Course Name: Radiation Protection and Biology  
Course Number: RAD-850  
Course Department: Health Sciences - STEMM  
Course Term: SP  
Last Revised by Department: 4/2021  
Total Semester Hour(s) Credit: 3  
Total Contact Hours per Semester:  
Lecture: 45  Lab:  Clinical:  Internship/Practicum:  

Catalog Description: This is a one semester course which explores the history and biological effects of ionizing radiation. This course is designed for students who are pursuing a radiologic technology degree. Methods of radiation measurement detection and protection are discussed. This course will help students to gain knowledge radiation protection and biology and will help provide entry-level skills related specifically to radiologic technologist job duties while enhancing their overall knowledge when making important life decisions.

Pre-requisites and/or Co-requisites: RAD-510, RAD-770, RAD-896

Co-requisites: RAD-738 & RAD-570

Credit for Prior Learning: None

There are no Credit for Prior Learning opportunities for this course.


Access Code: N/A

Required Materials: Surface Go or an approved device, calculator, and folders/planner to organize notes and handouts

Suggested Materials: N/A

Course Fees: None
Institutional Outcomes:

Critical Thinking: The ability to dissect a multitude of incoming information, sorting the pertinent from the irrelevant, in order to analyze, evaluate, synthesize, or apply the information to a defendable conclusion.

Effective Communication: Information, thoughts, feelings, attitudes, or beliefs transferred either verbally or nonverbally through a medium in which the intended meaning is clearly and correctly understood by the recipient with the expectation of feedback.

Personal Responsibility: Initiative to consistently meet or exceed stated expectations over time.

Program Goals/Outcomes:

1. Demonstrate disciplinary competence and/or professional proficiency.
2. Develop critical thinking skills in planning priorities and providing safe patient care.
3. Utilize basic communication skills to foster working relationships with individuals, families, and members of the health team.
4. Practice within the profession’s ethical and legal framework.

Student Learning Outcomes:

1. Identify radiation types, production, sources, and doses, explaining the nature of ionizing radiation and how it is measured and monitored.
2. Understand cell biology and the effects radiation has on it. Recognize molecular and cellular radiation biology, identifying early and late radiation and how it can relate to genetics.
3. Describe radiation energy transfer, radiation effects, and radio sensitivity and response.
4. Define dose limits, equipment design, and management of radiation dose to the patient and the occupational worker during diagnostic x-ray procedures. Along with the units, detection and measurement of radiation.
5. Describe test material/equipment, test procedures, and evaluation/interpretation relation to quality assurance for components of the radiographic system.
6. Identify state and federal agencies, surveys, and radiology organizations involved with radiation protection and regulation.
7. Understand the need and objectives of a radiation protection plan and radiation safety officer.
8. Develop an understanding of the different personnel monitoring systems used in radiology departments, their applications, and how they monitor radiation. And the different managements of radiation doses to personnel and patients.
Objectives:

Unit 1: Chapter 1, 2, & 3

- Identify the consequences of ionization in human cells.
- Give examples of how radiologic technologists and radiologists can exercise control of radiant energy while performing imaging procedures.
- Discuss the concept of effective radiation protection.
- Discuss the need to safeguard against significant and continuing radiation exposure.
- Explain the justification and responsibility for imaging procedures.
- Explain how imaging professionals can help ensure that both occupational and non-occupational dose limits remain well below maximum allowable levels.
- State the ALARA principle and discuss its significance in diagnostic imaging.
- List the responsibilities that radiation workers must fulfill to maintain an effective radiation safety program.
- Describe the importance of patient education as it relates to medical imaging.
- Explain how radiographers should answer patients’ questions about the risk of radiation exposure from an imaging procedure and give some examples.
- List the different forms of electromagnetic and particulate radiations and identify those forms that are classified as ionizing radiation.
- List and describe three sources of natural background ionizing radiation and six sources or manmade, or artificial, ionizing radiation.
- Differentiate between peak kilovoltage (k-Vp) and milliampere-seconds (mAs) as technical exposure factors.
- Describe the process of absorption and explain the reason why absorbed dose in atoms of biologic matter should be kept as small as possible.
- Differentiate among primary radiation; exit, or image-formation, radiation; and scattered radiation.
- List two types of x-ray photon transmission and explain the difference between them.
- Discuss the way x-rays are produced and explain the range of energies present in the x-ray beam.
- List the events that occur when x-radiation passes through matter.
- Describe and illustrate by diagram the x-ray photon interactions with matter that are important in diagnostic radiology.
- Describe the impact of positive contrast media effects on photoelectric absorption and identify its effects regarding absorbed dose in the body structure that contains it.
- Describe the effect of kVp on radiographic image quality and patient absorbed dose.

Unit 2: Chapter 4 & 5

- Explain the concepts of skin erythema, tolerance dose and threshold dose.
• List 5 examples of short-term somatic effects and three examples of long term, or late somatic effects.
• Differentiate between somatic and genetic effects.
• Differentiate among the radiation’s quantities exposure, absorbed dose, equivalent dose, and effective dose and identify the appropriate symbol for each quantity.
• List and explain the International System (SI) and traditional units for radiation exposure, absorbed dose, equivalent dose, and effective dose.
• Describe the function of a tissue weighting factor.
• Given the numeric value for an absorbed dose of radiation state in gray (rad), the radiation weighting factor for the type of energy of radiation in question, and the tissue weighting factor, determine the effective dose.
• State the purpose of the radiation quantity collective effective dose and list its SI and traditional units.
• Explain the importance of linear energy transfer as it applies to biologic damage resulting from irradiation of human tissue.
• State the formula for determining equivalent dose.
• Determine the equivalent dose in terms of SI and traditional units when given the radiation weighting factor and the absorbed dose for different ionizing radiations.
• State the reason why a radiation worker should wear a personnel dosimeter and explain the function and characteristics of such devices.
• Identify the appropriate location on the body where the personnel dosimeter should be worn during following procedures or conditions; (1) routine computed radiography, digital radiography, or conventional radiographic procedures, (d) fluoroscopic procedures, (3) special radiographic procedures, (4) pregnancy.
• Describe the various components of the film badge, optically stimulated luminescence (OSL) dosimeter, pocket ionization chamber, and thermoluminescent dosimeter (TLD), and explain the use of each of these devices as personnel monitors.
• Explain the function of radiation survey instruments.
• List three gas-filled radiation survey instruments.
• Explain the purpose of the following instruments: (1) ionization chamber-type survey meter (cutie pie), (2) proportional counter, (3) Geiger-Muller (GM) detector.

Unit 3: Chapter 6
• Acquire basic knowledge of cell structure, composition, and function
• Describe some important functions of the major classes or organic and inorganic compounds that exist in the cell.
• List the essential functions of water in the human body.
• Name and describe a landmark event pertaining to the human genome that occurred in 2001.
• Describe the molecular structure of deoxyribonucleic acid and explain the way it functions in the cell.
• List the various cellular components, and identify their physical characteristics and functions
• Distinguish between the two types of cell division, mitosis and meiosis, and describe each process.

Unit 4: Chapter 7
• List three radiation energy transfer determinants and explain their individual concepts.
• Differentiate among the three levels of biologic damage that may occur in living systems as a result of exposure to ionizing radiation and describe how the process of direct and indirect action of ionizing radiation on the molecular structure of living systems occurs.
• Draw a diagram to illustrate the various effects of ionizing radiation on a DNA macromolecule, and describe the effects of ionizing chromosomes, various types of cells, and ultimately the entire human body.
• Describe the target theory
• Explain the purpose and function of survival curves for mammalian cells.
• List the factors that affect cell radiosensitivity.
• State and describe the law of Bergonie and Tribondeau

Unit 5: Chapter 8 & 9
• List four factors on which the amount of somatic and genetic biologic damage resulting from radiation exposure depend.
• List and describe the various early nonstochastic somatic effects of ionizing radiation on living systems.
• Describe acute radiation syndrome, and list three separate dose-related syndromes that occur as part of this total body syndrome.
• Identify and describe the four major response stages of acute radiation syndrome.
• Describe the local tissue damage that occurs when any part of the human body receives a high radiation exposure.
• List three factors on which organ and tissue response to radiation exposure depend.
• Discuss the impact on human skin when high-level fluoroscopy is used for extended periods of time during cardiovascular or therapeutic interventional procedures.
• Explain the progression of both male and female germ cells from elementary stem cells to mature cells and describe how this development affects cell radio sensitivity.
• State the dose of ionizing radiation necessary to cause both temporary and permanent sterility in the human and male female.
• Discuss the impact on the human body if radiation exposure causes a decrease in the cells that protect it against disease.
• Explain how scientists use epidemiologic studies to predict the risk of cancer in human populations exposed to low doses of ionizing radiation.
Explain the purpose of a radiation dose-response curve.
Explain why regulatory agencies continue to use the linear dose-response model for establishing radiation protection standards.
Differentiate between threshold and non-threshold relationships. List and describe the various late nonstochastic somatic effects and late stochastic somatic effects of ionizing radiation on living systems.
Explain how spontaneous mutations occur and discuss the concept of radiation-induced genetic effects; also explain how ionizing radiation causes these effects and how they can be passed onto future generations.
Differentiate between dominant and recessive gene mutations.
Explain the doubling dose concept and give an example of how the number of mutations increases as dose increases.

Unit 6: Chapter 10
List and describe the function of the four major organizations that share the responsibility for evaluation the relationship between radiation equivalent dose and induced biologic effects and five U.S. regulatory agencies responsible for enforcing established radiation effective dose limiting standards.
Explain the function of the radiation safety committee (RSC) in a medical facility and describe the role of the radiation safety officer (RSO) by listing the various responsibilities he or she must fulfill.
Explain the ALARA concept
Describe current radiation protection philosophy and state the goal and objectives of radiation protection.
Identify radiation-induced responses that warrant serious concern for radiation protection.
Describe effective dose limit and the effective dose-limiting system.
Discuss current National Council on Radiation Protection and Measurements recommendations.
Given appropriate data, calculate the cumulative effective dose for the whole body for a radiation worker.
Explain the function of collective effective dose, and list the unit used to express this quantity.
Explain the concept of radiation hormesis.
State the following in terms of International System (SI) units and traditional units:
- Annual occupational effective dose limit and cumulative effective dose limit for whole-body exposure
- Annual occupational equivalent dose limits for tissues and organs such as lens of the eye, skin, hands, and feet
- Annual effective dose limits for continuous (or frequent) exposure and for infrequent exposure of the general public
- Annual equivalent dose limits for tissues and organs such as lens of the eye, skin, hands, and feel of members of the general public.
- Annual effective dose limit for an occupationally exposed student under the age of 18 years.
- Occupational monthly equivalent dose limit to the embryo-fetus.

Unit 7: Chapter 11

- Explain the requirements for diagnostic type protective tube housing, x-ray control panel, radiographic examination table, and source-to-image distance indicator, and discuss their purpose.
- List the various x-ray beam limiting devices, and describe each.
- Explain the importance of luminance of the collimator light source, state the requirements for good coincidence between the radiographic variable rectangular collimator is used, and explain the function of the collimator’s positive beam limitation (PBL) feature.
- Explain the function of x-ray beam filtration in diagnostic radiology, list two types of filtration used to adequately filter the beam, describe half-value layer (HVL), and give examples of HVL’s required for selective peak kilovoltage.
- Explain the function of a compensating filter in radiography of a body part that varies in thickness, and list two types of such filters.
- Explain the significance of exposure reproducibility and exposure linearity.
- Explain how the use to high-speed screen film combinations reduces radiographic exposure of the patient when film is the image receptor of choice.
- Explain how radiographic grids increase patient dose.
- Identify the minimal source-skin distance (SSD) that must be used for mobile.
- Explain the process of digital radiography and computed radiography.
- Explain how patient exposure may be reduced during routine fluoroscopic procedures, C-arm fluoroscopic procedures, high-dose (high-level-control (HLC)) fluoroscopy interventional procedures, cineradiography procedures, and digital fluoroscopic procedures.

Unit 8: Chapter 12, 13, 14, & 15

- Explain the meaning of holistic approach to patient care, and recognize the need for effective communication between imaging department personnel and the patient.
- Explain how voluntary motion can be eliminated or at least minimized and how involuntary motion can be compensated for during a diagnostic radiographic procedure.
- Explain the need for protective shielding during diagnostic imaging procedures, state the reason for using gonadal shielding or other specific area shielding, and compare the various types of shields available for use.
- Discuss the need to use appropriate radiographic technical exposure factors for all radiologic procedures, and explain how these factors may be adjusted to reduce patient dose.
- Explain how adequate immobilization and correct image processing techniques reduce radiographic exposure of the patient.
Compare the use of an air gap technique for certain examinations such as a cross-table lateral projection of the cervical spine with the use of a mid-ratio grid (8:1).

State the reason for reducing the number of repeat images, and describe the benefits of repeat analysis programs.

List six nonessential radiologic examinations, and explain the reason why each is considered unnecessary.

List four ways to indicate the amount of radiation received by a patient from diagnostic imaging procedures, and explain each.

Explain the concept of genetically significant dose (GSD).

Explain the reason children require special conventional diagnostic imaging procedures.

Describe special precautions employed in radiography to protect the pregnant or potentially pregnant patient during an x-ray examination.

Identify the type of x-radiation that poses the greatest occupational hazard in diagnostic radiology, and explain the various ways this hazard can be reduced or eliminated.

Explain how the various methods and techniques that reduce patient exposure during a diagnostic examination also reduce exposure for the radiographer and other diagnostic personnel.

Discuss the responsibilities of the employer for protecting declared pregnant diagnostic imaging personnel from radiation exposure.

List and explain the three basic principles of radiation protection that can be used for personnel exposure reduction.

State and explain the inverse square law by solving mathematical problems applying its concept.

Explain the purpose of diagnostic-type protective tube housing, differentiate between a primary and secondary protective barrier, and list examples of each.

Describe the construction of protective structural shielding, and list the factors that govern the selection of appropriate construction materials.

List and describe the protective garments that may be worn to reduce whole- or partial-body exposure.

Explain the various methods and devices that may be used to reduce exposure for personnel during routine fluoroscopic examinations and during interventional procedures that use high-level-control fluoroscopy.

Explain the various methods and devices that may be used to reduce the radiographer’s exposure during a mobile radiographic examination.

Describe methods used to provide patient restraint during a diagnostic x-ray procedure, and identify individuals who might use them.

List the three categories of radiation sources that may be generated in an x-ray room; list the considerations on which the design of radiant-absorbent barriers should be based; and explain the importance of each.

Differentiate between a controlled area and an uncontrolled area.

Discuss the requirements for posting caution signs for radioactive materials and radiation areas.
College Procedures: All college-wide procedures are located in the Iowa Central Community College Student Handbook.

Assessments: Reading, challenge questions, workbook assignments, in class activities, presentations, worksheets, quizzes, tests, exams.

Please note that assessments are subject to change

Non-discrimination Statement:

It is the policy of the Iowa Central Community College not to discriminate in its programs, activities, or employment on the basis of race, color, national origin, sex, disability, age, sexual orientation, gender identity, creed, religion, and actual or potential family, parental, or marital status.

If you have questions or complaints related to compliance with this policy, please contact Stacy Ihrig, Human Resources, 515-574-1138, ihrig@iowacentral.edu, or the Director of the Office for Civil Rights U.S. Department of Education, Citigroup Center, 500 W. Madison Street, Suite 1475, Chicago, IL 60661-7204, Telephone: (312) 730-1560 Facsimile: (312) 730-1576, Email: OCR.Chicago@ed.gov.

Disability/Accommodation Services:

If you have a request for an accommodation based on the impact of a disability, it is Iowa Central’s policy that you contact the Academic Assistance & Accommodations Coordinator to discuss your specific needs and to provide supporting information and documentation, so we may determine appropriate accommodations. The office for accommodations is located in the Academic Resource Center, and it can be reached by calling 515-574-1045. For online information about accommodations, please go to www.iowacentral.edu/accommodations.

Bias-Free Classroom Statement:

Lindsay Heffernan maintains high standards of respect in regard to individual beliefs and values when selecting classroom materials including textbooks, project activities, power points, videos, presentations, and classroom discussions.

It is our belief that all people have the right to obtain an education within our department/program courses free of bias, with full respect demonstrated to all who enroll in the courses of this department/program.
External Accreditation: The Iowa Central Community College Radiology Program is accredited by the Joint Review Committee on Education in Radiologic Technology (JRCERT).

Contact information for JRCERT: 20 N. Wacker Drive, Suite 2850 Chicago, IL 60606-3182 Phone 312-704-5300 Fax 312-704-5304 Website www.jrcert.org E-mail mail@jrcert.org