Virginia Western Community College
RAD 111
Radiographic Science I

Prerequisites
Admission into the Radiography Program.

Course Description
Teaches concepts of radiation, radiography physics, and fundamentals of electromagnetic radiation, electricity and magnetism, and application of these principles to radiography. Focuses on x-ray production, emission, and x-ray interaction with matter. Develops skills in analysis, quantification and synthesis, and applies problem-solving strategies.

Semester Credits: 4 **Lecture Hours: 3** **Lab/Clinical/Internship Hours: 3**

Required Materials

Textbook:
Essentials of Radiologic Science. Robert Fosbinder & Diane Orth. 2nd Edition. ISBN: 9781496317278
Radiologic Science for Technologists. Bushong. 11th Edition. ISBN: 9780323353779

Supplementary Materials:
Several resource textbooks are located in the Radiography Lab

Course Outcomes
At the completion of this course, the student should be able to:

- Understand the major concepts of radiation and radiography physics.
- Understand the fundamentals of electromagnetic radiation, electricity and magnetism.
- Apply fundamental principles of electromagnetic radiation, electricity and magnetism production to clinical situations.
- Understand x-ray production, emission and interactions with matter.

Topical Description

1. Chapter 4 – Atomic Structure
   - Define Atomic mass and atomic number
   - Describe the Bohr model of the atom and its components
   - Define electron binding energy
   - Describe the process of ionization
   - Identify the types of ionizing radiation

2. Chapter 5 – Electromagnetic Radiation
   - Name the different types of electromagnetic radiation and describe each
   - Describe the characteristics of electromagnetic waves
   - Describe the relationships between frequency, wavelength, velocity, and energy of electromagnetic radiation
   - Define radiation intensity and descry e how it varies with distance from the radiation source
   - Explain the difference between electromagnetic and particulate radiation
   - Define wave-particle duality and how it relates to x-rays and gamma rays
   - Discuss ionization an the characteristics of alpha and beta particles

3. Chapter 6 - Electricity
   - Identify the four types of electrical materials
   - Describe the direction and movement of current flow
   - Define current, voltage, and electric power and identify their units
   - Identify Ohm's law and state the relationship between current, voltage, and resistance
   - Distinguish between alternating and direct current
   - Describe series and parallel circuits

4. Chapter 7 – Electromagnetism and Magnetism
   - State the laws and Units of magnetism
   - Identify the different types of magnetic materials
   - Identify the four types of electrical materials
   - Describe the direction an movement of current flow
   - Explain electromagnetic induction: both mutual induction and self-induction
   - Distinguish the basic principles of operation of generators and motors

5. Chapter 8 – X-ray Unit Circuitry
   - Identify single-phase, three-phase, and high frequency waveforms
   - Describe the purpose and operation of a rectifier
   - Identify the components of a typical x-ray circuit and their purpose
   - Describe the purpose and operation of a rectifier
   - Describe the operation of a transformer
   - Define voltage ripple
   - Explain the component of the control console and how each used during an exposure

6. Chapter 9 – The X-ray Tube

- Identify the construction of the x-ray tube
- Describe the process of producing a beam of x-radiation
- Explain the material used to construct an anode
- Define Thermionic emission
- Describe the line focus principle
- Explain how the anode heel effect can be used in radiography
- Define and calculate anode heat units
- Recognize allowed and forbidden tube heat loads

6. Chapter 10 – X-ray Production

- Describe the Bremsstrahlung x-ray production process
- Describe the characteristic x-ray production process
- Explain the effect of kVp and filtration on beam quality
- Identify the information contained in an x-ray spectrum
- Explain the effect of kVp, mA, filtration, x-ray circuit waveform, and anode material on the x-ray emission spectrum

7. Chapter 11 – X-ray Interactions with Matter

- Describe the x-ray interactions of coherent scattering and Compton scattering
- Explain the Photoelectric effect
- State how backscatter radiation is determined
- Discuss the difference between a photoelectron and a Compton scattered photon
- State the importance of the atomic number and how it relates to the photoelectric effect
- Differentiate between pair production and photodisintegration

8. Chapter 12 – Beam Attenuation

- Describe the factors that affect absorption of x-ray photons
- Explain the process of beam attenuation
- Stat the factors that affect beam attenuation
- Identify the factors that make up subject contrast
- Distinguish between differential absorption, scatter, radiation, and transmission of x-ray photons
- Explain the effect of scatter radiation on the radiographic image
- State how fog affects the image
- Define remnant radiation

9. Chapter 13 – Radiographic Image Characteristics

- Explain the importance of density for image quality
- List and describe the regions of the characteristic curve
- Explain sensitometry and how the characteristic curve is constructed
- Identify the optical density for a radiographic film
- Identify the factors that make up radiographic contrast
- Explain the image characteristics of speed, contrast, and exposure latitude
- Describe the difference between long-scale and short-scale contrast images
- Differentiate between high and low contrast images

- Describe the differences of size and shape distortion
- Explain the principles of magnification radiography
- Define the factors that affect image detail
- Discuss appropriate techniques to prevent motion

10. Chapter 14 – Image Exposure
    - Define radiation quantity and its relation to x-ray beam intensity
    - List the factors that affect the intensity of the x-ray beam
    - Explain x-ray quality and how it is related to penetrability
    - Explain the relationship between milliamperage and exposure time with radiation production and image receptor exposure
    - Calculate changes in milliamperage and exposure time to change or maintain milliamperes per second
    - Discuss how kVp affects exposure to the image receptor
    - Calculate changes in kVp to change or maintain exposure
    - Calculate changes in mAs for changes in source-to-image receptor distance

11. Chapter 15 – Controlling Scatter
    - Describe the effect of scatter on radiographic contrast
    - Identify the factors that affect the amount of scatter
    - Identify methods of scatter reduction
    - Describe the construction of an antiscatter grid
    - Identify the types of grids
    - Explain the types of grid errors

12. Chapter 18 – Automatic Exposure Control (AEC)
    - State the purpose of using automatic exposure control (AEC) in radiography
    - Distinguish between the various types of radiation detectors
    - Describe how the detector size and configuration affect the AEC response to radiation
    - Explain the positioning errors, which affect how the AEC responds to radiation
    - Discuss patient and exposure technical factors and their effect on the AEC detector
    - Describe anatomically programmed radiography (APR)
    - Explain the purpose of the mAs readout and how it can be used to learn manual technique
    - Discuss the effect of the back timer/mAs has on the length of the exposure when the AEC malfunctions
    - List the various types of operators errors that are seen when using the AEC device
    - Stat the purpose of using the density controls

Specific Course Outcomes

At the end of the course, the student should be able to:

- Define atomic mass and atomic number
- Describe the Bohr model of the atom and its component
- Define electron binding energy
- Describe the process of ionization
- Identify the types of ionizing radiation

- Name the types of electromagnetic radiation and describe each
- Describe the characteristics of electromagnetic radiation
- Describe the relationship between frequency, wavelength, velocity, and energy of electromagnetic radiation
- Define radiation intensity and how it varies with distance from the source
- State the laws and units of magnetism
- Identify the different types of magnetic materials
- Describe the methods of electrification
- State the laws of electrostatics
- State Coulomb's Law
- Identify the four types of electrical materials
- Describe the direction and movement of current flow
- Define current, voltage, and electric power and identify their units
- Identify Ohm's Law and state the relationship between current, voltage, and resistance
- Distinguish between alternating and direct current
- Describe current induction
- Distinguish between electric generators and motors
- Identify single-phase, three-phase, and high-frequency waveforms
- Describe the relationship between current and voltage in the primary and secondary sides of the step-up and step-down transformers
- Identify the components of a typical x-ray circuit and their purpose
- Describe the purpose and operation of a rectifier
- Describe the operation of a transformer
- Define voltage ripple
- Define thermionic emission
- Describe the line focus principle and the anode heel effect
- Describe the bremsstrahlung x-ray production process
- Describe the characteristic x-ray production process
- Identify the information contained in an x-ray spectrum
- Identify the changes in x-ray beam quality and quantity resulting in changes in kVp, mAs, filtration, x-ray circuit waveform, and anode material
- Distinguish between absorption, scattering, and transmission of x-ray photons
- Identify the factors that affect the amount of attenuation
- Define half-value layer
- State five ways in which x-rays interact with matter
- Describe the two x-ray interactions important in image formation
- Identify the factors that affect image density
- Describe the operation of an automatic exposure control system
- Identify the factors that make up radiographic contrast
- Identify the factors that make up subject contrast
- Describe the difference between long-scale and short-scale images
- Define the factors that affect image detail
- Describe the factors that affect image detail
- Describe the principles of linear tomography
- Describe the various geometric factors
- Discuss appropriate techniques to prevent motion

- Describe the effect of scatter on radiographic contrast
- Identify the factors that affect the amount of scatter
- Identify methods of scatter reduction
- Describe the construction of an anti-scatter grid
- Identify the types of grids
- Explain the types of grid errors

Note to Instructors

1. Students will continue to identify and set proper radiographic technique in the clinical setting.
2. Students will discuss technical factors and image quality into their procedure competency reviews.
3. Students will apply radiation protection practices while in the clinical setting.