

Summer 2022

Advanced Diagnostic Radiological Physics

BME 6505; Section 7402; 3 Credits

CLASS MEETING INFO

10:00^{AM} -11:40^{AM} Tue/Thu
C2-33

INSTRUCTOR

Manuel Arreola, PhD (arreom@radiology.ufl.edu); Office Hours by appointment

TEACHING ASSISTANT

Zahra Razi, MS (zraz0001@shands.ufl.edu) Office Hours by appointment

DESCRIPTION

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

PRE-REQUISITES

ENU 6657, Diagnostic Radiological Physics

OBJECTIVES

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

- The basic quantum mechanical description of the magnetic resonance phenomenon, including energy states & state transitions
- The basic classical (electromagnetic) description of the magnetic resonance phenomenon, including magnetization, precession and energy absorption
- The concepts of spin-lattice and spin-spin relaxation and the characteristic relaxation times T1 and T2
- Field inhomogeneities and the basic spin-echo sequence
- Carr-Purcell & multi-echo sequences
- Signal encoding for image reconstruction: gradients
- Selective-excitation, frequency and phase encoding gradients
- Gradient-recovered echo sequences
- K-space and Fourier reconstructions
- RARE and EPI sequences
- Inversion recovery and other saturation sequences
- MR spectroscopy, diffusion weighted diffusion sensor, functional MR Imaging & other modern techniques; RARE & EPI sequences
- Biological effects of MRI, safety issues in MRI
- Design of MR facilities
- ACR safety guidelines, TJC & ACR accreditation issues

REQUIRED TEXTBOOKS & SOFTWARE

- 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

| Date | Topic | Lecturer |
|--------------------|---|----------|
| Tuesday, May 9 | QM description: Nuclear magnetic moment and Zeeman Energy States | Arreola |
| Wednesday, May 16 | QM description: Alternating Fields and Free-Induction Decay signal | Arreola |
| Tuesday, May 17 | Classical description: Equations of motion; Lab and Rotating Frames of Reference | Arreola |
| Thursday, May 19 | Classical description: Bloch's Equations, Spin-spin and Spin-Lattice Relaxation processes | Arreola |
| Tuesday, May 24 | Spin-echo (SE) Sequence: Field Inhomogeneities and spin refocusing | Arreola |
| Thursday, May 26 | Measuring T1 and T2: Carr-Purcell and Inversion Recovery sequences | Arreola |
| Tuesday, May 31 | SE sequence; T1-, T2- and Proton density-weighted signals | Arreola |
| Thursday, June 2 | Review of Fourier Analysis and concepts of frequency domain | Arreola |
| Tuesday, June 7 | EXAM 1 | Arreola |
| Thursday, June 9 | MR Image reconstruction :Magnetic field gradients and selective excitation of spins | Arreola |
| Tuesday, June 14 | MR Image reconstruction: Frequency Encoding – one-dimensional k-space | Arreola |
| Thursday, June 16 | MR Image reconstruction: Phase encoding – two-dimensional k-space | |
| Tuesday, June 21 | No Class – Summer Break | |
| Tuesday, June 23 | No Class – Summer Break | Arreola |
| Tuesday, June 28 | MR Image reconstruction: Populating k-space: single and multiple-slice acquisitions | Arreola |
| Thursday, June 30 | Fast SE and RARE sequences – total acquisition time and spatial resolution | Arreola |
| Tuesday, July 5 | Gradient-recovered echo (GRE) and Echo-planar (EPI) sequences | Arreola |
| Thursday, July 7 | Contrast agents in MRI | Razi |
| Tuesday, July 12 | EXAM 2 | Arreola |
| Thursday, July 14 | Advanced applications: MRA, DTI, DWI, Functional MR | Arreola |
| Tuesday, July 19 | In-vivo MR Spectroscopy | Arreola |
| Thursday, July 21 | MR Scanner components and biological effects of MRI | Arreola |
| Tuesday, July 26 | American College of Radiology (ACR) Safety Program (projects assigned) | Arreola |
| Thursday, July 28 | ACR and TJC Accreditation programs | Arreola |
| Tuesday, August 2 | EXAM 3 | Arreola |
| Thursday, August 4 | PROJECT PRESENTATIONS | Arreola |

LAB DEMONSTRATION

There will be an MRI demo lab and observation of clinical MRI studies to take place between late June and early July. The actual dates and locations of these observations will be announced. To let you know, access to MRI scanners for these purposes is usually in the early mornings.

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% |

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>