# RADT-1301: RADIOGRAPHIC FUNDAMENTALS AND TECHNIQUE

## Cuyahoga Community College

### Viewing: RADT-1301 : Radiographic Fundamentals and Technique

**Board of Trustees:**
January 2025

**Academic Term:**
Fall 2025

**Subject Code**
RADT - Radiography

**Course Number:**
1301

**Title:**
Radiographic Fundamentals and Technique

**Catalog Description:**
Basic study of ionizing radiation relative to its nature, production, interaction with matter and effect on radiographic quality. Includes the fundamentals of radiation protection and image acquisition methods.

**Credit Hour(s):**
4

**Lecture Hour(s):**
3

**Lab Hour(s):**
2

**Other Hour(s):**
0

### Requisites

**Prerequisite and Corequisite**
Departmental approval: admission to program.

### Outcomes

**Course Outcome(s):**
Apply knowledge of radiation concepts as they relate to the field of x-ray.

**Essential Learning Outcome Mapping:**
Not Applicable: No Essential Learning Outcomes mapped. This course does not require application-level assignments that demonstrate mastery in any of the Essential Learning Outcomes.

**Objective(s):**
1. Describe the properties of matter, energy, subatomic structure and electron shells.
2. Differentiate between types of radiation along the electromagnetic spectrum.
3. Diagram the X-ray tube and explain its components.
4. Describe the process of X-ray production (SCADE) as it relates to the X-ray tube.
5. Differentiate between Characteristic and Bremsstrahlung interaction in the tube.
6. Explain the interactions between X-rays and matter at the patient level including: Photoelectric absorption, Compton scatter, and Coherent scatter.
7. Explain the X-ray circuit.

8. Describe how automatic exposure control (AEC) terminates an exposure.
9. Explain how beam filtration affects X-ray beam intensity and patient exposure.

---

**Course Outcome(s):**

Correctly set prime factors and identify their effects on an image.

**Objective(s):**

1. Describe the different X-ray prime factors and be able to properly adjust the factors based on an under or over exposed image while keeping patient dose as low as possible
2. Perform calculations for milliamperage per second.
3. Solve for the law of reciprocity and understand its application.
4. Demonstrate understanding of how distance including source-to-image distance (SID), source-to-object distance (SOD), and object-to-image distance (OID) can affect how the image is displayed and its exposure indicator.
5. Apply the inverse square law (ISL) and the direct square law (DSL)/exposure maintenance formula.
6. Understand and apply the fifteen percent rule.
7. Demonstrate a basic understanding of Automatic Exposure Control's (AEC) and its effect on an image.
8. Properly adapt technique relative to patient pathology or body habitus.
9. Identify and correct for gross over-exposure, quantum mottle, and dose creep in digital images.

---

**Course Outcome(s):**

Perform basic skills for radiographic image acquisition.

**Objective(s):**

1. Recognize differences and similarities between conventional (film screen) and computed radiography (CR)/photostimulable phosphor (PSP).
2. Recognize differences between PSP and flat panel detector (FPD) including direct and indirect capture.
3. Appropriately evaluate images from any of the acquisition methods for quality.

---

**Course Outcome(s):**

Manipulate and apply basic radiation principles as they relate to the protection of the patient, the radiographer and image production.

**Objective(s):**

1. Practice safe radiation protection principles.
2. Apply appropriate collimation during exposures.
3. Demonstrate appropriate scatter reduction techniques.
4. Identify advantages and methods used for beam restriction.
5. Discuss beam restriction and beam filtration and their uses towards image production and patient dose.
6. Describe the purpose, construction, and appropriate uses for various grid types.
7. Evaluate grid cut-off/errors.
8. Evaluate patient dose with the use of grids including grid conversion factors.
9. Summarize the relationship of factors affecting scatter and secondary radiation.

---

**Course Outcome(s):**

Evaluate image processing and display characteristics.

**Objective(s):**

1. Distinguish factors controlling and influencing, brightness, gray scale, spatial resolution and distortion.
2. Evaluate images for adequate brightness, gray scale, spatial resolution and distortion.
3. Recommend appropriate adjustments to correct brightness, gray scale, spatial resolution and distortion.
4. Describe how density and contrast in film-screen imaging relate to brightness and gray scale in digital imaging.
5. Identify windowing and leveling and describe what they control.

6. Understand factors affecting spatial resolution in digital imaging.
7. Define pixel and matrix as they relate to digital imaging.

---

**Course Outcome(s):**

Appreciate various methods of image evaluation.

**Objective(s):**

1. Describe various exposure response indicators and their range of acceptance.
2. Describe medical image management and processing system (MIMPS)/picture archiving and communication system (PACS), digital imaging and communications in medicine (DICOM) and health level seven (HL7) and their functions.

---

**Course Outcome(s):**

Apply previously learned knowledge from the classroom to the laboratory and evaluate laboratory experiments as they relate to both film-screen and digital technology.

**Objective(s):**

1. Prove by experiment the ISL and the direct square law DSL/exposure maintenance formula.
2. Demonstrate the law of reciprocity.
3. Produce long and short scale contrast.
4. Manipulate (CR) to produce an image.
5. Manipulate digital radiography equipment to create an image.
6. Calculate and create images demonstrating the fifteen percent rule.
7. Demonstrate proper grid usage and grid errors.
8. Demonstrate collimation and its effect on radiographic quality.
9. Manipulate a digital image on a monitor to demonstrate windowing and leveling.
10. Acquire and accurately annotate digital images.

---

**Methods of Evaluation:**

1. Homework assignments
2. Quizzes
3. Midterm examination
4. Final examination
5. Projects
6. Assessment of laboratory experiments

**Course Content Outline:**

1. Structure of the atom
    a. Nucleus
    b. Subatomic structure
    c. Electron shells
        i. Binding energy
        ii. Valence shell
    d. Nomenclature
        i. Atomic number
        ii. Mass number
2. Electromagnetic spectrum
    a. Wave-particle duality
    b. Properties (e.g., frequency, wavelength, energy, velocity)
    c. Ionizing vs non-ionizing (excitation)
3. Radiation physics basic principles
    a. Radiology history
    b. X-ray production (SCADE)

i. Source of free electrons (e.g., thermionic emission)
ii. Confinement of electrons
iii. Acceleration of electrons
iv. Deceleration of electrons
v. Energy conversion

c. X-ray beam
i. Fundamental properties (e.g., travel in straight lines, ionize matter)
ii. Frequency and wavelength
iii. Beam characteristics
iv. Milliampere-seconds (mAs)
1. Beam quantity
2. Milliamperes (mA)
3. Time
4. DSL/Exposure maintenance formula
5. Law of reciprocity
v. Kilovoltage peak (kVp)
1. Beam quality/penetrability
2. Beam quantity
3. Subject contrast
4. 15 percent rule
vi. Primary versus remnant (exit)
vii. Secondary vs leakage radiation
viii. Off-focus/stem radiation
ix. Patient protection basic principles (ALARA)
x. Scatter radiation
1. Production
a. Collimation
b. kVp
c. Irradiated tissue
i. Thickness
ii. Composition
2. Reduction
a. Grid
b. Collimation
xi. Attenuation by various tissues
1. Thickness of body part
2. Type of tissue (atomic number)

d. Distance
i. SID
ii. SOD
iii. OID
iv. Inverse square law
v. Anode heel effect

e. Spatial resolution
i. Focal spot size
ii. Movement

f. Distortion
i. Size
1. Distance (e.g., SID, SOD, OID)
ii. Shape
1. Foreshortening
2. Elongation

g. Effect on image

4. Diagnostic X-ray tubes
a. Construction
b. Extending tube life
i. Warm-up procedures
ii. Rotor considerations
iii. Filament considerations

iv. Anode thermal capacity and exposure limits
v. Tube movement

c. Focal spot size

5. X-ray circuit
   a. Electricity
      i. Potential difference
      ii. Current
      iii. Direct
      iv. Alternating
      v. Resistance
   b. Electrical safety
      i. Ground
      ii. Circuit breaker
   c. Transformers
      i. Step-up
      ii. Step-down
      iii. Autotransformer
   d. Components and functions
      i. Operating (control) console
      ii. Filament circuit
      iii. Tube circuit
   e. Rectification
      i. Purpose
      ii. Mechanisms
   f. High-frequency generators
6. X-ray anode/target interactions
   A. Bremsstrahlung
   B. Characteristic
7. X-ray photon interactions with matter
   A. Photoelectric
   B. Compton
   C. Coherent (classical)
8. Radiation Protection
   a. Minimizing patient exposure
      i. Dose creep
   b. Anatomically programed radiography (APR)
      i. Manual exposure factors/controls
   c. AEC
      i. Effects of changing exposure factors on radiographic quality
      ii. Detector/ionization chamber selection
      iii. Alignment and positioning considerations
      iv. Radiation detector selection
      v. Radiation detector configuration
      vi. Radiation detector sensitivity
      vii. Anatomic alignment
      viii. Back-up timer
      ix. Minimum response time (MRT)
      x. Patient/Compensation issues
         1. Contrast agents
         2. Patient size
         3. Pathology
         4. Prosthetics/implants
         5. Collimation
         6. Positioning
         7. Body habitus
      xi. Exposure adjustment (e.g., density, +1 or –1)
   d. Beam restriction

i. Purpose of primary beam restriction
    1. Reduce irradiated tissue volume
    2. Reduce patient dose
    3. Reduce scatter radiation
ii. Types (e.g., collimators)
    1. Manual collimators
    2. Automatic collimators
    3. Cylinders and cones
    4. Ancillary devices (e.g., lead blockers/lead masks)
iii. Collimator components
    1. Lead shutters
    2. Light source

e. Filtration
    i. Effect on skin and organ exposure
    ii. Effect on average beam energy
    iii. Total
        1. Inherent
        2. Added
    iv. Compensating
    v. Measurement
        1. Aluminum equivalency
        2. Half-value layer (HVL)
    vi. Material
        1. Aluminum
        2. Copper
        3. Clear lead
f. Dose area product (DAP) meter

9. Grids
    a. History/purpose
    b. Construction
    c. Types of grids
        i. Linear/parallel
        ii. Focused
        iii. Crossed
        iv. Virtual
    d. Stationary vs. moving (Potter-Bucky mechanism)
    e. Grid physical factors
        i. Grid ratio
        ii. Grid frequency
    f. Grid functional factors
        i. Contrast improvement factor (k)
        ii. Selectivity
    g. Grid conversion factors
    h. Grid errors
        i. Off-level
        ii. Off-center
        iii. Off-focus
        iv. Upside down
        v. Moiré effect (aliasing)
10. ALARA
    a. Sources of radiation exposure
        i. Primary X-ray beam
        ii. Secondary radiation
            1. Scatter
            2. Leakage
        iii. Patient as source
    b. Basic methods of protection

i. Time
ii. Distance
iii. Shielding

11. Factors affecting radiographic quality (+/- charts)
    a. Receptor exposure
    b. Subject contrast
        i. Long scale vs. short scale
    c. Spatial resolution/recorded detail
    d. Distortion
12. Digital imaging
    a. Analog vs. digital imaging
    b. Bit vs. byte
    c. Matrix
    d. Pixel vs. del
    e. Histogram
    f. Exposure indicators
    g. Noise
        i. Quantum mottle
        ii. Over-saturation
    h. Post-processing
        i. Windowing
            1. Window width (WW)
            2. Window level (WL)
        ii. Post-processing cropping
13. Digital imaging storing and processing
    a. DICOM
    b. MIMPS formally known as PACS
    c. HL7
    d. Health Insurance Portability and Accountability Act of 1996 (HIPAA)

## Resources

Carlton, R., and Adler, A., & Frank, E. (2020) *Principles of radiographic imaging, An art and a science (6th ed.)*, Cengage.

Carroll, Q. B. (2018) *Radiography in the digital age: Physics, exposure, radiation biology (3rd ed.)*, Charles C. Thomas, Publisher, Ltd.

Carroll, Q. B. (2019) *Digital radiography in practice*, Charles C. Thomas, Publisher, Ltd.

Bushong, S. C. (2021) *Radiologic science for technologists: Physics, biology, and protection (12th ed.)*, Elsevier.

Martensen, K. M. (2020) *Radiographic image analysis (5th ed.)*, Elsevier.

Fauber, T. (2020) *Radiographic imaging and exposure (6th ed.)*, Mosby.

**Resources Other**

1. American Registry of Radiologic Technologists. Radiographic Certification Handbook containing examination content specifications. www.arrt.org (http://www.arrt.org)
2. American Society of Radiologic Technologists. Radiography Curriculum. www.asrt.org (http://www.asrt.org)

Top of page

Key: 5304