



A POLYTECHNIC INSTITUTION

School of Health Sciences

Program: Medical Radiography

Option:

MRAD 3322**Image Recording, Equipment and Quality Control****Start Date:** January, 2003**End Date:** April, 2003**Total Hours:** 33 **Total Weeks:** 14**Term/Level:** 3 **Course Credits:** 3**Hours/Week:** 2 **Lecture:** **Lab:****Shop:** **Seminar:** **Other:****Prerequisites****MRAD 3322 is a Prerequisite for:****Course No. Course Name****Course No. Course Name**MRAD 2222 Image Recording, Equipment and
Quality Control

None.

■ Course Description

This course is divided into two parts. Part A will explore the fundamental physical principles of mammography, mobile x-ray imaging systems, and outline the essential concepts and procedures of quality assurance/quality control in diagnostic radiology. Part B will describe the elements of digital imaging in radiology. Specifically, digital image acquisition technologies such as computed radiography (CR), digital radiography (DR), digital fluoroscopy, and digital mammography will be described followed by a discussion of laser film digitizers and laser imagers. Additionally, the principles of CT and MRI will be described. Finally, the course will explain the nature and technology of picture archiving and communications systems (PACS) and teleradiology as well as present an overview of the characteristics of integrated medical imaging including enterprise-wide distribution of medical images.

■ Detailed Course Description

- To outline the fundamental physical principles and instrumentation concepts of x-ray mammography, mobile imaging systems, and elements of quality assurance/quality control for diagnostic radiology.
- To outline the essential elements of digital image acquisition systems, PACS, teleradiology, and integrated digital imaging in diagnostic radiology.

■ Evaluation

Laboratory	10%
Project (Article Summary)	10%
Midterm Exam	30%
Final Exam	50%
TOTAL	100%

Comments:

- A grade of 60% is required to pass this course.
- The final examination is cumulative and is based on the entire course.

■ Course Learning Outcomes/Competencies

Upon successful completion, the student will be able to:

1. Describe the major features of mobile radiographic and fluoroscopic imaging systems.
2. Outline the characteristics of x-ray mammography imaging systems.
3. Differentiate between the terms quality assurance (QA) and quality control (QC) and list the advantages of a continuous quality improvement (CQI) program in diagnostic radiology.
4. Describe the elements of QC in terms of:
 - a. equipment for QC
 - b. parameters for QC monitoring
 - c. QC test procedures
 - d. image quality standards
 - e. tolerance limits
 - f. error correction
5. Describe the following QC tests for radiographic imaging systems:
 - a. level accuracy, section thickness in conventional tomography
 - b. collimator test
 - c. focal spot assessment
 - d. screen-film contact test
 - e. automatic exposure control (AEC)
 - f. inspection procedures for radiographic equipment
6. Describe each of the following QC tests for fluoroscopic equipment:
 - a. protective apparel
 - b. film illuminators
 - c. fluoroscopic resolution
 - d. maximum exposure rate
 - e. fluoroscopic timer accuracy
 - f. inspection procedures for fluoroscopic procedures
 - g. fluoroscopic timer
7. Outline the essential features of a repeat/reject analysis.
8. Describe the essential characteristics of digital imaging and list the applications of digital imaging in diagnostic radiology.
9. Describe the fundamental principles of each of the following computer-assisted imaging techniques, information, and communication systems:
 - a. computed tomography (CT) and magnetic resonance imaging (MRI)
 - b. digital fluoroscopy (DF)
 - c. digital radiography (DR) including computed radiography (CR) and direct/indirect digital systems
 - d. radiology information system (RIS)
 - e. picture archiving and communication systems (PACS)
 - f. integrated medical imaging

CAMRT COMPETENCY PROFILE (Equipment Operation)

On successful completion of these outcomes, students will be prepared to meet the requirements of the following competencies as listed in the CAMRT "Competency Profile" for Radiography.

A2 Prepare the room for radiographic/fluoroscopic imaging procedures.

- A2.5 Obtain accessory imaging equipment.
- A2.6 Select the correct image receptor system (conventional vs digital).

A4 Position the patient.

- A4.10 Collimate to the area of interest only to maximize image quality.

A5 Operate imaging equipment.

- A5.1 Select and use apparatus and accessory equipment safely.
- A5.2 Perform the initial set-up of the equipment.
- A5.3 Select the computer protocol for digital imaging.
- A5.4 Select the source-image distance.
- A5.5 Use radiographic markers.
- A5.6 Select the fastest film/screen/grid combination for optimum image quality appropriate for the examination.
- A5.7 Select appropriate kV, mA and time or automatic exposure control parameters.
- A5.8 Modify exposure factors on the basis of the patient's age, physique and condition.
- A5.9 Take the exposure.

A6 Process images.

- A6.1 Imprint ID information.
- A6.2 Manipulate computer data, if applicable.
- A6.3 Unload the film cassette/magazine and process exposed film.
- A6.4 Reload the cassette/magazine.

A7 Critique images and implement corrective measures.

- A7.8 Manipulate the digital image.

D2 Monitor radiographic/fluoroscopic equipment.

- D2.1 Perform visual inspection of cables and equipment.
- D2.2 Recognize improper functioning of imaging and accessory equipment/devices.
- D2.3 Ensure the proper operation of safety devices.
- D2.4 Record and report equipment malfunctions to the appropriate person.

D3 Perform quality control tasks.

- D3.1 Perform quality control tests on imaging and accessory equipment.
- D3.2 Use test results to initiate corrective action.
- D3.3 Record and maintain records/charts of all tests.
- D3.4 Test lead aprons and shields.
- D3.5 Report test results to appropriate person.
- D3.6 Conduct repeat/reject analysis

■ **Verification**

I verify that the content of this course outline is current.

Euclid Seeram
Authoring Instructor

Jan 4-03
Date

I verify that this course outline has been reviewed.

Program Head/Chief Instructor

Date

I verify that this course outline complies with BCIT policy.

Dean/Associate Dean

Date

Note: Should changes be required to the content of this course outline, students will be given reasonable notice.

■ Instructor(s)

Euclid Seeram, RTR, BSc, MSc,
FCAMRT

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■ Learning Resources

Required:

- Bushong, S. *Radiologic Science for Technologists*. Mosby-Year Book, Inc., Seventh Edition. 2001.

Additional References:

- Gray, J. et al. *Quality Control in Diagnostic Imaging*. Aspen Publishers Inc. 1983.
- Seeram, E. *Rad. Tech. Guide to Equipment Operation and Maintenance*. Blackwell Science. 2001.
- Thompson, M.A. et al. *Principles of Imaging Science and Protection*. W.B. Saunders Co. 1994.
- *Safety Code 20A: X-ray Equipment in Medical Diagnosis*. Ottawa, 1999.
- Seeram, E. *Computed Tomography*. W.B. Saunders Co. 2001.
- Huang, H.K. *PACS-Basic Principles and Applications*. Wiley-Liss. 1999.

■ Information for Students

(Information below can be adapted and supplemented as necessary.)

Assignments: Late assignments, lab reports or projects will **not** be accepted for marking. Assignments must be done on an individual basis unless otherwise specified by the instructor.

Makeup Tests, Exams or Quizzes: There will be **no** makeup tests, exams or quizzes. If you miss a test, exam or quiz, you will receive zero marks. Exceptions may be made for **documented** medical reasons or extenuating circumstances. In such a case, it is the responsibility of the student to inform the instructor **immediately**.

Ethics: BCIT assumes that all students attending the Institute will follow a high standard of ethics. Incidents of cheating or plagiarism may, therefore, result in a grade of zero for the assignment, quiz, test, exam, or project for all parties involved and/or expulsion from the course.

Attendance: The attendance policy as outlined in the current BCIT Calendar will be enforced. Attendance will be taken at the beginning of each session. Students not present at that time will be recorded as absent.

Illness: A doctor's note is required for any illness causing you to miss assignments, quizzes, tests, projects, or exam. At the discretion of the instructor, you may complete the work missed or have the work prorated.

Attempts: Students must successfully complete a course within a maximum of three attempts at the course. Students with two attempts in a single course will be allowed to repeat the course only upon special written permission from the Associate Dean. Students who have not successfully completed a course within three attempts will not be eligible to graduate from the appropriate program.

Course Outline Changes: The material or schedule specified in this course outline may be changed by the instructor. If changes are required, they will be announced in class.

■ Assignment Details

There are two assignments in this course:

1. **Laboratory:** Conduct and write a brief report on ONE QC test (to be discussed in detail during lectures).
2. **Article Summary:** To be discussed in class during the course outline discussion.

Schedule

Week	Outcome/Material Covered	Reference/Reading
TERM 3A – 5 weeks (3 hours/week) = 15 hours		
1 (2 hours)	COURSE OUTLINE REVIEW <ul style="list-style-type: none"> • Goals • Description • Evaluation • Outlines/CAMRT Competencies • Learning Resources MOBILE IMAGING SYSTEMS <ul style="list-style-type: none"> • Radiographic Systems <ul style="list-style-type: none"> – Generators and Power Supply – Advantages/Disadvantages • Fluoroscopic Systems <ul style="list-style-type: none"> – Mobile C-Arms – Mini C-Arms 	
1–2 (4 hours)	MAMMOGRAPHY IMAGING <ul style="list-style-type: none"> • Definition of Mammography • Type of Mammography <ul style="list-style-type: none"> – Screening – Diagnostic • Basic Principles of Imaging • Equipment <ul style="list-style-type: none"> – X-Ray Tube – Filtration – Compression – Grnds – AEC • Screen-Film Mammography • Digital Mammography–An Overview QUALITY MANAGEMENT IN RADIOLOGY <ul style="list-style-type: none"> • Purpose of a QM Program • JCAHO Model • QA/QC Definitions • QC and Levels of Testing • Continuous Quality Improvement • Tools for QC Monitoring • Measurement and Control Charts • Benefits of QM 	

Week	Outcome/Material Covered	Reference/Reading
3 + 4 (4 hours)	RADIOGRAPHIC QUALITY CONTROL <ul style="list-style-type: none"> Parameters for QC Monitoring Elements of a QC Test QC Tests <ul style="list-style-type: none"> Review Test done by Darlene <ul style="list-style-type: none"> Exposure Reproducibility Exposure Linearity Output vs kVp kVp Accuracy HVL Assessment Inspection Procedures Collimation Film/Screen Contact Automatic Exposure Control Focal Spot Assessment Tomographic Tests <ul style="list-style-type: none"> Level Accuracy Section Thickness 	
4 + 5 (3 hours)	FLUOROSCOPIC QUALITY CONTROL <ul style="list-style-type: none"> Inspection Procedures Maximum Exposure Rate Fluoro Timer Accuracy Fluoroscopic Resolution Test Protective Apparel Film Illuminators 	
5 (1 hour)	REPEAT/REJECT FILM ANALYSIS <ul style="list-style-type: none"> What is a Repeat/Reject Analysis? Why Conduct an Analysis? Definitions Ways to Conduct an Analysis Repeat/Reject Analysis Program 	
5 (1 hour)	END OF TERM 3A EXAMINATIONS	Euclid
	A set of multiple choice questions on all topics covered	

Week	Outcome/Material Covered	Reference/Reading
6 (2 hours)	DIGITAL IMAGING CONCEPTS <ul style="list-style-type: none"> • Limitations of Film-Based Radiography • What is Digital Imaging? • Steps to Digitizing an Image • Advantages of Digital Imaging • Brief History • Characteristics of the Digital Image <ul style="list-style-type: none"> – Image Matrix – Pixels/Voxels – Pixel Value as a Function of Tissue Characteristics – FOV and Pixel Size – Dynamic Range – Bit Depth – Windowing • Applications in Radiology • The Filmless (Digital) Radiology Department 	
7 (2 hours)	COMPUTED RADIOGRAPHY (CR) <ul style="list-style-type: none"> • What is CR? • Brief History • Physical Principles • Technology <ul style="list-style-type: none"> – Components – Imaging Plates/Cassettes – Laser Scanning and Detection of CR Latent Image • Processing the Digitized Image <ul style="list-style-type: none"> – Pre-acquisition Processing – Post-acquisition Processing • Control of Exposure of Exposure Factor Selection • Artifacts 	
8 (1 hour)	DIGITAL RADIOGRAPHY (DR) <ul style="list-style-type: none"> • CR Limitations • Indirect Digital Radiography <ul style="list-style-type: none"> – CCD-based Systems – Large Area Flat Panel Detectors • Direct Digital Radiography <ul style="list-style-type: none"> – Detection Technology – Principles of Operation • Comparing Technologies <ul style="list-style-type: none"> – Image Quality – Detective Quantum Efficiency (DQE) • Benefits • Digital Mammography 	

Week	Outcome/Material Covered	Reference/Reading
8 (1 hour)	DIGITAL FLUOROSCOPY (DF) <ul style="list-style-type: none"> • What is Digital Fluoroscopy? • System Components <ul style="list-style-type: none"> – X-Ray Source – Image Receptor – Video Camera and Optics – Digital Chain • Digital Subtraction Angiography <ul style="list-style-type: none"> – Principles – Technology 	
9 (1 hour)	LASER DIGITIZERS AND PRINTERS <ul style="list-style-type: none"> • Laser Digitizers <ul style="list-style-type: none"> – Purpose – Principles and Technology • Laser Printers (Imagers) <ul style="list-style-type: none"> – Purpose – Principles and Technology 	
9,10,11,12 (7 hours) <i>Week 10 is Spring Break</i>	COMPUTED TOMOGRAPHY (CT) and RESONANCE IMAGING (MRI) PRINCIPLES (CT will be described in detail and an overview of MRI will be presented.)	NOTE WEEK 10 IS SPRING BREAK
	COMPUTED TOMOGRAPHY <ul style="list-style-type: none"> • Limitations of Radiography • Brief History <ul style="list-style-type: none"> – Hounsfield – Cormack – Kalender • Basic Physics <ul style="list-style-type: none"> – Attenuation • Image Reconstruction • Equipment Configuration • Image Manipulation • Single-Slice Volume CT • Multi-Slice Volume CT • Applications of MSCT <ul style="list-style-type: none"> – CT Fluoroscopy – CT Angiography – 3-D Imaging – Virtual Reality Imaging 	
13 (1 hour)	MAGNETIC RESONANCE IMAGING <ul style="list-style-type: none"> • Basic Principles • Instrumentation 	

Week	Outcome/Material Covered	Reference/Reading
14 (3 hours)	PICTURE ARCHIVING AND COMMUNICATION SYSTEMS (PACS) <ul style="list-style-type: none"> • Definition • Image Acquisition • PACS Components <ul style="list-style-type: none"> – Network Infrastructure – Image Management – Display of Images – Image Storage 	
15 (1 hour)	TELERADIOLOGY AND INTEGRATED DIGITAL IMAGING <ul style="list-style-type: none"> • Telemedicine • Teleradiology <ul style="list-style-type: none"> – Principles – Equipment Components – Standards • Integrated Imaging <ul style="list-style-type: none"> – Enterprise-wide Image Distribution – Integrated Health Enterprise (IHE) 	
16	FINAL EXAMINATION	
	The final examination will be based on all materials covered in Term B – Multiple Choice Questions.	