**IMPORTANT: This syllabus form should be submitted to OAA (gsbs_academic_affairs@uth.tmc.edu) a week before the start of each semester.**

**NOTE to STUDENTS:** If you need any accommodations related to attending/enrolling in this course, please contact one of the Graduate School's 504 Coordinators, Cheryl Spitzenberger or Natalie Sirisaengtaksin. We ask that you notify GSBS in advance (preferably at least 3 days before the start of the semester) so we can make appropriate arrangements.

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|---|---|
| **Term and Year Summer 2022**<br>Course Number and Course Title:<br>**TBD: Diagnostic Medical Physics II**<br>Credit Hours: **3**<br>Meeting Location:<br>Building/Room#:<br>WebEx/Zoom Link: | Program Required Course: ☑ Yes ☐ No<br>Approval Code: ☑ Yes ☐ No<br>**(If yes,** the Course Director or the Course Designee will provide the approval code.)<br>Audit Permitted: ☑ Yes ☐ No<br>Classes Begin: **May 16, 2022**<br>Classes End: **August 5, 2022**<br>Final Exam Week: **August 8-11, 2022** |

**Class Meeting Schedule**

| Day | Time |
|---|---|
| **Tue/Thurs** | **2:00-3:30PM** |
| | |
| | |

**Course Director**
Name and Degree: **R. Jason Stafford, Ph.D**.
Title: Professor
Department: Imaging Physics
Institution: ☐ *UTH* ☑ *MDACC*
Email Address: jstafford@mdanderson.org
Contact Number: 713-563-5082

**Course Co-Director/s:** (if any)
Name and Degree: **Richard R. Bouchard, Ph.D.**
Title: Associate Professor
Department: Imaging Physics
Institution: ☐ *UTH* ☑ *MDACC*
Email Address: RRBouchard@mdanderson.org
Contact Number: 713-745-0626

**Instructor/s**

1. **See attached Course Outline**
   Name and Degree
   Institution: MD Anderson
   Email Address:
2. Name and Degree
   Institution:
   Email Address:
3. Name and Degree
   Institution:
4. Name and Degree
   Institution:
   Email Address

| **Teaching Assistant**: (if any) | **Cont. Instructor/s** |
|---|---|
| Name and Email Address<br><br>Name and Email Address | 5.<br>Name and Degree<br>Institution:<br>Email Address |

**Course description**: Diagnostic Medical Physics II
Stafford, R. Jason & Bouchard, Richard. Three semester hours. Summer, annually. Grading System: Letter Grade. Suggested prerequisites: Working knowledge of calculus up through partial differential equations as well as Fourier Series and Fourier Transform at the level covered in GS02-1052 (Imaging Science).
This course provides graduate students with a foundation in the fundamental physics, principles of image formation & reconstruction, instrumentation, safety, and quality assurance of ultrasound and magnetic resonance imaging.

**Textbook/Supplemental Reading Materials** (if any)

- As assigned and/or provided

**Course Objective/s:**
Upon successful completion of this course, students will

***Specific Learning Objectives*:**

1. Outline and review fundamental physics underlying Ultrasound & MRI
2. Describe and explain key principles of Ultrasound & MR image formation and contrast
3. Name common Ultrasound & MR acquisition techniques and explain underlying physical principles of operation, advantages, and disadvantages.
4. Identify common Ultrasound & MRI artifacts and quality control methodologies
5. Recognize key safety risks in Ultrasound & MRI and explain underlying physical principles.

**Student responsibilities and expectations:**

Students enrolled in this course will be expected to perform the following activities each week.
1. Read, process, and review (study) material from assigned reading in textbooks or provided literature.
2. Complete assigned homework and participate in discussions of assignments in class.
3. Prepare for and take course quizzes based on course lectures/ readings.
4. Participate in and contribute to course discussions during lecture, review sessions
5. Participate in and complete assigned work in laboratory sessions
6. Prepare for and take a final examination based on lecture and some reading material

Students are expected to complete all assigned reading material prior to class. While you may work and discuss all course materials and assignments in groups, all assignments must be your own. Plagiarism and failure to properly cite scientific literature and other sources will not be tolerated and are grounds for dismissal from the course and further GSBS disciplinary action. Cheating or engaging in unethical behavior during examinations (quizzes and exams) will be grounds for dismissal from the course without credit and further GSBS disciplinary action.

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|---|---|
| **Grading System:** ✔ Letter Grade (A-F) Pass/Fail | |
| **Student Assessment and Grading Criteria** : (May include the following:) | |
| Homework **( 20 %)** | Description**: Assigned problems, writing, and laboratory assignments** |
| Quiz **( 20 %)** | Description: **In-class assessment and discussion of current course content.** |
| Presentation (0 %) | Description: |
| Midterm Exams **(30%)** | Description: **Ultrasound exam** |
| Final Exam (**30%)** | Description: **MRI Exam** |
| Workshop or Breakout-Session ( 0 %) | Description |
| Participation and/or Attendance (0 %) | Description |

**CLASS SCHEDULE**

| Day/Date | Duration (Hr) | Lecture Topic | Lecturer/s |
|---|---|---|---|
| | | See attached | |
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NOTE: **Provide other class information as needed.**

**COURSE DESCRIPTION**

**Diagnostic Medical Physics II**
Stafford, R. Jason & Bouchard, Richard. Three semester hours. Summer, annually. Grading System: Letter Grade.
Prerequisite: Diagnostic Medical Physics I or consent of instructor.

This course provides graduate students with a foundation in the fundamental physics, principles of image formation & reconstruction, instrumentation, safety, and quality assurance of ultrasound and magnetic resonance imaging.

**JUSTIFICATION**

As part of a restructuring of the Medical Physics program and consolidation of courses by the program curriculum committee, this course serves to separate and focus on the non-ionizing radiation modalities in Diagnostic Medical Physics in a single course.

**OVERLAP**

There is no overlap.

**COURSE OBJECTIVES**

Outline and review fundamental physics underlying Ultrasound & MRI
Describe and explain key principles of Ultrasound & MR image formation and contrast
Name common Ultrasound & MR acquisition techniques and explain underlying physical principles of operation, advantages and disadvantages.
Identify common Ultrasound & MRI artifacts and quality control methodologies
Recognize key safety risks in Ultrasound & MRI and explain underlying physical principles

**COURSE OUTLINE**
Summer Term
Tue/Thurs, 2:00-3:30PM

**ULTRASOUND (1.5hr courses)**

| | | | |
|---|---|---|---|
| XX | 1 | Ultrasound introduction: history of ultrasound, modern uses and fundamentals of ultrasound physics | Bouchard |
| XX | 2 | Interactions with tissue I: derivation of the acoustic wave equation | Bouchard |
| XX | 3 | Interactions with tissue II: introduction to acoustic scattering and absorption | Bouchard |
| XX | 4 | Beamforming I: design and performance features of a modern ultrasound array transducer | Bouchard |
| XX | 5 | Beamforming II: derivation of an array-based ultrasound diffraction pattern and description of factors ultrasound resolution | Bouchard |
| XX | 6 | Ultrasound imaging I: technical workflow to generate a B-mode image on a modern ultrasound system | Bouchard |
| XX | 7 | Ultrasound imaging II: ultrasound imaging features and modalities (e.g., Doppler imaging) | Bouchard |
| XX | 8 | Ultrasound imaging artifacts: explanation regarding the source and appearance of common ultrasound imaging artifacts | Bouchard |
| XX | 9 | Ultrasound quality assurance & safety: methodology used to conduct QA plan on a modern ultrasound system | Bouchard |
| XX | 10 | Advanced ultrasound: an in-depth introduction to two new ultrasound imaging modalities, elasticity and photoacoustic imaging, with an emphasis on the modality-specific physics and hardware | Bouchard |
| XX | | Exam: Ultrasound | Bouchard |

**LAB 1:** US image acquisition, data filtering/processing, and reconstruction for a B-mode image of an ultrasound phantom target (Bouchard)

MRI (1.5hr courses)

| | | | |
|---|---|---|---|
| XX | 11 | Introduction to Magnetic Resonance | Stafford |
| XX | 12 | Signal Generation & Contrast Concepts | Stafford |
| XX | 13 | Pulse Sequences I | Stafford |
| XX | 14 | Image Formation & Reconstruction I | Stafford |
| XX | 15 | Image Formation & Reconstruction II | Stafford |
| XX | 16 | Signal, Contrast & Noise in MRI | Stafford |
| XX | 17 | Pulse Sequences II | Stafford |
| XX | 18 | Magnetization Preparation | Stafford |
| | 19 | Functional & Physiological MRI | Stafford |
| | 20 | MR Hardware | Stafford |
| | 21 | Troubleshooting, Artifacts & Quality Control | Stafford |
| | 22 | Physics of MR Safety | Stafford |
| | | Exam: MRI | |

LAB 2: Pulse Sequences & Contrast
LAB 3: Post-Processing
LAB 4: Principles of Quality Control

**Books**

The Essential Physics of Medical Imaging, 3rd edition, Bushberg, et al, Lippincott Williams & Wilkins, 2011. ISBN-10: 0781780578, ISBN-13: 9780781780575. ~$170-220.

Imaging Systems for Medical Diagnostics: Fundamentals, Technical Solutions and Applications for Systems Applying Ionizing Radiation, Nuclear Magnetic Resonance and Ultrasound, Arnulf Oppelt (Editor), Wiley-VCH, 2006. ISBN: 3895782262.

Christakis Constantinides, Magnetic Resonance Imaging: The Basics, Boca Raton: CRC Press, 2014, ISBN 978-1-4822-1731-5. ~$75 [CC in the readings above].