RAD-510: RADIOLOGY PHYSICS & IMAGING TECHNIQUES

Effective Term
Fall 2024

BOT Approval Date
12/14/2023

Discipline
RAD - Radiologic Technology

Course Number
510

Course Title
Radiology Physics & Imaging Techniques

Short Title
Rad Physics & Techniques

Credit Status (CB 04)
D - Credit - Degree applicable

Units

Lecture Units
4.00

Total Units
4

Hours

Lecture Contact Hours
64-72

Out of Class Hours Lecture
128-144

Total Contact Hours
64 - 72

Total Out of Class Hours
128 - 144

Total Student Learning Hours
192 - 216

Distance Education
No

Catalog Description
This course includes basic knowledge of scientific units, the structure of matter, electromagnetic radiation, electromagnetism, the imaging system, x-ray tube construction, x-ray production and interactions, radiographic quality and techniques, digital imaging and artifacts, scatter control, radiation protection, and quality assurance.

Attach Supporting Documents
ASRT 2022 radiography curriculum guide.pdf
JRCERT 2021 Radiography Standards pg 28.pdf

Attach Supporting Documents
LMI.pdf

Requisites

Prerequisite(s)

Prerequisite(s) (must be taken before)
Acceptance to the Radiologic Technology Program.

Recommended Preparation

Recommended Preparation (note that students can enroll in the class even if they haven't take the recommended course)
MATH-105.

Codes

TOP Code (CB 03)
1225.00* - *Radiologic Technology

CIP Code
51.0911 - Radiologic Technology/Science - Radiographer.

Student Accountability Model (SAM) Priority Code (CB 09)
C - Clearly Occupational

Noncredit Category (CB 22)
Y - Credit Course

Repeatability Code
No

Grading Option
Letter grade OR P/NP

Minimum Qualifications

Minimum Qualifications	And/Or
Radiological Technology	End

CSU Area(s)

IGETC Area(s)

Learning Objectives

Learning Objectives

Learning Objective
1. Discuss the basic concepts of fundamental and derived units along with the mechanics of basic physics.
2. Describe electromagnetic energy to include frequency, wavelength, energy, and velocity.
3. Identify the components of the x-ray imaging system and tube with the function of each.
4. Analyze how milliampere-seconds, kilovoltage, filtration, target material, and voltage ripple affect the x-ray emission spectrum along with the radiographic image.
5. Assess each of the x-ray interactions with matter and how the interaction contribues to differential absorption.
6. Evaluate how radiation scatter can be controlled using proper beam limitation and grids.
7. Compare and contrast digital and computerized radiography.
8. Apply radiation protection techniques, tailored to the diverse needs of patients, encompassing different genders, races, cultures, and disabilities.

9. Compare the various types of quality assurance and control procedures for a radiology department.
10. Analyze image artifacts and their causes.

Learning Outcome Information

Course Learning Outcomes

Learning Outcome
1. Students will identify the three types of x-ray production.
2. Students will list methods of radiation protection procedures for the patient and the radiographer.
3. Students will describe the relationship between milliampere-seconds, kilovoltage, and distance to radiographic quality and quantity.

Program Learning Outcomes

Learning Outcome
Apply positioning skills in all required radiographic examinations.
Practice radiation protection for all radiographic examinations.
Employ proper patient care techniques and effectively provide care for patients from diverse groups/populations.
Demonstrate oral and written communication skills.
Relate to and anticipate the needs of the doctors and technologists.
Adjust to changes, situations, patient conditions, updated evidence-based practice, and deviation from the normal routine.
Demonstrate knowledge of ethical requirements for an entry level radiographer along with ethical practices in a healthcare setting.
Understand professional obligations upon gaining the ARRT status.

Institutional Learning Outcomes

Aesthetic Awareness: The student will identify and evaluate how aesthetic expression leads to an appreciation of social and cultural context as well as the values of art and nature.
Communication: The student will effectively express and exchange ideas through listening, speaking, reading, writing, visual works, and other modes of interpersonal expression.
Critical Thinking: The student will analyze problems, gather and synthesize relevant information, evaluate ideas, information, and evaluate alternative points of view to create, innovate and implement effective solutions.
Cultural Awareness and Humility: The student will demonstrate knowledge of and sensitivity toward individuals of diverse ethnicity, age, gender, sexual orientation, and religious affiliations, as well as toward those individuals with diverse abilities and socio-economic classes to respectfully interact with individuals of diverse perspectives, beliefs and values while being mindful of the limitation of their own cultural frameworks.
Information and Technology Literacy: The student will access, interpret, evaluate, and apply relevant information sources and digital media effectively, and in an ethical and legal manner.
Scientific Awareness: The student will apply the scientific method of inquiry to assess potential solutions for real-life challenges by employing science-based knowledge and methodologies in daily life.
Social Awareness: The student will recognize and analyze the interconnectedness of global, national, and local concerns, analyzing cultural, political, social, and environmental issues from multiple perspectives and appreciate similarities and differences among cultures.
Civic
Personal
and Professional Responsibility

Content

Course Lecture Content

1. History of radiography and public reaction
2. Units of measurement
   a. Fundamental units
   b. Derived units
   c. Systems of units
3. Mechanics
   a. Inertia
   b. Forces

   c. Fields
   d. Work
   e. Energy
   f. Momentum
   g. Power
4. The structure of matter
   a. Fundamental particles
   b. Atomic Structure
   c. Atomic Nomenclature
   d. Combinations of atoms
   e. Radioactive atoms
   f. Types of ionizing radiation
5. Electromagnetic Energy
   a. Photon velocity, frequency, wavelength, and energy
   b. Electromagnetic spectrum
   c. Inverse square law
   d. Matter and energy
6. Electrostatics
   a. Types of electrification
   b. Electrostatic laws
7. Electrodynamics
   a. Electrical terminology
   b. Electric circuits
   c. Ohm's law
   d. Electrical symbols
   e. Circuit power
8. Magnetism
   a. Properties of magnetism
   b. Magnetic laws
   c. Magnetic induction
9. Electromagnetism
   a. Electromagnetic induction
   b. Farady's law
   c. Generators and motors
   d. Transformers
10. X-ray Imaging System
   a. Operating console
   b. Control of kilovoltage and milliamperage
   c. Exposure timers
   d. Types of rectification
   e. Single and three phase generators
   f. Voltage ripple
   g. X-ray circuit
11. X-ray tube
   a. External components and functions
   b. Cathode
   c. Stationary and rotating anode
   d. Focal spot
   e. Line focus principles
   f. Tube rating charts
   g. X-ray tube failure
12. X-ray production
   a. Bremsstrahlung radiation
   b. Characteristic radiation
   c. Factors affecting emission spectra

i. kVp
ii. mA
iii. Time
d. Atomic number of target
e. Distance
f. Filtration

13. X-ray Emission
a. Factors influencing x-ray beam intensity
b. Half value layer
c. Types of filtration

14. Interactions of photons with matter
a. Transmission of photons
b. Unmodified scattering
c. Photoelectric effect
d. Modified scattering (Compton)
e. Pair production
f. Photodisintegration

15. Radiographic technique
a. Exposure factors
i. Milliamperes
ii. Kilovoltage
iii. Exposure time
b. Imaging system characteristics
i. Focal spot size
ii. Filtration
iii. High-voltage generation
c. Patient factors
i. Thickness
ii. Composition
iii. Pathology

16. Radiographic image quality
a. Resolution
b. Noise
c. Speed
d. Geometric Factors
i. Magnification
ii. Distortion
iii. Focal-spot blur
iv. Heel effect
e. Subject factors
i. Subject contrast
ii. Motion blur
f. Tools for improved radiographic image quality
i. Patient positioning
ii. Image receptors
iii. Selection of technique factors

17. Image quality factors
a. Density/brightness
b. Contrast
c. Detail
d. Distortion

18. Exposure technique charts
a. Variable mA
b. Variable kV

19. Automatic exposure techniques
20. Control of scatter radiation

a. Production of scatter radiation
    i. Kilovoltage
    ii. Radiaiton field size
    iii. Patient thickness
b. Effects of scatter radiation on image
c. Control of scatter radiation
    i. Beam restrictors
    ii. Radiographic grids
d. Grid Performance
    i. Contrast improvement factor
    ii. Bucky factor
e. Grid types
    i. Parallel
    ii. Crossed
    iii. Focused
    iv. Moving
f. Grid cut off
g. Grid selection
    i. Patient dose
    ii. Air-gap technique

21. Computed Radiography
    a. Photostimulable luminescence
    b. Imaging plate layers and functions
    c. Reader functions
    d. Imaging characteristics
22. Digital radiography
    a. Direct and indirect methods
    b. Scanned projection radiography
    c. Charge-coupled device
    d. Cesium iodide/charge-coupled device
    e. Cesium iodide/amorphous silicon
    f. Amorphous selenium
23. Digital radiographic technique
    a. Spatial resolution
    b. Contrast resolution
    c. Contrast-detail curve
    d. Patient radiation dose considerations
24. Quality control and assurance
    a. Definitions
    b. Regulations
    c. Quality ControlTesting
        i. Filtration
        ii. Collimation
        iii. Focal spot size
        iv. Kilovolt calibration
        v. Exposure timer accuracy
        vi. Exposure linearity
        vii. Exposure reproducibility
        viii. Protective apparel
        ix. Performance assessment standards
        x. Luminance meter
        xi. Digital display device
25. Digital radiographic artifacts

a. Image receptor artifacts
b. Software artifacts
c. Object artifacts

26. Radiation protection and patient considerations
    a. Units
    b. Effective doses
    c. Biological effects
    d. Regulations
    e. Personnel monitoring devices
    f. Protective apparel for the radiographer and patient
        i. Lead equivalency
        ii. Types
        iii. Gonadal shielding
    g. Pregnancy and radiation protection
        i. Pregnant patient considerations
        ii. Pregnant radiographer considerations
    h. Addressing radiation exposure concerns and effective communication with a diverse patient population
        i. Gender identity
        ii. Race
        iii. Culture
        iv. Patients with disabilities
        v. Pregnant patients

Methods of Instruction

Method

Lecture

Integration

Face to face lecture and demonstration will be used to present information about the fundamentals of x-ray physics along with x-ray tube circuitry and construction, x-ray production, radiographic techniques and image quality, and radiation protection.

Method

Reading

Integration

The student is expected to complete reading assignments from the required textbook, which will be followed by classroom discussions aimed at fostering the critical thinking skills essential for a radiographer to produce high-quality radiographic images.

Method

Discussion

Integration

Classroom and group discussions are designed to cultivate the critical thinking skills essential for radiographers to achieve excellence in producing high-quality radiographic images. These discussions encompass various topics, including radiation protection practices for all patients, the impact of radiation on pregnancy, and strategies for minimizing radiation exposure to both patients and radiographers. These discussions also focus on radiation protection practices that account for the diverse characteristics of patients from different racial and cultural backgrounds, different gender identities, and disabilities thus ensuring equitable care for all patients.

Method

In-class Exercises

Integration

In-class exercises will promote student understanding of radiation protection and radiation control. In-class exercises include, but are not limited to, using critical thinking skills to determine how to protect a pregnant female patient during a radiographic procedure of the chest and labeling the components of an x-ray tube with the function of each. In-class exercises provide the students an opportunity to determine their retention and understanding of concepts.

Methods of Evaluation

Method

Exams/Tests

Integration

Exams/tests will be used to measure competency of scientific units, electromagnetism, the x-ray imaging system and tube, radiation production and interactions, digital imaging and artifacts, scatter control, radiation protection, and quality assurance. Exams will be given to measure student understanding of the subject matter and the ability to analyze contributions to a high quality image. The exams will be multiple choice to help prepare the students to pass the American Registry of Radiologic Technologists exam which is also in multiple choice format. Exams/tests are graded on accuracy.

Method

Homework

Integration

Homework is assigned to help the students review the material presented in lecture. Homework topics include practice problems for calculating the inverse and direct square law, the 15% rule for kilovoltage, and the milliampere-seconds reciprocity law. As an option, the homework can also be done in class in small groups to promote discussion and interactions among the students. The homework assignment is also an opportunity to determine if the student adequately understands the concepts. Homework is graded for accuracy and completion.

Method

Papers

Integration

Written analysis on radiation protection practices on pregnant female patients from diverse backgrounds can be used to evaluate various approaches to imaging. Papers will be evaluated on the inclusion of ancillary equipment needed, pre- and post- exam instructions, radiation limits, and how patients from diverse backgrounds may need a different type of approach. Proper grammar, syntax, and spelling will also be evaluated.

Assignments

Assignment Type

Reading

In-class and/or outside of class

Outside of class

Formative or Summative

Formative

Assignment

Read the American Society of Radiologic Technologists (ASRT) article titled "Best Practices in Digital Radiography." This article delves into essential guidelines and recommendations for healthcare professionals in the field of digital radiography. The objective is to

review this article and summarize its key points while also sharing personal opinions on the content. These insights will serve as the basis for an in-class discussion.

Assignment Components:

Read the ASRT Article:
Access the article titled "Best Practices in Digital Radiography" by the American Society of Radiologic Technologists (ASRT) provided by the instructor. Carefully read the entire article to gain a comprehensive understanding of its content.

Key Points Summary:

Summarize the main points, guidelines, and recommendations presented in the ASRT article regarding best practices in digital radiography. Ensure that your summary is clear, concise, and includes the most critical information.

Opinions and Insights:

Share your personal opinions, insights, and reflections on the article's content. Discuss whether you agree or disagree with the recommendations and why. Provide real-world examples or scenarios if applicable to illustrate your points.

Class Discussion:

Come to class prepared to engage in a discussion about the article. Be ready to share your summarized key points and opinions, and actively participate in the conversation.

Please ensure that you read the ASRT article thoroughly, summarize its key points, and formulate thoughtful opinions for our in-class discussion. Your active participation and contributions during the discussion will also be considered in your assignment evaluation.

Assignment Type
Writing

In-class and/or outside of class
In-class

Formative or Summative
Formative

Assignment
Analyze and identify the components of an X-ray tube using a provided diagram from the instructor. Understanding the inner workings of an X-ray tube is crucial for radiologic technologists involved in diagnostic imaging. By the end of this assignment, you should be able to identify each component and explain its function within the X-ray tube.

Assignment Components:

X-Ray Tube Diagram:
Begin by reviewing the provided X-ray tube diagram. Familiarize yourself with the various parts depicted in the illustration.

Component Identification:
Carefully identify and label each component within the X-ray tube diagram. Be precise in your descriptions and labeling.

Function Explanation:
For each identified component, provide a clear and concise explanation of its function within the X-ray tube. Consider how each part contributes to the generation of X-rays.

Accuracy and Clarity :
Ensure that the identification and explanations are accurate, well-structured, and easy to understand.

Submit the assignment by the specified deadline, ensuring that identification and explanations are accurate and easy to follow. This assignment will be graded based on the correctness of your identification and the clarity of explanations regarding the components and functions of the X-ray tube.

Assignment Type

Writing

In-class and/or outside of class

In-class

Formative or Summative

Summative

Assignment

Examine the essential measures to ensure the safety of pregnant female patients during a chest radiographic procedure. Explore various aspects, including the use of protective devices and equipment, establishing radiation limits for both the pregnant patient and the fetus, and providing pre- and post-exam instructions and information to the patient. Furthermore, investigate how instructions and actions may need to be adapted to accommodate patients from diverse racial, cultural, ethnic backgrounds, and those with disabilities.

Assignment Components:

Protective Devices and Equipment:
Describe the specific protective devices and equipment used to safeguard pregnant female patients during chest radiographic procedures.
Explain their significance in minimizing radiation exposure.

Radiation Limits:
Define the radiation limits for both the pregnant patient and the fetus during such procedures.
Discuss the rationale behind these limits and their importance.

Pre- and Post-Exam Instructions:
Outline the essential pre-exam instructions provided to pregnant patients before the radiographic procedure.
Detail the post-exam instructions and information given to the patient after the procedure.

Cultural Competence and Adaptation:
Investigate potential variations in instructions and actions necessary for patients from diverse racial, cultural, ethnic backgrounds, and those with disabilities. Provide specific examples of how healthcare providers can adapt their approach to ensure effective communication and care.

Accuracy and Clarity:
Ensure the analysis is accurate, well-researched, and clearly presented. Use credible sources and cite them appropriately.

Please adhere to the deadline and format your assignment according to the guidelines provided. This assignment will be graded for accuracy and adherence to the outlined criteria.

Course Materials

Textbooks

Bushong, S., (2021) Radiologic Science for Technologists: Physics, Biology, and Protection, 12th Ed., Elsevier. ISBN#: 978-0323661348

Class Size Information

Class Size

40

Class Size Category

A - Lecture/discussion 40

Diversity and Inclusion

Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.

Students will analyze radiation protection practices on female patients and how instructions and approaches will differ with patients from diverse backgrounds.

Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.

Lecture materials are thoughtfully designed to accommodate for a diverse range of learning preferences. Multiple formats are employed, such as PowerPoint slides and textbook readings, to accommodate visual learners, while verbal communication from the instructor accommodate audio learners. Additionally, students are encouraged to collaborate in small groups to complete assignments. This approach fosters interaction among students, promoting personal and cultural connections in the learning process

Interactions

Explain how the course will incorporate student-to-student interaction.

In-class assignments on radiation protection practices for pregnant patients and labeling the X-ray tube circuitry will be completed collaboratively by students in small groups. These assignments are structured to encourage discussions and foster meaningful interactions among students.

Explain how the course will incorporate instructor-to-student interaction.

Instructors interact through face to face lectures where students may ask questions about electromagnetic radiation, x-ray circuitry and tube, radiation techniques and quality, radiation production and protection. Instructors offer feedback based on their professional insights and personal experiences when addressing the ASRT Code of Ethics. Additionally, instructors play a pivotal role in guiding students to develop critical thinking skills, enabling them to determine the most effective strategies for minimizing radiation exposure in diverse cultural and racial contexts, with particular attention to pregnant patients.

Explain how the course will incorporate student-to-content interaction.

This course has a detailed textbook which supports the lecture material and includes information on scientific units and measurements, x-ray circuitry, radiation production and interaction, and radiation protection. Students will also have access to PowerPoint presentations and supplemental materials through the course management system, such as Canvas.

Explain how the course will incorporate student-to-self interaction (metacognitive).

This course provides opportunities for students to analyze how they will produce a high quality radiographic image on a diverse population of patients, using appropriate technical factors and radiation protection practices, for diagnostic interpretation from a radiologist.

Key: 3067