

Manuel Arreola, PhD (arreom@radiology.ufl.edu)

G-097 Health Science Center

352.265.0293

Office Hours by appointment

TEACHING ASSISTANT

Graham Stoddard (graham.stoddard@ufl.edu)

DESCRIPTION

Basic physics of magnetic resonance, applications to imaging, modern approaches

PRE-REQUISITES

ENU 6652 Diagnostic Radiological Physics II

OBJECTIVES

At the end of semester, students will have the basic knowledge of:

- Interpret the basic quantum mechanical description of the magnetic resonance phenomenon, including energy states & state transitions
- Interpret the basic classical (electromagnetic) description of the magnetic resonance phenomenon, including magnetization, precession and energy absorption
- Illustrate the concepts of spin-lattice and spin-spin relaxation and the characteristic relaxation times T1 and T2
- Formulate basic spin-echo sequence and field inhomogeneities
- Devise Carr-Purcell & multi-echo sequences
- Qualify selective-excitation, frequency and phase encoding gradients, & signal encoding for image reconstruction: gradients
- Compare gradient-recovered echo sequences
- Identify K-space and Fourier reconstructions
- Construct RARE and EPI sequences
- Contrast inversion recovery and other saturation sequences
- Describe MR spectroscopy, diffusion weighted diffusion sensor, functional MR Imaging & other modern techniques; RARE & Epi sequences
- Assess Biological effects of MRI, safety issues in MRI
- Recommend design of MR facilities
- Survey ACR safety guidelines, TJC & ACR accreditation issues

REQUIRED TEXTBOOKS & SOFTWARE

The Foundation for The Gator Nation

An Equal Opportunity Institution

- The Essential Physics of Medical Imaging by Bushberg, Seibert, Leidholdt Jr, and Boone; 3rd Edition
- MRI from Picture to Proton by Donald W. McRobbie, 2nd Edition
- Other reading assignments will be provided

COURSE SCHEDULE

<u>Date</u>	<u>Topic</u>	<u>Lecturer</u>
Tuesday, May 23, 2023	QM Description: Nuclear Magnetic Moment and Zeeman Energy States	Arreola
Wednesday, May 24, 2023	QM Description: Alternating Fields and Free-Induction Decay Signal	Arreola
Tuesday, May 30, 2023	Classical Description: Equations of Motion; Lab and Rotating Frames of Reference	Arreola
Thursday, June 1, 2023	Classical Description: Bloch's Equations, Spin-Spin and Spin-Lattice Relaxation Processes	Arreola
Tuesday, June 6, 2023	Spin-echo (SE) Sequence: Field Inhomogeneities and Spin Refocusing	Arreola
Thursday, June 8, 2023	Measuring T1 and T2: Carr-Purcell and Inversion Recovery Sequences	Arreola
Friday, June 9, 2023	SE Sequence; T1-, T2- and Proton density-Weighted Signals	Arreola
Tuesday, June 13, 2023	Review of Fourier Analysis and Concepts of Frequency Domain	Arreola
Thursday, June 15, 2023	EXAM 1	Arreola
Tuesday, June 20, 2023	MR Image Reconstruction: Magnetic Field Gradients and Selective Excitation of Spins	Arreola
Thursday, June 22, 2023	Contrast Agents in MRI	Arreola
Tuesday, June 27, 2023	No class – Summer Break	
Thursday, June 29, 2023	No Class – Summer Break	
Thursday, July 6, 2023	MR Image Reconstruction: Frequency Encoding – One-Dimensional K-Space	Arreola
Friday, July 7, 2023	MR Image Reconstruction: Phase Encoding – Two-Dimensional K-Space	Arreola
Tuesday, July 11, 2023	MR Image Reconstruction: Populating K-Space: Single and Multiple-Slice Acquisitions	Arreola
Wednesday, July 12, 2023	Fast SE and RARE Sequences – Total Acquisition Time and Spatial Resolution	Arreola
Thursday, July 13, 2023	Gradient-Recovered Echo (GRE) and Echo-Planar (EPI) Sequences	Arreola
Tuesday, July 18, 2023	EXAM 2	Arreola
Thursday, July 20, 2023	Advanced Applications: MRA, DTI, DWI, Functional MR	Arreola
Thursday, July 27, 2023	In-Vivo MR Spectroscopy	Arreola
Tuesday, August 1, 2023	MR Scanner Components and Biological Effects of MRI	Arreola
Thursday, August 3, 2023	American College of Radiology (ACR) Safety Program (Projects Assigned)	Arreola
Friday, August 4, 2023	ACR and TJC Accreditation Programs	Arreola
Tuesday, August 8, 2023	EXAM 3	Arreola
Thursday, August 10, 2023	PROJECT PRESENTATIONS	Arreola

ATTENDANCE POLICY; MAKE-UP POLICY

Students are expected to attend each class period. Periods which may be missed should be brought to the attention of the Instructor as far in advance of the class period as possible. In the event of an unexcused absence, it is the student's responsibility to obtain and review the material that was covered during that class period.

Excused absences must be consistent with university policies in the Graduate Catalog and require appropriate documentation:
<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>

Make-up assignments will only be considered for exceptional circumstances and will be implemented by the instructor on a case-by-case basis.

CLASS EXPECTATIONS

Class distractions such as cell phones and pagers are unacceptable. Students will ensure that any such devices that are brought into the classroom will be turned off, or operated in a silent mode, during the class period.

EVALUATION OF GRADES

Assignment	Total Points	Percentage of Final Grade
Homework	100	5%
Exam 1	100	25%
Exam 2	100	25%
Exam 3	100	25%

Project	100	20%
		Total: 100%

a. Homework

1. Calculation of theoretical signal in MR images
2. Quantum mechanical description of magnetization of matter
3. Investigation of functional MRI and its applications in the clinic

b. Project

Design a plan for MR safety zoning in real clinical facilities including generation of a report and presentation to peers outlining and illustrating decisions made in MR zoning

c. Exams

Three multiple-choice exams (20-25 questions each) will be administered, each encompassing the topics discussed in the classes preceding the exam.

GRADING POLICY

Percent	Grade
93-100	A
90-92	A-
86-89	B+
83-85	B
80-82	B-
76-79	C+
73-75	C
70-72	C-
66-69	D+
63-65	D
60-62	D-
0 - 59	E

More information on UF grading policy may be found at: <http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

STUDENTS REQUIRING ACCOMMODATIONS

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565; <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

EVALUATIONS

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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.

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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.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

352-392-1575; <http://www.counseling.ufl.edu/cwc>

Sexual Assault Recovery Services (SARS)

352-392-1161; Student Health Care Center

University Police Department

352-392-1111 (or 911 for emergencies); <http://www.police.ufl.edu/>

Academic Resources

E-learning Technical Support

352-392-4357 (select option 2); learning-support@ufl.edu; <https://lss.at.ufl.edu/help.shtml>

Career Resource Center

Career assistance and counseling.

352-392-1601; Reitz Union; <https://www.crc.ufl.edu/>

Library Support

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

Teaching Center

General study skills and tutoring.

352-392-2010 or 352-392-6420; Broward Hall; <https://teachingcenter.ufl.edu/>

Writing Studio

Help brainstorming, formatting, and writing papers.

352-846-1138; 302 Tigert Hall; <https://writing.ufl.edu/writing-studio/>

Student Complaints Campus

https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf

On-Line Students Complaints

<http://www.distance.ufl.edu/student-complaint-process>