Course Abstract

If you need accommodations due to a disability, contact Disability Services in Edison Hall Room 100, 732.906.2546.

To foster a productive learning environment, the College requires that all students adhere to the Code of Student Conduct which is published in the college catalog and website.

Course ID and Name: RAD 171- Radiographic Imaging and Science I

Department: Radiography Education
Chairperson or Course Coordinator: K. Krapels
Office Location: LH 108
E-mail Address: KKrapels@middlesexcc.edu
Telephone: 732-548-6000 ext. 3336

Prerequisites: None **Co-requisites:** RAD 190, 141, 142, 128

Course Description: This first part of a three-part course is designed to introduce the student to the basic concepts and practices in radiation protection and image production. Content covered includes x-ray production, the x-ray tube, filtration, technical factor selection, interactions of x-rays with matter, beam restriction, grids, and an introduction to image receptors.

General Education Status:

Credits: 4 **Lecture Hours: 4** **Lab Hours: 0**

Learning Outcomes:

1. Identify the components of the x-ray tube, describe their use/function and explain the production of radiation.
2. Identify basic concepts and practices of radiation protection and apply the Inverse Square Law to radiation exposure.
3. Identify devices utilized to improve image quality and/or reduce patient dose.
4. Explain the use of kVp, mAs, and distance and calculate for various changes as required to produce a quality diagnostic medical image.
5. Describe interactions of x-radiation with matter and the process of attenuation.
6. Describe the process of image formation and the basics of various image receptors.

Course Content Areas:

1. Radiation Concepts
2. The X-Ray Tube
3. X-Radiation Production
4. Introduction to Radiation Protection
5. Filtration
6. Technical Factor Selection

7. Interactions of X-Radiation with Matter
8. Beam Restriction
9. Attenuation
10. The Grid
11. Image Receptors

Textbook Requirement:

Principles of Radiographic Imaging: An Art and a Science, 6th Edition
Cengage Publishing 2018. Richard Carlton, Arlene Alder and Vesna Balac.
ISBN-13: 978-1-337-71106-7 www.cengage.com

Clover Leaf Rad Tech Boot Camp- 14- month subscription. The access code must be purchased from the bookstore.

Grading Standard:

A	**94-100**
A-	**90-93.99**
B+	**88-89.99**
B	**84-87.99**
B-	**80-83.99**
C+	**78-79.99**
C	**75-77.99**
D	**70-74.99**
F	**<70**

Success Criteria:

The student must earn a minimum course grade of "C" (75%) or higher in order to continue in sequencing of radiography courses. The following course grade distribution will be utilized:

Homework/Class Assignments	20%
Quizzes	30%
Mid-term Examination	20%
Final Examination	30%
	Total- 100%

Program Policy and Regulation Compliance:

- Students are expected to attend all classes.
- Any student found cheating or plagiarizing will, at minimum, receive a grade of zero for that test or assignment. The instructor reserves the right to fail the student for the course and/or pursue further action including the enforcement of the "Code of Student Conduct."

Students are encouraged to become familiar with the "Code of Student Conduct" as described in the College Catalog- **http://www.middlesexcc.edu/registrar/images/cosc.pdf**. Cheating and/or plagiarism will not be condoned and will result in a course grade of "F".

- Assignments are due on the date specified by the instructor. Late assignments will receive a grade penalty.
- No make-up tests or quizzes will be given. If you arrive late for a test/quiz, no extra time will be given.
- Quizzes on Respondus Lockdown and Monitor are moderated. If you are having difficulty accesses the quiz, please contact me via email or Remind ASAP.
- During a Respondus quiz you must not access other resources (a phone, tablet, notes, books, etc.) or communicate with others. Please stay in your seat and focus on the computer screen until the quiz is complete. If an interruption occurs, briefly explain what happened by speaking directly to your webcam. And finally, remember that you cannot exit the quiz until all questions are completed and submitted for grading. Do not share any content with your classmates. If you have technical questions about anything mentioned above, please don't hesitate to submit a ticket at https://support.respondus.comLinks to an external site.
- All lecture sessions will be live-remote via Canvas or Zoom. Canvas lecture recordings will only available for a maximum of two weeks after the live-remote session. You are expected to have an updated laptop or tablet, with a webcam.
- **All on-line quizzes will auto-launch** – If a quiz or test requires the use of LockDown Browser, it will automatically launch from your regular browser session. At the end of the quiz, LockDown Browser will close, allowing you to continue with your standard browser. **To be clear, the LockDown Browser application must first be installed to the computer or device.** But once installed, it will automatically launch (and close) as needed.
- Zoom or Canvas etiquette: Here are five easy-to-follow rules to ensure you are making the best virtual impression.
    - **Clothing is NOT optional.** Remember that even though you may be alone at home, your professor and classmates can SEE you!
    - **Be aware of your surroundings.** Your professor and classmates can also see BEHIND you. Let your family, partner, or roommate know you are in a live class session using your webcam.
    - **Mute is your friend.** Once you log in to the virtual classroom, be sure to mute your microphone (lower left-hand corner). This will help to eliminate background noise that could distract others.
    - **Raise your hand and wait to be called upon.** If you wish to speak, use the "Raise Hand" button at the center of the bottom of your screen when using Zoom. Once the professor calls on you, unmute yourself and begin speaking. When you have finished speaking, indicate you are done by saying something like "That's all" or "Thank you" and then mute your microphone again. When using Canvas you will need to interrupt me to ask your question since the chat box is not always visible when the screen is enlarged.
    - **If you don't have anything nice to say…**The Zoom and Canvas chat feature is a tool to make comments and ask questions without interrupting the speaker but be

aware that your comments are public and are recorded in the minutes of the session.

Student Class Absence Due to Covid-19-related Illness

- If you need to miss a class due to COVID-19-related illness, you are responsible for contacting your instructor to let them know of the need as soon as possible.
- You are responsible for completing any work that you might miss due to COVID-19-related illness, including assignments, quizzes, tests, and exams.
- If you might need to miss more than two consecutive weeks of classes in any one semester due to COVID-19-related illness, you must contact the Dean of the Division of your major (Dr. Theresa Orosz, TOrosz@middlesexcc.edu, Liberal Arts Division; Dr. Donna Howell (DHowell@middlesexcc.edu) Business, STEM, and Health Professions Division). You may be required to provide a doctor's note of explanation. The Dean will communicate the receipt of the note (with expected end date) to the relevant faculty.

General Course Objectives:

Radiation Concepts

1. Differentiate between matter and energy.
2. Explain the basic concepts of atomic theory.
3. Define x-radiation.
4. Differentiate between the radiations along the electromagnetic spectrum.
5. Describe the wave/particle duality of x-radiation.
6. Discuss the discovery of x-radiation.
7. Identify the characteristic properties of x-radiation

The X-ray Tube

8. List the parts of an x-ray tube.
9. Describe the characteristics and functions of the components of the x-ray tube.
10. Describe the control of thermionic emission from the filament.
11. Explain the line-focus principle and its effect on anode target design.
12. Discuss the term focal spot.
13. Explain the production of off-focus (extra-focal) radiation and its effect on the radiographic image.
14. Describe the anode heel effect.
15. Calculate safe exposures when provided with a tube rating chart, anode cooling curve, and housing cooling curve.
16. Define spatial resolution.
17. Describe the relationship between focal spot size and spatial resolution.
18. Discuss recommendations for extending tube life.

X-ray Production

19. State the percentage of energy that is converted to x-ray photon energy in the x-ray tube.
20. Describe a bremsstrahlung target interaction.
21. Describe a characteristic target interaction.
22. Identify factors affecting characteristic K-shell photon production.
23. Explain the shape of the x-ray photon emission spectrum curve.

Introduction to Radiation Protection

24. Describe the nature of ionizing radiation.
25. Describe the sources and magnitude of ionizing radiation exposure.
26. Define the quantities and units relevant to radiation protection.
27. Compare traditional units to SI units.
28. Describe the most common types of personnel monitoring devices.
29. Explain basic principles for reducing exposure to radiation.
30. Describe the ALARA concept.
31. Explain the concept of dose-equivalent limits related to the use of x-radiation.
32. List effective dose limit recommendations as put forth in NCRP report No. 116.
33. Describe techniques/devices used to minimize radiation exposure to patients and personnel.
34. Discuss the precautions that should be taken to minimize potential fetal exposures.
35. List the shielding requirements for patients and personnel for diagnostic x-ray ranges.
36. Apply the "Inverse Square Law" to radiation exposure.

Filtration

37. Define filtration.
38. Differentiate between inherent filtration, added filtration, and total filtration.
39. Describe compensating filtration.
40. Describe compound filtration.
41. Explain the concept of half-value layer equivalency measurements of filtration.
42. List the recommended minimum total filtration levels by the NCRP.
43. Discuss the effect of filtration on patient dose.
44. Describe the effect of filtration on the average beam energy.
45. Describe the effect of filtration on the radiographic image quality.
46. Calculate the Half Value Layer for a given set of problems.

Technical Factor Selection

47. Define milliamperage and milliamperage-second (mAs).
48. Differentiate between receptor exposure and x-ray emission.
49. Explain the relationships between milliamperage, exposure time, mAs and x-ray emission.
50. Discuss the exposure index (IE) and identify its relationship with exposure values used.
51. State the reciprocity law.
52. Calculate mAs when given mA and exposure time, mA when given mAs and exposure time, and exposure time when given mAs and mA.
53. Identify the relationship between mAs and radiographic film receptor exposure.
54. Define Kilovoltage Peak (kVp).
55. Explain the relationship between kVp, x-ray emission, and receptor exposure.
56. Define subject contrast.
57. Explain the relationship between kVp and subject contrast.
58. State the 15% Rule and calculate the new kVp value needed to maintain receptor exposure when changes are made in mAs.
59. Differentiate between receptor contrast and subject contrast.
60. Differentiate between short scale (high) and long scale (low) contrast.
61. Describe source-to image-distance (SID), source-to-object-distance (SOD) object-to-image-distance (OID).
62. Describe the relationship between distance (SID) and receptor exposure.

63. Analyze sets of technical factors to determine receptor exposure.
64. Calculate x-ray emission (mR) when distance is changed using the inverse square law.
65. Calculate the mAs need to maintain receptor exposure when changes are made in distance (SID) using the exposure maintenance formula.
66. Describe the relationship between distance (SID, SOD and OID) to receptor exposure.
67. Describe the basic function of Automatic Exposure Controls (AEC).

Interactions of X-Radiation with Matter

68. Define attenuation.
69. Explain the interaction between x-rays and matter during a photoelectric absorption interaction.
70. Explain the interaction between x-rays and matter during a Compton scattering interaction.
71. Explain the interaction between x-rays and matter during a coherent scattering interaction.
72. Explain the interaction between x-rays and matter during a pair production interaction.
73. Discuss the two interactions that have an impact on the x-ray image.
74. Describe the relationship between x-ray interactions and technical factor selection.
75. Describe the relationship between x-ray interactions and image quality.
76. Describe the relationship between x-ray interactions and patient dose.

Beam Restriction

77. Identify the factors that affect the amount of scatter radiation produced
78. Discuss the primary methods used by radiographers to control scatter radiation.
79. Explain the purpose and construction of the collimator.
80. Identify the purpose of each set of shutters.
81. Describe the effect of beam restriction on image quality.
82. Describe the effect of beam restriction on patient dose.
83. Describe the procedure used to determine light field to radiation field alignment.
84. Discuss positive beam limitation (PBL).
85. Discuss various beam restricting devices used in the past.

Attenuation

86. Explain the process of attenuation.
87. Describe the basic composition of the human body.
88. Describe the effect of the human body on the attenuation of the x-ray beam.
89. Describe differential absorption.
90. Explain the patient's relationship to image quality.
91. Discuss how pathology can affect attenuation.

The Grid

92. Describe the purpose of the grid.
93. Explain the construction of a grid.
94. Define grid ratio.
95. Define grid frequency.
96. Describe the various grid patterns.
97. Differentiate between parallel and focused grids.
98. Differentiate between the uses of a stationary and a moving grid.
99. Explain the process of grid selection for specific radiographic procedures.
100. Calculate the changes in technical factors to compensate for changes in grid selection.

101. Describe methods for evaluating the performance of a grid.
102. Discuss common grid errors.
103. Describe the Air-Gap technique.
104. Discuss the use of grids with digital image receptors.
105. Discuss virtual grids (grid replacement software).
106. Describe the effect of grids on image quality.
107. Describe the effect of a traditional grid on patient dose.

Image Receptors

108. Differentiate between CR, DR and film screen imaging systems.
109. Describe the history and use of radiographic film, intensifying screens, chemical processing and sensitometry.
110. Describe the CR imaging process.
111. Describe the construction and characteristics of the photostimulable imaging plate
112. Describe CR latent image formation
113. Explain the process of photostimulable imaging plate.
114. Describe the two steps involved in CR image processing.
115. Discuss the impact of technical factors on CR image quality.
116. Discuss the various types of digital radiography (DR) imaging systems.
117. Describe the process of digital image data formation.
118. Describe the types of digital image processing operations.
119. Describe the process by which the histogram is acquired and the look-up table (LUT) is applied to the collected data.
120. Explain the function of the digital image window level and window width controls.
121. Describe the factors that affect digital image quality.
122. Explain how exposure indicators can be used as a quality control tool for image quality and radiation protection.

DATE AGENDA

SEE SEPARATE AGENDA WITH DATES!
-Subject to change

Week #1	Orientation Chapter #2: Radiation Concepts
Week #2	Chapter #5: The X-Ray Tube
Week #3	Chapter #5: The X-Ray Tube –Continued Heat Units, Tube Rating Charts and Anode Cooling Curves
Week #4	Chapter #8: X-Ray Production
Week #5	Chapter #9: Radiation Concepts and Equipment
Week #6	Chapter #10: Radiation Protection for Patients and Personnel

Week #7	Chapter #11: Filtration Half Value Layer Calculations
Week #8	**Mid-Term exam** Chapter #12: The Prime Factors
Week #9	Chapter #12: The Prime Factors Calculate mAs & the Law of Reciprocity
	Calculations using the Exposure Maintenance Formula An Overview of Manual & Automatic Exposure Control (AEC)
Week #10	Chapter #13: X-ray Interactions
Week #11	Chapter #14- Minimizing Patient Exposure Chapter #15: Beam Restriction
Week #12	Chapter #17: Attenuation-The Patient as a Beam Emitter. Chapter #18: The Grid
Week #13	Chapter #18: The Grid-Continued Grid Errors & Calculations
	Imaging Receptors-An Overview of Film/Screen, Computed Radiography (CR), & Digital Radiography (DR).
Week #14	Chapter #20: Digital Imaging Processing
	Chapter #21: Computed Radiography
Week #15	Review
	Final Examination!