

Advanced Medical Imaging (RADR 2333)



Credit: 3 semester credit hours

Pre-requisite: RADR 2301 Intermediate Radiographic Procedures

Course Description

The course describes specialized imaging modalities and includes concepts and theories of equipment operations, positioning and examination considerations, and their integration for medical diagnosis.

Textbooks Required

- **Digital Radiography An Introduction**, Euclid Seeram
 - ISBN# 978-1-4018-8999-9
- **Radiographic Positioning and Related Anatomy**, Bontrager, 7th Ed.
 - ISBN# 978-0-323-05410-2
- 882 Scan Trons

Reference

- **Digital Radiography and PACS**, Carter and Veale
 - ISBN# 978-0-323-07221-2
- **Radiologic Science for Technologists**, 10th Ed., Bushong
 - ISBN# 978-0-323-08135-1

Course Objectives

Upon completion of this course, the student will be able to:

1. Differentiate among the various specialized imaging modalities and associated equipment
2. Identify and compare anatomy as imaged by different modalities

Course Outline

Digital Imaging

1. Define image brightness.
2. Discuss analog vs. digital imaging.
3. Identify the components of image plates.
 - a. Phosphor layer
 - b. Base
 - c. Protective layer
4. Describe the read process.
 - a. Photostimulable luminescence
 - b. Laser scanning

- c. Erasure
- 5. Explain the speed of digital systems.
- 6. Define digital radiography.
 - a. Collection elements
 - i. Photodiodes
 - ii. Charged-coupled devices
 - iii. Thin-film transistors
 - iv. CMOS
 - b. Direct Capture
 - i. Advantages
 - ii. Disadvantage
 - c. Indirect Capture
 - i. Advantages
 - ii. Disadvantages
- 7. Identify and describe image characteristics.
 - a. Image matrix
 - b. Pixels
 - c. Image sampling
 - d. Histograms
 - e. Equalization
- 8. Define spatial resolution and controlling factors.
 - a. Matrix size
 - b. Pixel size
- 9. Define contrast resolution in digital imaging.
 - a. Dynamic range
 - i. Bit depth
 - ii. Pixels
- 10. Define post processing and describe components.
 - a. Window level
 - b. Window width
- 11. Define dose creep and how it relates to technique selection.
 - a. ALARA
 - b. Kvp selection
 - c. Mas selection
- 12. Describe exposure index and explain corrections for errors.
 - a. Underexposure
 - b. Overexposure
 - c. Normalization
 - d. Signal to noise ratio
 - e. Photometric properties
 - f. Lumen
 - g. Luminance
- 13. Describe the characteristics of viewing monitors.
 - a. Cathode ray tubes (CRT)
 - b. Active matrix liquid crystal display (AMLCD)

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- c. Plasma
- 14. Define preprocessing modes for the digital image.
 - a. Flat fielding
 - b. Offset images
 - c. Gain images
 - d. Signal interpolation
 - e. Image lag
 - f. Look up tables (LUT)
 - g. Line noise
- 15. Define the post processing options for the digital image.
 - a. Annotation
 - b. Magnification
 - c. Image flip/image inversion
 - d. Subtraction (DSA)
 - e. Background shuttering
 - f. Pixel shift
 - g. Region of interest (ROI)
 - h. Image orientation
 - i. Image stitching
 - j. Edge enhancement
- 16. Define the components of image storage.
 - a. Picture archiving and communication system (PACS)
 - b. System components and functions
 - c. Emergency contingency plan
 - d. Network
 - e. Teleradiology
- 17. Describe quality management in digital imaging.
 - a. Equipment calibration
 - b. Plate reader QM
 - c. Image monitor
- 18. Define performance assessment standards in digital imaging.
 - a. SMPTE
 - b. AAPM TG18
- 19. Define the standards in image monitor evaluation.
- 20. Define and describe digital image artifacts.
 - a. Image receptor
 - b. Pixel malfunction
 - c. Ghost images
 - d. Moire effect/aliasing
 - e. Backscatter
 - f. Rough handling
 - g. Software
 - i. Dead pixels/rows/columns
 - ii. Flatfielding

- iii. Image compression
 - 1. Lossless
 - 2. Lossy
- h. Patient positioning
- i. Collimation
- j. Fading
- k. Heat
- l. Banding
- m. Overexposure

Design Elements for Advanced Procedures

1. Identify the differences between diagnostic and interventional procedures.
2. Define the principles of room design for advanced procedures and additional design considerations.
 - a. room requirements
 - b. generators
 - c. control booth
 - d. patient preparation room

Principles of Angiography

1. Describe the historical background of angiography.
2. List and describe the methods of patient monitoring.
3. Define the principles of pulse oximetry.
4. Describe the basic principles of electrocardiography.
5. Identify some common cardiac arrhythmias.
6. Identify and describe the various means for obtaining vessel access.
7. Describe the procedure for the Seldinger technique for vessel puncture.
8. Describe the various arterial and venous access approaches.
9. Describe the direct exposure of an artery or vein for vessel access.
10. Describe the various vessel closure devices.

History of Angiography

1. Describe the history of image recording in advanced procedures.
 - a. serial changers
 1. roll film
 2. cut film
 3. cassette changers
2. Describe biplanar radiography.
3. Identify the various indirect methods of recording the radiographic images.
 - a. image intensification
 - b. video disk
 - c. video tape
 - d. laser disk
 - e. cine
4. Subtraction

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- a. basic
- b. digital

Automatic Injection Devices

1. Identify the need for automatic injection devices.
2. List the basic components of an automatic injector.
 - a. control panel
 - b. syringe
 - c. heating device
3. List and describe the advantages of optional components.
 - a. detachable injector head
 - b. dual syringe capacity
4. Define the concept of flow rate.
5. Identify the factors that affect the flow rate.
 - a. catheter length
 - b. catheter diameter
 - c. viscosity of contrast
 - d. amount of contrast
6. Explain the injectors that are used for computed tomography (CT) and magnetic resonance imaging (MRI).

Instrumentation and Accessories

1. Identify the instruments used in angiography.
 - a. catheters
 - b. guide wire
 - c. needles
2. Identify the accessory items that might be found in the interventional suite.
3. Define the use of prepackaged and sterilized procedure trays.

Introduction to Pharmacology

1. Define common terms used in pharmacology.
2. List the routes of administration of pharmacologic agents.
3. Identify the general guidelines for drug administration.
4. Identify the principles of intravenous (IV) therapy including complications and equipment .
5. Differentiate between osmolality and osmolarity.
6. Define the principle of venipuncture.
7. Define local anesthesia .
8. Define conscious sedation.
9. Identify the various types of pharmacologic agents used in conjunction with the advanced radiographic and interventional procedures.
10. List the medications used in cases of cardiac or respiratory emergencies.
11. List the principles of medication dose calculation.
12. Define the medication reconciliation form and its purpose.

Contrast Media

1. Identify the necessity for the use of contrast agents.
2. Describe the classes of contrast agents.
 - a. positive media
 - b. negative media
3. Describe the evolution of the organic iodine contrast media.
 - a. ionic
 - b. non-ionic
4. Define the characteristics of a good contrast agent.
 - a. osmolality
 - b. toxicity
 - c. viscosity
 - d. miscibility
 - e. persistence
5. Describe the excretory pathways of the various contrast agents.
 - a. urinary
 - b. gastrointestinal
6. Define informed consent as it applies to contrast media studies.
 - a. verbal consent
 - b. written consent
7. List and describe the general precautions that should be applied to contrast media studies.
 - a. BUN
 - b. Creatinine
 - c. allergies
8. Identify the reactions and complications resulting from the use of contrast agents.
 - a. overdose
 - b. anaphylactic
 - c. cardiovascular
 - d. psychogenic

Principles of Patient Care

1. Identify the general principles for all special studies.
2. Identify the need for strict confidentiality.
3. List and describe the components of the patient pre-examination and history.
4. Identify the need for pharmacologic awareness.
5. Identify the need and describe the process for obtaining an informed consent.
6. Identify the need for pre-procedure equipment preparation.
7. Describe the need and process for proper documentation.
8. Describe the process of patient instruction.
9. Describe the patient's pre-procedural, intra-procedural, and post-procedural care.
10. Define contrast material administration and filming.
11. Identify the risks associated with the catheterization procedure.

12. Identify the requirements for patient discharge.

Cardiac and Thoracic Procedures

1. Discuss vascular pathology.
2. Discuss the anatomy of the heart and its vasculature.
3. Discuss the anatomy of the thoracic aorta.
4. Discuss the anatomy of the pulmonary circulation.
5. List the indications contraindications for cardiac and thoracic angiography.
6. List the procedures for cardiac and thoracic anatomy.
7. Discuss vessel access for cardiac and thoracic angiography.
8. Discuss hemodynamics and the various calculations performed during cardiac catheterization.
9. Discuss the contrast agents used in cardiac catheterization.
10. List the specialized equipment found in the cardiac catheterization suite.
11. List the patient positions for cardiac angiography.
12. Identify common complications of cardiac and thoracic procedures.

Abdominal Aortography and Genitourinary System Procedures

1. Identify the anatomy of the abdominal aorta.
2. Identify the vascular anatomy of the urinary system and celiac and mesenteric circulation.
3. Describe the vascular anatomy of the reproductive system.
4. List the various procedures that can be performed in these areas.
5. List the indications and contraindications for angiography in these areas.
6. Identify vessel access for these procedures.
7. Describe the contrast agents used in angiography of the genitourinary system.
8. Identify common complications of these procedures.

Visceral Angiography

1. Describe the vascular anatomy of the abdominal viscera.
2. List the various procedures that can be performed in these areas.
3. List the indications and contraindications for angiography in these areas.
4. Explain vessel access for these procedures.
5. Describe the contrast agents used in visceral angiography.
6. List suggested patient positions for various visceral angiography studies.
7. Identify common complications of these procedures.

Peripheral Vascular Procedures

1. Discuss the vascular anatomy of the upper and lower extremities.
2. List the various procedures that can be performed in these areas.
3. List the indications and contraindications for angiography in these areas.
4. Discuss vessel access for these procedures.
5. List the contrast agents that are suggested for peripheral angiography.
6. Discuss the patient positioning for peripheral angiography.
7. Identify common complications of these procedures.

Neurologic Vascular Procedures

1. Describe the extracranial and intracranial vascular anatomy.
2. List the various procedures that can be performed in these areas.
3. List the indications and contraindications for angiography in these areas.
4. Describe vessel access for these procedures.
5. Identify the contrast agent used for these procedures.
6. List the equipment required for cerebral angiography.
7. List the patient positions used during diagnostic cerebral angiography.
8. Identify common complications of these procedures.

Vascular Interventional Procedures

1. Describe the general interventional techniques used to reduce blood flow.
2. List the specific indications and contraindications for the reduction of blood flow.
3. List the various procedures used to reduce blood flow.
4. Identify the complications inherent in interventional blood flow reduction.
5. Identify the general interventional techniques used to increase blood flow.
6. List the specific indications and contraindications for increasing blood flow.
7. List the various procedures used to increase blood flow.
8. Describe the complications resulting from interventional vessel dilation.
9. Explain the techniques used to remove foreign bodies from the vascular system.
10. Describe vena cava filtration.

Cardiac Interventions

1. List the percutaneous coronary interventional techniques.
2. List and describe the various cardiac intervention procedures that can be performed.
3. Identify the indications and contraindications for the various procedures.
4. Identify the complications associated with each procedure.
5. Describe percutaneous transluminal coronary angioplasty (PCTA).
6. Describe stent placement in the coronary vasculature.

Nonvascular Interventional Procedures

1. Identify the anatomy and pathophysiology of the gastrointestinal system.
2. Identify the anatomy and pathophysiology of the biliary system.
3. Identify the anatomy and pathophysiology of the urinary system.
4. Describe the general methodology used for needle biopsies.
5. Explain the general methodology of puncture and drainage procedures.
6. Describe the general methodology for percutaneous calculi removal procedures.
7. Explain the general methodology of endoscopic retrograde cholangiopancreatography.
8. Explain and describe the modified barium swallow procedure.

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9. Describe extracorporeal shock wave lithotripsy.
10. Describe vertebroplasty and Kyphoplasty.
11. Explain and describe the epidural spinal injection.
12. Identify the indications for epidural spinal injections.

Magnetic Resonance Imaging

1. Describe the history of magnetic resonance imaging (MRI).
 - a. NMR
 - b. MRI
2. Explain the elements of room design in MRI.
 - a. ferromagnetic walls
 - b. radio frequency shields
3. Identify the types of magnets used in MRI.
 - a. permanent
 - b. resistive
 - c. superconductor
4. Identify the common equipment groups in MRI systems.
 - a. coils
 1. quadrant
 2. surface
 3. volume
5. Describe the basic physical principles of MRI.
6. Describe the use of MRI in vascular imaging.

Nuclear Medicine—SPECT, PET, and Fusion Imaging

1. Describe how nuclear medicine is used as a diagnostic tool.
2. Explain the indications and contraindications for nuclear medicine studies.
3. Identify the various types of radiopharmaceuticals used in nuclear medicine.
4. Differentiate between SPECT, PET, and fusion imaging.
5. Describe the equipment used in each of these modalities.

Female Reproductive System

1. Identify the anatomy of the female reproductive system.
2. List the indications and contraindications for the procedure.
3. Identify the type of contrast media used for the procedure.
4. Describe the patient preparation for the procedure.
5. List the specialized equipment necessary for the procedure.
6. Describe the patient positioning for the procedure.
7. Explain the other modalities used to evaluate the female reproductive system.
 - a. Pelvimetry
 - b. Fetograms

Myelography

1. Identify the anatomy of the brain, ventricular system, and spinal cord.
2. List the indications and contraindications for the procedure.

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3. Describe the patient preparation for the procedure.
4. Identify the type of contrast media used for the procedure.
5. Describe the two major puncture methods for myelography.
6. Describe the needle placements for lumbar, thoracic, and cervical myelography.
7. Describe computed tomography myelography.
8. Explain magnetic resonance myelography.
9. List the specialized equipment necessary for the procedure.
10. Describe the patient positioning for the procedure.
11. Describe the other modalities used to evaluate the central nervous system.

Sialography

1. Identify the anatomy of the salivary glands.
2. List the indications and contraindications for the procedure.
3. Identify the type of contrast media used for the procedure.
4. Describe the patient preparation for the procedure.
5. List the specialized equipment necessary for the procedure.
6. Describe the patient positioning for the procedure.

Arthrography

1. Identify the various types of joints and their movement.
2. List the indications and contraindications for the procedure.
3. Identify the type of contrast medium used for the procedure.
4. Describe the patient preparation for the procedure.
5. List the specialized equipment necessary for the procedure.
6. Describe the patient positioning for the procedure.
7. Explain the other modalities used to evaluate the joints and muscles.

Additional Topics

Describe the methods for measuring bone density.

2. Describe the method for measuring bone length.
3. Explain the procedure for imaging skeletal age.
4. Describe the aspects of forensic radiology.
5. Describe and explain various types of venous access devices.
 - a. correct placement
 - b. incorrect placement
 - c. peripherally inserted catheters.
 - d. dialysis catheters
 - e. implanted ports
6. Describe and explain endotracheal tubes.
 - a. correct placement
 - b. incorrect placement
 - c. ventilator patients
7. Describe chest tubes and associated pathologies.
8. Describe cardiac pacemakers and radiologic evaluation of their placement.

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9. Describe various nasogastric tubes and radiologic evaluation of their placement.
10. Describe nasoenteric tubes and radiologic evaluation of their placement.
11. Explain various types of tissue drains.

Grade Scale

93-100	A
92-84	B
83-77	C
65 -76	D
64 & below	F

Course Evaluation

Grades will be determined from three (3) tests, and a comprehensive final.

3 tests (20% each)	60%
Final	20%
Homework & quizzes	20%

Course Requirements

1. There will be three major tests and a comprehensive final exam
2. Homework and quizzes will be averaged together for 20% of the grade.

Course Policies

- **Attendance Policy:** Students missing over 3 class days will be dropped from the course and will not be permitted to continue in the program.
- Cell-phones, headphones and any other noisemakers must be turned off while in class. If one of these devices goes off during class you will be asked to leave the classroom. Do not bring children or pets to class. If you enter the classroom late, do not walk in front of the instructor or projector.
- Lap top computers, I-pad...may be used to take notes during class but may not be used to “surf” the internet, look-up answers, nor anything else not directly related to note taking.
- **Missed Examinations:** Any student missing an examination will be allowed to make up the test with a 10 point reduction on their grade for that test.
- **Homework Policy:** Late homework will be accepted but will result in a reduction of 10 points for each class day it is late.

EXAM POLICY

1. Everything must be on the floor, i.e. purses, books/book bags, water/drink bottles etc.
2. Students are not allowed to use anything other than their brain to answer questions on the exam.
3. No cell phones or other electronic media on the desk.

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4. Scratch paper will be provided by the instructor and must be turned in at the end of class
5. If a calculator is required it cannot be programmable and you cannot use your cell phone, instructor has the right to examine all calculators
6. All exams will be taken in pencil on a Scan-Tron from 882 unless informed otherwise by the instructor.
7. All changed answers must be erased completely.
8. Cheating will not be tolerated and will result in immediate dismissal from the program.
9. Students must read and abide by the Academic Dishonesty Policy in the LIT Catalog and LIT Student Handbook.

Contact Information

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Office Hours: M/W 9:15-10:30am

Disabilities Statement

The Americans with Disabilities Act of 1992 and Section 504 of the Rehabilitation Act of 1973 are federal anti-discrimination statutes that provide comprehensive civil rights for persons with disabilities. Among other things, these statutes require that all students with documented disabilities be guaranteed a learning environment that provides for reasonable accommodations for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Special Populations Coordinator, Jamie Fox, at (409) 880-1737 or visit her office located in the Cecil Beeson Building, room 116B

Homework Schedule:

Bontrager Ch.2	Sept.9
Test 2 Vocabulary	Oct. 9
Test 3 Vocabulary	Nov.20

Course Schedule:

	Topic	Carter	Bushong	Bontrager
Aug.26	Digital Radiography - Seeram Intro to course/syllabus			
Aug.28 Ch. 1	Digital Radiography: An Overview	1,4,5	25	2
Sept.4 Ch.2,3	Digital Image Processing Computed Radiography (CR)	6	26	
Sept.9 Ch. 4	Effective us of CR	7	28	
Sept.11 Ch. 5	Flat-Panel Digital Radiography	4,5	29	

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	Topic	Carter	Bushong	Bontrager
Sept.16 Ch.8,9	PACS/Medical Informatics	11,12	30	
Sept.18 Ch.10	Quality Control/Test review	5	31	
Sept.23	Test 1			
Sept.25	Go over test/Room Specs & History			p.696
Sept. 30	Auto injectors/Pharmacology			p.697
Oct.2	Contrast Media/Angiography			20 p.533/p.694/
Oct.7	Cerebral Angiography/Abdominal Angiography			p.699,702
Oct.9	Angiocardiography/Pulmonary arteriograms			p.701
Oct.14	Venous Angiography/Lymphangiography			p.703-704
Oct.16	Vascular Interventional procedures			p.705
Oct.21	Non-vascular Interventional procedures			p.708
Oct.23	Review for Test 2			
Oct.28	Test 2			
Oct.30	Go over test Arthrograms/Myelograms			22
Nov.4	Urinary Procedures			16,p.550,p.709
Nov.6	Reproductive/GI			8,22,p.758,p.756
Nov.11	MRI (Bobby Pousson, RT)			
Nov.13	Ultrasound (Sheila Trahan, RT)			23
Nov.18	Nuclear Medicine			23
Nov.20	Lines & Tubes			
Nov.25	Bone densitometry/Bone length/Skeletal age			17 p.769/p.650
Nov.27	Forensic radiology/Review for Test 3			
Dec.2	Test 3			
Dec. 4	Go over Test 3/Review for final			
Dec.9	Final Exam			

All dates are subject to change at the discretion of the instructor