

Summer 2024

Diagnostic Radiological Physics III

GMS 6653; Section 2024; 3 Credits

CLASS MEETING INFO

10:00^{AM} -11:40^{AM} Wed/Thu

C2-33 Communicore

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)

Office hours by appointment

DESCRIPTION

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

PRE-REQUISITES

GMS 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

- MRI from Picture to Proton by Donald W. McRobbie/Moore/Graves/Prince; 2nd Edition

COURSE SCHEDULE

Date	Topic	Lecturer
Wednesday, May 15, 2024	QM Description: Nuclear Magnetic Moment and Zeeman Energy States	Dr Arreola
Thursday, May 16, 2024	QM Description: Energy Absorption from Alternating Fields and Resonance	Dr Arreola
Wednesday, May 22, 2024	Classical Description: Equations of Motion for Macroscopic Magnetization; Lab and Rotating Frames of Reference	Dr Arreola
Thursday, May 23, 2024	Classical Description: Bloch's Equations, Spin-Spin and Spin-Lattice Relaxation Processes	Dr Arreola
Wednesday, May 29, 2024	Effect of Field Inhomogeneities and Spin Refocusing; the Basic Spin-echo (SE) sequence	Dr Arreola
Thursday, May 30, 2024	Measuring T1 and T2: Carr-Purcell and Inversion Recovery Sequences	Dr Arreola
Wednesday, June 5, 2024	SE Sequence; T1-, T2- and Proton density-Weighted Signals; Subject Contrast in MRI	Dr Arreola
Thursday, June 6, 2024	EXAM 1	
Wednesday, June 12, 2024	Magnetic Field Gradients and selective excitation of spins	Dr. Arreola
Thursday, June 13, 2024	MR Image Reconstruction: Frequency encoding, receiving bandwidth	Dr Arreola
Wednesday, June 19, 2024	No Class – UF Holiday	
Thursday, June 20, 2024	MR Image Reconstruction: phase-encoding, k-space	Dr Arreola
Wednesday, June 26, 2024	No Class – Summer Break	
Thursday, June 27, 2024	No Class – Summer Break	
Wednesday, July 3, 2024	MR Image Reconstruction: Populating k-Space: Single and Multiple-Slice Acquisitions	Dr Arreola
Thursday, July 4, 2024	No Class – UF Holiday	
Wednesday, July 10, 2024	Total Acquisition Time and Spatial Resolution tradeoffs; Fast-Spin Echo sequence	Dr Arreola
Thursday, July 11, 2024	Gradient-Recovered Echo (GRE) and Echo-Planar (EPI) Sequences	Dr Arreola
Wednesday, July 17, 2024	EXAM 2	
Thursday, July 18, 2024	Image Quality in MRI	Dr Arreola
Wednesday, July 24, 2024	MRI Artifacts	Dr Arreola
Thursday, July 25, 2024	Advanced applications in MRI: MRA, DTI, DWI, fMRI and MRS	Dr Arreola
Wednesday, July 31, 2024	Biological Effects and Safety in MRI (Projects Assigned)	Dr Arreola
Thursday, August 1, 2024	ACR and TJC Accreditation Programs	Dr Arreola
Wednesday, August 7, 2024	EXAM 3	
Thursday, August 8, 2024	PROJECT PRESENTATIONS	Dr 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:
<https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

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: <https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/>

STUDENTS REQUIRING ACCOMMODATIONS

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

EVALUATIONS

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing online 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/>

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>

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.

CAMPUS RESOURCES

Health and Wellness

U Matter, We Care

352-392-1575; umatter@ufl.edu; <https://umatter.ufl.edu/>

Counseling and Wellness Center

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

Student Health Care Center

352-392-1161; <https://shcc.ufl.edu/>

University Police Department

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

UF Health Shands Emergency Room / Trauma Center

352-733-0111; 1515 SW Archer Rd; <https://ufhealth.org/locations/uf-health-shands-emergency-room-trauma-center/>

GatorWell Health Promotion Services

352-273-4450; <https://gatorwell.ufsa.ufl.edu/>

Academic Resources

UF Computing Help Desk

352-392-4357; helpdesk@ufl.edu; <https://helpdesk.ufl.edu/>

Career Resource Center

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

Library Support

<http://cms.uflib.ufl.edu/ask>

Teaching Center

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

Writing Studio

352-846-1138; 2215 Turlington Hall; <https://writing.ufl.edu/writing-studio/>

Student Complaints On-Campus

<https://sccr.dso.ufl.edu/policies/student-honor-%20code-student-conduct-code/>

On-Line Students Complaints

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