PHYS-2250: RADIOGRAPHIC PHYSICS AND QUALITY CONTROL

Cuyahoga Community College

Viewing: PHYS-2250 : Radiographic Physics and Quality Control

Board of Trustees:
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Academic Term:
Fall 2023

Subject Code
PHYS - Physics

Course Number:
2250

Title:
Radiographic Physics and Quality Control

Catalog Description:
Course designed for Radiography program students. Basic introduction to college physics. Reviews basic mathematical operations needed for this course. Discusses energy, matter, Newtonian laws, atomic structure, electrostatic, electrodynamics, magnetism, electromagnetism that will lead to the study of x-ray generators, x-ray circuitry, and automatic exposure devices. Includes laboratory application of related physics experiments and the use of quality assurance testing tools to ensure radiographic quality control.

Credit Hour(s):
4

Lecture Hour(s):
3

Lab Hour(s):
2

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
RADT-1351 Image Acquisition and Evaluation, and departmental approval:
admission to Radiography program.

Outcomes

Course Outcome(s):
Apply concepts of matter and energy, atomic structure and methods of measurement to radiography.

Objective(s):

a. Discuss the characteristics of matter and energy.
b. Accurately locate elements on the periodic chart, and correctly read their atomic numbers and weights.
c. Compare work as it relates to force and distance.
d. Identify various forms of energy.
e. List the three systems of measurement.
f. Identify categories of mechanics such as mechanical, electrical, heat, and energy.
g. Calculate problems using fractions, decimals, exponents, and algebraic equations.
h. Convert values from British to Metric and back again.
i. Classify scientific methods, laws, and theories.

j. Analyze the physical concept of energy, force, and distance.
k. Define atomic structure.

Course Outcome(s):

Apply knowledge and principles of radioactivity.

Objective(s):

a. Describe the proper safe handling and disposal of radioactive materials.
b. Discuss the discovery of radioactivity.
c. Define radioactivity.
d. Differentiate between particulate vs. electromagnetic energy decay.
e. Define and calculate half-life of a radioactive isotope.

Course Outcome(s):

Apply knowledge of Automatic Exposure Control Devices.

Objective(s):

a. Explain why the art of AEC is the art of positioning.
b. Accurately identify configuration size, shape, and position for various brands of ionization chambers.
c. Explain how to modify image density/IR exposure, contrast, and time when using an automatic exposure control.
d. Describe various common subject density and subject contrast problems when using automatic exposure control devices.
e. Explain the importance of accurate collimation when using automatic exposure control devices.
f. Provide solutions to minimum response time and back-up time problems when using automatic exposure control devices.
g. Explain how to modify the suggested technical factors on an anatomically programmed control unit.
h. Discuss the use of creative positioning when using automatic exposure control devices.

Course Outcome(s):

Evaluate within a controlled laboratory enfiroment quality control and quality assurance tests that may be conducted in an active health care environment.

Objective(s):

a. Identify the need for quality management in diagnostic imaging.
b. Describe the process of identifying imaging requirements, developing equipment specifications, selecting equipment, installing and testing equipment, and training the technical staff.
c. Explain the objectives and responsibilities of monitoring equipment performance.
d. Explain primary quality control tests for tests for external radiation beam monitoring of diagnostic radiographic systems, flouroscopic systems tomographic systems, and automatic exposure controls.
e. List primary quality control tests for miscellaneous ancillary equipment, including image receptors, and computed radiography.
f. Explain maintenance procedures for Digital Imaging Receptors.
g. Describe various film artifacts related to digital imaging and methods to prevent them.
h. Evaluate the results of basic QC tests.

Course Outcome(s):

Display an effective image critique method.

Objective(s):

a. Discuss the elements of a diagnostic image as they relate to the art of film critique.
b. Identify the steps of the decision making process.
c. Describe an effective film critique method and the appropriate use of film critique method.
d. Use an effective film-critique method.
e. Explain the differences between technical factor problems, procedural factor problems, and equipment malfunctions.

f. Explain the rationale behind the data collection process and the basic analysis of a radiographic repeat-rate study.
g. Describe a basic troubleshooting procedure.

Course Outcome(s):

Correctly apply basic principles of electricity

Objective(s):

a. Explain the atomic nature of electricity.
b. State the elementary law of electrostatics.
c. Describe the methods of electrification.
d. Interpret the results of various electrostatic interactions.
e. Differentiate conductors from insulators.
f. Describe the basic factors of electrodynamics.
g. Calculate the effect of changes in voltage, amperage, and resistance according to Ohm's law.
h. Calculate voltage, amperage, and resistance in a simple series and parallel circuit.
i. List the four deciding factors that control resistance in a circuit.
j. Identify electrical hazards.
k. Identify units of electric current, electric potential, and electric power.

Course Outcome(s):

Accurately explain and diagram basic laws of electromagnetism

Objective(s):

a. Identify interactions between matter and magnetic fields.
b. State Fleming's hand rules of electromagnetics.
c. Explain how a solenoid and an electromagnet function.
d. Identify laws of magnetic and electromagnetic induction.
e. State the factors that regulate the strength of electromagnetic induction.
f. Differentiate between self-induction and mutual induction.
g. Illustrate the generator and motor principles.
h. Explain the waveform produced by direct and alternating current generators and motors.
i. Define Eddy currents.
j. Describe the function of a transformer.
k. Calculate voltage and amperage according to the Transformer Law.
l. Identify causes of transformer power losses.
m. Discuss various factors affecting transformer efficiency and construction.
n. Describe and explain the function of an autotransformer and a capacitor.
o. Relate Orsted, Lenz, and Faraday's experiments to electricity and magnetism.
p. Explain the function of a Rectifier.
q. Explain the waveforms that are produced by half-wave and full-wave rectification.
r. Identify the function of solid-state rectification.
s. Describe N-P junctions in solid-state rectifiers.

Course Outcome(s):

Examine, identify, describe, and explain the components of the x-ray circuit and x-ray tube.

Essential Learning Outcome Mapping:

Oral Communication: Demonstrate effective verbal and nonverbal communication for an intended audience that is clear, organized, and delivered effectively following the standard conventions of that language.

Objective(s):

a. Describe the incoming line current for various diagnostic equipment.
b. Describe the differences between single-phase, three-phase, and high frequency power.
c. Explain the functions of the basic components of the main and filament x-ray circuits.

d. Identify the voltage ripple associated with various high-voltage generators.
e. Discuss the importance of voltage ripple to x-ray quantity and quality.
f. Define the power rating of an x-ray imaging system.
g. Identify the components of diagnostic x-ray tubes.
h. Explain protocols used to extend x-ray tube life.
i. Relate the differences between single-phase, three-phase six and twelve-pulses, and high-frequency waveforms on generator output.
j. Describe the function of capacitor discharge and battery-operated mobile units.
k. Explain the function of a falling load generator.
l. Construct a model of an X-ray circuit, present, and explain the function of each component.
m. Compare three different timer types used in x-ray circuits, including Automatic Exposure Control (A.E.C.).
n. Differentiate phototimers from ionization chamber automatic exposure controls.
o. Explain the placement and function of a phototimer and ionization chamber automatic exposure control.
p. Describe potential problems that could be caused by minimum reaction times.
q. Justify the use of backup time when using automatic exposure controls.

Methods of Evaluation:

a. Class attendance and punctuality
b. Quizzes
c. Midterm examination
d. Final examination
e. Assessment of laboratory activities
f. Completion of assigned Corectec Online Registry Quizzes

Course Content Outline:

a. Matter and Energy
    i. Characteristics
    ii. Unit conversions
    iii. Scientific methods
    iv. Atomic structures
b. Electricity
    i. Electrostatics
    ii. Electrodynamics
    iii. Series and Parallel Electrical Circuits
c. Electromagnetism
    i. Magnetism
    ii. Controlling electrical current
    iii. Rectification
d. Radiographic equipment
    i. Types of x-ray equipment
    ii. Power for x-ray generation
    iii. Basic x-ray circuit
        1. Main circuit
        2. Filament Circuit
    iv. Radiographic Generators
    v. Automatic exposure controls
        1. Types
        2. Positioning considerations
e. Radioactivity
    i. History and discovery
    ii. Types of radioactive decay
    iii. Half-life
    iv. Decay formula
f. The art of automatic exposure control
    i. Ionization chambers
    ii. Positioning skills

g. Quality management
    i. Quality assurance and quality control
    ii. Monitoring equipment performance
    iii. Ancillary equipment
    iv. Repeat film studies
    v. Troubleshooting
    vi. Digital Imaging
    vii. Artificats
h. Establishing imaging standards
    i. Professional imaging standards
    ii. The analytical process
    iii. Acceptance limits
i. The art of Image critique
    i. Implementing imaging standards
    ii. Identifying an imaging problem
    iii. An effective image critique method
    iv. Applying the image critique method

Resources

Carlton, Balac & Adler. *Principles of Radiographic Imaging: an Art and Science* . 6th. Boston, MA: Cengage , 2020.

Jahami, Yasser. *Physics 2250 Workbook & QC Experiments Manual*. 6th. Parma, Ohio: Cuyahoga Community College, 2023.

Resources Other

a. American Registry of Radiologic Technologists Radiographic.Certification Examination Content Specifications. www.arrt.org
b. American Society of Radiologic Technologists Radiography Curriculum. www.asrt.org
c. Bushong, Stewart C. *Radiologic Science for Technologists*. 12th edition. Elsevier, 2021.
d. Papp, Jeffrey D. *Quality Management in the Imaging Sciences*. 6th. St. Louis, MO: Elsevier, 2018.
e. Clover Learning | Radiography Training Registry Exam Prep (https://cloverlearning.com/)

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