Course Information Form (CIF)

Course Code: XMR 211

Course Title: Magnetic Resonance Imaging

Department: Allied Health
Effective Date: Summer 2026
PCS Code: 1.2 - Occupational/Technical Instruction
CIP Code: 51.0907
Repeatability: 0

Credit Hours

Catalog Notation: 3-0-3
Credit Hour Distribution:

Lecture: 3	Lab: 0	Clinical: 0	**Total: 3**

General Course Information

Catalog Description

MRI imaging history, physics, and system operational components. Image acquisition, display, reconstruction, and quality control.

General Course Objectives

This course will focus on the general physical principles, operating systems, and history of magnetic resonance imaging (MRI). This course will also examine MRI data acquisition, reconstruction, processing, and image artifacts.

Minimum Placement Levels

English	Reading	Math
Placement out of ENG 099	Placement out of CCS 099	None

Prerequisites

ARRT primary certification
Admission into the Radiologic Technology program

Methods of Evaluation

6-8 objective quizzes, 6-8 homework assignments, and 1 objective exam.

Instructional Materials and Additional Supplies

Magnetic Resonance Imaging, current edition, Bushong, S.

Course Content

General Learning Outcomes (GLOs)

- Technology: Students will demonstrate the ability to evaluate, select, and appropriately use current and emerging tools.

Course Segments and Student Learning Outcomes

Course Segment	Learning Outcomes	Lecture Hours	Lab Hours	Clinical Hours
MRI Instrumentation: a. Electricity and Magnetism - 1) Faraday's law, 2) types of magnets, 3) magnetic strength, 4) shim coils; b. Radiofrequency System - 1) coil configuration, 2) surface and phased array coils, 3) transmit and receive coils, 4) transmit and receive bandwidth, 5) pulse profile; c. Gradient System - 1) Gradient coil configuration, 2) slew rate, 3) rise time, 4) duty cycle	1. Classify the basic components of MRI equipment. 2. Restate advantages and disadvantages of various types of magnets. 3. Describe various coil configurations. 4. Give examples of differences between coil and bandwidth transmission and reception. 5. Describe the function of radiofrequency in MRI imaging systems. 6. Discuss pulse profile and phased array. 7. Describe slew rate and state the significance. 8. Describe rise time. 9. Describe duty cycle.	6	0	0
Fundamentals: a. Nuclear Magnetism - 1) Larmor equation, 2) precession, 3) gyromagnetic ratio, 4) resonance, 5) RF pulse, 6) equilibrium magnetization, 7) energy state transitions, 8) phase coherence, 9) free induction decay (FID), 10) magnetic susceptibility; b. Tissue Characteristics - 1) T-1 relaxation, 2) T-2 relaxation, 3) T-2 susceptibility, 4) proton spin density, 5) flow, 6) diffusion, 7) perfusion; c. Spatial Localization - 1) vectors, 2) X, Y, Z coordinate system, 3) physical and logical gradient, 4) slice select gradient, 5) phase-encoding gradient, 6) frequency (readout) gradient and sampling frequency/rate, 7) k-space (raw data)	1. Describe nuclear magnetism. 2. Describe the function of the Larmor equation. 3. Describe the process of precession. 4. Discuss resonance and describe the function of resonance. 5. Describe the function of RF pulses. 6. Discuss equilibrium magnetization. 7. Describe energy state transitions, phase coherence, and free induction. 8. Explain the difference between T-1 and T-2 relaxation. 9. Discuss T-2 susceptibility. 10. Describe proton spin density. 11. Discuss the proton spins involved in MT. 12. Discuss flow, diffusion, and perfusion. 13. Discuss how vectors relate to x, y, and z coordinates. 14. Interpret the region of k-space most responsible for contrast resolution and spatial resolution. 15. Explain the difference between slice select gradient, phase-encoding gradient, and frequency gradient. 16. Discuss the difference between spin echo and gradient echo.	12	0	0

Course Segment	Learning Outcomes	Lecture Hours	Lab Hours	Clinical Hours
Artifacts: a. Cause, Appearance, and Compensation of Artifacts - 1) aliasing, 2) Gibbs, truncation, 3) chemical shift, 4) magnetic susceptibility, 5) radio-frequency, 6) motion and flow, 7) partial volume averaging, 8) crosstalk, 9) cross excitation, 10) moiré pattern, 11) parallel imaging artifacts, 12) eddy currents, 13) dielectric effect; b. Compensation for Artifacts	1. Discuss the term aliasing and how it impacts the MR image. 2. Explain Gibbs and truncation. 3. Discuss chemical shift. 4. Explain what is meant by magnetic susceptibility. 5. Explain radio frequency artifacts. 6. Explain motion and flow artifacts. 7. Discuss partial volume averaging. 8. Explain the term crosstalk. 9. Explain cross excitation. 10. Discuss moiré pattern. 11. Discuss parallel imaging artifacts. 12. Discuss the various compensation methods to minimize MR artifacts.	3	0	0
Quality Control: a. slice thickness, b. spatial resolution, c. contrast resolution, d. signal to noise ratio, e. center frequency, f. transmit gain, g. geometric accuracy, h. equipment inspection	1. Discuss the term slice thickness and its determining factors. 2. Explain the difference between spatial resolution and contrast resolution. 3. Explain how signal to noise ratio is utilized in MR. 4. Explain center frequency and transmit gain. 5. Explain the term geometric accuracy. 6. Restate the various methods of equipment and handling processes.	3	0	0
Data Acquisition and Processing: a. Pulse Sequences - 1) spin echo, 2) inversion recovery, 3) gradient recall echo, 4) echo planar imaging, 5) diffusion weighted imaging, 6) susceptibility weighted imaging, 7) perfusion 8) spectroscopy; b. Data Manipulation - 1) k-space mapping and filling, 2) fast Fourier transformation, 3) post processing, 4) cardiac analysis; c. Informatics - 1) hard/electronic copy, 2) archive, 3). PACS and EMR, 4) security and confidentiality, 5) networking	1. Discuss the difference between conventional spin echo and fast spin echo. 2. Discuss the process of inversion recovery. 3. Discuss STIR and FLAIR. 4. Discuss the process of gradient recall echo. 5. Explain how echo planar imaging is accomplished in MRI. 6. Discuss diffusion weighted imaging. 7. Discuss susceptibility weighted imaging. 8. Describe perfusion. 9. Discuss spectroscopy. 10. Describe k-space mapping and filling. 11. Describe fast Fourier transformation. 12. Explain how 3-D is accomplished during post processing. 13. Describe the processes of informatics. 14. Explain hard/electronic copy. 15. Discuss archiving. 16. Describe PACS and EMR. 17. Describe security and confidentiality. 18. Describe networking.	9	0	0

Course Segment	Learning Outcomes	Lecture Hours	Lab Hours	Clinical Hours
Sequence Parameters and Options: a. Imaging Parameters - 1) TR, TE, and TI, 2) number of signal averages, 3) flip angle (Ernst angle), 4) FOV, matrix, pixel, and voxel, 5) number of slices, slice thickness, and gap, 6) phase and frequency, 7) echo train length, 8) effective TE, 9) bandwidth, 10) concatenations, 11) b-value, 12) velocity encoding; b. Image Contrast - 1) T1, T2, T2* and PD weighted, 2) diffusion and susceptibility weighted imaging; c. Imaging Options - 1) 2-D/3-D, 2) slice order, 3) saturation pulse, 4) gradient moment nulling, 5) suppression techniques, 6) physiologic gating and triggering, 7) in-phase/out-of-phase, 8) rectangular FOV, 9) anti-aliasing and parallel imaging, 10) filtering	1. Describe TR, TE, and TI. 2. Describe how the number of signal averages affects the image quality. 3. Describe the term flip angle. 4. Define FOV, matrix, pixel, and voxel. 5. Explain how FOV and matrix affect spatial resolution. 6. Explain how T-1 weighted and T-2 weighted images affect contrast in MRI. 7. Describe the term proton (spin) density. 8. Explain the difference between 2-D and 3-D images. 9. Explain the importance of bandwidth. 10. Explain the importance of concatenations in relation to TR. 11. Discuss b-value. 12. Discuss velocity encoding. 13. Describe T1, T2, and PD weighted images. 14. Describe diffusion weighted imaging. 15. Describe susceptibility weighted imaging. 16. Define saturation pulse and gradient moment nulling. 17. Explain how suppression techniques work in MRI. 18. Describe how selective excitation is achieved. 19. Define physiologic gating and triggering. 20. Explain the difference between in-phase and out-of-phase. 21. Describe how anti-aliasing affects the image quality. 22. Describe parallel imaging. 23. Explain filtering.	12	0	0

Total Contact Hours

Lecture Hours	Lab Hours	Clinical Hours
45	0	0