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-275, Radiographic Physics and Equipment Maintenance

Department: Radiography
Chairperson or Course Coordinator: J. Ferrell
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Prerequisites: RAD 145,146,172,220

Co-requisites: RAD 230, 247,248

Course Description: Radiographic Physics and Equipment Maintenance is designed to build upon previous objectives in Radiographic Imaging and science I & II and introduce additional concepts and practices in the physics of equipment operation and maintenance and as well as digital and analog image production and evaluation. Topics discussed include basic principles of physics, physics of radiographic equipment, advanced circuit theory, radiographic quality control, digital x-ray imaging, physics of mammography and bone densitometry,

General Education Status: N/A

Credits: 3 **Lecture Hours: 2** **Lab Hours: 2** **Clinical Hours: 0**

Learning Outcomes:

Upon successful completion of the course and lab, students will be able to:

1. Apply knowledge and perform the principles of Radiological Quality Management.

2. Discuss the Basic Physical Principles / Application to Radiographic Equipment.

3. Describe and explain Advanced Circuit Theory.

4. Have a working knowledge of Quality Control.

5. Discuss the principles related to the Technical Aspects of Mammography.

6. Apply a working knowledge of Digital X-ray Imaging.

7. Have a understanding of PACs.

8. Discuss the basic principles and theory of Bone Densitometry.

9. X-ray production a. source of free electrons (e.g., thermionic emission) b. acceleration of electrons c. focusing of electrons d. deceleration of electrons

10. Target interactions a. bremsstrahlung b. characteristic

11. X-ray beam a. frequency and wavelength b. beam characteristics 1. quality 2. quantity 3. primary versus remnant (exit) c. inverse square law d. fundamental properties (e.g., travel in straight lines, ionize matter)

12. Photon interactions with matter a. Compton effect b. photoelectric absorption c. coherent (classical) scatter d. attenuation by various tissues 1. thickness of body part 2. type of tissue (at atomic number).

13. Minimizing Patient Exposure 1. exposure factors a. kVp b. mAs c. automatic exposure control (AEC) 2. shielding a. rationale for use b. types c. placement 3. beam restriction a. purpose of primary beam restriction b. types (e.g., collimators) 4. filtration a. effect on exposure b. effect on average beam energy.

14. Image Acquisition and Technical Evaluation. Selection of Technical Factors Affecting Radiographic Quality.

15. Technique Charts 1. anatomically programmed technique 2. caliper measurement 3. fixed versus variable kVp.

16. Automatic Exposure Control (AEC) 1. effects of changing exposure factors on radiographic quality 2. detector selection 3. anatomic alignment 4. exposure adjustment (e.g., density, +1 or –1).

17. Digital Imaging Characteristics 1. spatial resolution (equipment related) a. pixel characteristics (e.g., size, pitch) b. detector element (DEL) (e.g., size, pitch, fill factor). c. matrix size d. sampling frequency.

18. Contrast resolution (equipment related) a. bit depth b. modulation transfer function (MTF) c. detective quantum efficiency (DQE).

19. Image signal (exposure related) a. dynamic range b. quantum noise (quantum mottle) c. signal to noise ratio (SNR) d. contrast to noise ratio (CNR).

20. Image Identification 1. methods (e.g., radiographic, electronic) 2. legal considerations (e.g., patient data, examination data).

21. Imaging equipment and components of radiographic unit (fixed or mobile): a. operating console b. x-ray tube construction 1. electron source 2. target materials 3. induction motor c. automatic exposure control (AEC) 1. radiation detectors 2. back-up timer 3. exposure adjustment (e.g., density, +1 or –1) 4. minimum response time d. manual exposure controls and beam restriction.

22. X-ray generator, transformers and rectification system a. basic principles b. phase, pulse and frequency c. tube loading.

23. Components of fluoroscopic unit (fixed or mobile) a. image receptors 1. image intensifier, flat panel b. viewing systems c. recording systems d. automatic exposure rate control (AERC) e. magnification mode.

24. Components of digital imaging a. CR components 1. plate (e.g., photo-stimulable phosphor (PSP)) 2. plate reader b. DR image receptors 1. flat panel 2. charge coupled device (CCD) 3. complementary metal oxide semiconductor (CMOS).

25. Image Processing and Display 1. raw data (pre-processing) a. analog-to-digital converter (ADC) b. quantization c. corrections (e.g., rescaling, flat fielding, dead pixel correction) d. histogram.

26. Corrected data for processing a. grayscale b. edge enhancement c. equalization d. smoothing.

27. Data for display a. values of interest (VOI) b. look-up table (LUT).

28. Post-processing a. brightness b. contrast c. region of interest (ROI) d. electronic cropping or masking e. stitching.

29. Display monitors a. viewing conditions (e.g., viewing angle, ambient lighting) b. spatial resolution (e.g., pixel size, pixel pitch) c. brightness and contrast.

30. Imaging informatics a. DICOM b. PACS c. RIS (modality work list) d. HIS e. EMR or EHR.

31. Criteria for Image Evaluation of Technical Factors 1. exposure indicator 2. quantum noise (quantum mottle) 3. gross exposure error (e.g., loss of contrast, saturation) 4. contrast 5. spatial resolution 6. distortion (e.g., size, shape) 7. identification markers (e.g., anatomical side, patient, date) 8. image artifacts 9. radiation fog.

32. Quality Control of Imaging Equipment and Accessories: 1. beam restriction a. light field to radiation field alignment b. central ray alignment 2. recognition and reporting of malfunctions 3. digital imaging receptor systems a. maintenance (e.g., detector calibration, plate reader calibration) b. QC tests (e.g., erasure

thoroughness, plate uniformity, spatial resolution) c. display monitor quality assurance (e.g., grayscale standard display function, luminance).

33. Shielding accessories (e.g., lead apron, glove testing).

Course Content Area:

At the end of each lecture, class discussion and reading assignment, the student will define each topic objective outlined in the course syllabus.

1. Introduction to Quality Management
2. Implementation of QM and QC procedures in a Lab.
3. Basic Physical Principles / Application to Radiographic Equipment
4. Advanced Circuit Theory
5. Quality Control
6. Review of Digital X-ray Imaging (Essentials of Digital Imaging)
7. Technical Aspects of Mammography
8. Introduction to Bone Densitometry

Textbooks/On-line:

Principles of Radiographic Imaging, 5rd edition, Carlton/Adler, Delmar 2013, ISBN 13-978-1-4390-5872-5

Compliance Guidance for RADIOGRAPHIC QUALITY CONTROL, NJDEP, 4th Edition, 5/1/03 (Provided)

Essentials of Digital Imaging: 7 Modules (ASRT, 2017, MCC provided on Canvas)

Code of Student Conduct:

- All students must abide by the Code of Student Conduct. 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."
  http://www.middlesexcc.edu/registrar/images/ cosc.pdf

General Course Objectives:

1. Students will have a basic understanding of Radiographic Quality Management.
2. Be capable of implementation and performance of QM and QC procedures in a Lab.
3. Have an understanding of Basic Physical Principles with an Application to Radiographic Equipment.
4. Understand Radiographic Advanced Circuit Theory.
5. Understand the legal and manufacturers Quality Control requirements.
6. Have a basic understanding of Digital X-ray Imaging, (ASRT Essentials of Digital Imaging).
7. Have a basic understanding of the Technical Aspects of Mammography.
8. Understand the concept of Bone Densitometry and perform a basic sonographic procedure.

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:

Mid-term…… 20%
Digital Imaging /Assignments……..……..20%
Laboratory Experience/QC Manual.....25%
Homework/Assignments…….....15%
Final……..…..20%

STUDENTS ARE EXPECTED TO **ATTEND ALL CLASSES and LABS**. FAILURE TO DO SO WILL RESULT IN A GRADE OF "O" FOR ANY WORK MISSED DURING THE CLASS PERIOD (INCLUDING TESTS, QUIZZES and experiments).

STUDENTS EARNING BELOW A "C" GRADE IN THIS COURSE WILL NOT BE PERMITTED TO ADVANCE TO CONSECUTIVE "RAD" COURSES.

ANY STUDENT HAVING SPECIAL NEEDS THAT MAY AFFECT PERFORMANCE IN THIS CLASS SHOULD FEEL FREE TO TALK WITH THE INSTRUCTOR ABOUT SPECIAL SUPPORT SERVICES EITHER AFTER CLASS OR DURING HER / HIS OFFICE HOURS.

ANY STUDENT FOUND VIOLATING THE "CODE OF STUDENT CONDUCT" BY **CHEATING** WILL BE GIVEN A GRADE OF "O" FOR THE ASSIGNMENT. IF THE VIOLATIONS CONTINUE, SANCTIONS WILL BE APPLIED ACCORDING TO THE "CODE OF STUDENT CONDUCT" (SEE COLLEGE CATALOG).

Agenda:

WEEK	TOPIC
Week 1	Introduction and Physics Review
Week 2	Quality Management/Control
Week 3	Basic Radiographic Physics
Week 4	Radiographic Circuitry
Week 5	Advanced Radiographic Circuitry
Week 6	Test and Introduction to: **Essentials of Digital Imaging**
Week 7	Processing
Week 8	Display
Week 9	Image Analysis
Week 10	PACS
Week 11	Dose reduction and patient safety
Week 12	Quality
Week 13	Bone Densitometry, and Technical Aspects of Mammography
Week 14	Review
Week 15	Final Exam (or Specially Scheduled Final Examinations)