



A POLYTECHNIC INSTITUTION

School of Health Sciences  
Program: Medical Radiography  
Option:

**MRAD 3308**  
**Radiobiology and Radiation Protection**

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<b>Start Date:</b>	January, 2006	<b>End Date:</b>	April, 2006
<b>Total Hours:</b>	<b>Total Weeks:</b> 16	<b>Term/Level:</b> 3	<b>Course Credits:</b>
48			
<b>Hours/Week:</b> 3	<b>Lecture:</b>	<b>Lab:</b>	<b>Shop:</b>
			<b>Seminar:</b>
			<b>Other:</b>
<b>Prerequisites</b>		<b>MRAD 3308 is a Prerequisite for:</b>	
<b>Course No.</b>	<b>Course Name</b>	<b>Course No.</b>	<b>Course Name</b>
	Anatomy and Physiology;		None.
	Physics for Medical Radiography		

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**Course Description**

The **first part** of this course deals with the fundamental concepts of Radiobiology through a discussion of radiation interaction with tissue, radiosensitivity, and early and late effects of radiation.

In the **second part** of the course, radiation protection concepts are introduced. First, the principles of radiation protection and the establishment of dose limits are described. This is followed by a discussion of various methods used to not only estimate the dose to patients, but also to minimize radiation dose to both patients and personnel. The course concludes with equipment specifications and shielding guides for diagnostic x-ray installations.

*Finally, it is important to note that all radiation protection codes covered will be those for Canada (SC-20A-see reference listed in the Required Resources of this Course Outline) and not for the United States as described in Stewart Bushong's textbook on Radiologic Science*

**Detailed Course Description**

To provide students with a knowledge of radiation biology so that they can apply effective radiation protection measures to patients, personnel and members of the public; in meeting the entry to practice competencies of the CAMRT, for radiation, health and safety in radiology.

**Evaluation**

Final Examination	50%	<b>Comments:</b> <ul style="list-style-type: none"><li>• A grade of 60% is required to pass this course.</li><li>• Project details to be discussed in the first class</li><li>• The nature of the midterm and final exams will be discussed in the first class</li></ul>
Midterm Examination	30%	
Projects	10%	
Quiz	10%	
<b>TOTAL</b>	<b>100%</b>	

### Course Learning Outcomes/Competencies

Upon successful completion, the student will be able to:

1. Define the term radiobiology and trace important historical events relating to the injury of humans exposed to radiation.
2. Explain how radiation interacts with tissue with emphasis on photoelectric absorption and Compton effect.
3. Explain two theories of biologic damage by radiation.
4. Define the term "radiosensitivity" and state the law of Bergonie and Tribondeau.
5. Describe the early effects of radiation.
6. Describe the late effects of radiation, including; radiation effects on the embryo, fetus and child, based on the stages of development: pre-implantation, major organogenesis and growth stage.
7. Describe stochastic and non-stochastic effects of low level radiation over an extended period of time with specific reference to radiology personnel.
8. Explain the fundamental principles of radiation protection for diagnostic radiology; time, shielding and distance.
9. Describe current radiation protection standards, including; the triad of justification, optimization (ALARA) and dose limitation as well as the triad of time, shielding and distance.
10. State the dose limits for radiation workers and members of the public.
11. Explain various methods used to estimate the dose to patients.
12. Describe various methods for minimizing exposure of both patients and personnel to radiation.
13. Identify equipment specifications for diagnostic radiology and explain how these specifications serve to protect patients and personnel from unnecessary radiation exposure.
14. Explain the concept of radiation risk to the patient according to department radiation protection guidelines.

## CAMRT COMPETENCIES

On successful completion of the above outcomes, you should be prepared to perform the following competencies as defined in the "Competency Profile" for radiographers, established by the CAMRT.

### RADIATION HEALTH AND SAFETY

#### **CRITICAL TASK B1** *Protect the patient*

- B1.1 Question female patients to ascertain possibility of pregnancy
- B1.2 Consult with the radiologist or physician in cases of suspected pregnancy
- B1.3 Adjust routine for radiography of pregnant women
- B1.4 Provide information regarding radiation exposure to the fetus
- B1.5 Use protective practices to reduce the risk of damaging effects of radiation in the diagnostic range
- B1.6 Collimate only to the area of interest to minimize patient dose
- B1.7 Select exposure factors consistent with optimal image quality and minimum radiation dose
- B1.8 Use addition filters as required
- B1.9 Monitor fluoroscopic exposure and note fluoroscopic time

#### **CRITICAL TASK B2** *Protect the technologist*

- B2.1 Stand behind protective barriers
- B2.2 Wear lead protective apparel when remaining in the radiation area
- B2.3 Remain as far as possible from patient and source during exposure
- B2.4 Use position aids/immobilization devices to avoid having to hold the patient during the procedure
- B2.5 Direct x-ray towards primary barriers only

#### **CRITICAL TASK B3** *Protect others required to be present during the procedure*

- B3.1 Advise accompanying females to leave the radiation area when pregnancy is known or suspected
- B3.1 Instruct people in the radiation area to maintain a safe distance and/or use radiation barriers during the exposure
- B3.3 Provide protection for people remaining with the patient during exposure

#### **CRITICAL TASK B4** *Protect others not required to be present during the procedure*

- B4.1 Close the doors of the radiation area when in use
- B4.2 Instruct people to leave the vicinity during imaging procedure

#### **CRITICAL TASK B5** *Monitor personal radiation exposure*

- B5.1 Wear radiation monitoring device
- B5.2 Check the accumulation of the radiation dose
- B5.3 Take appropriate action should readings exceed recommended standards

### Verification

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

Euclid Seeram  
Authoring Instructor

Dec 30-05

Date

I verify that this course outline has been reviewed.

M. Filippelli  
Program Head/Chief Instructor

December 30-05

Date

I verify that this course outline complies with BCIT policy.

Allen Gill  
Dean/Associate Dean

21 December, 2005

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:

1. Safety Code – 20A; *X-Ray Equipment in Medical Diagnosis*, Part A, Health and Welfare Canada, 1999.  
This code can be downloaded from the website (active at the time of writing this course outline on December 15<sup>th</sup>-2005) located at:

[http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-codes-securite\\_e.html](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/safety-codes-securite_e.html)

2. Seeram, E : *Radiation Protection*, Lippincott. Reprinted by the BCIT Bookstore
3. MRAD 3308: *Radiobiology and Radiation — A Study Guide and Workbook*. (Handout Notes)

#### Recommended:

1. Bushong, S., *Radiologic Science for Technologists* by Bushong, 8th Edition, C.V. Mosby, 2004.
2. Seeram, E., *Rad. Tech's Guide to Radiation Protection*, Blackwell Science, Inc., 2001.

## Information for Students

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

The following statements are in accordance with the BCIT Student Regulations Policy 5002. To review the full policy, please refer to: <http://www.bcit.ca/~presoff/5002.pdf>.

### Attendance/Illness:

In case of illness or other unavoidable cause of absence, the student must communicate as soon as possible with his/her instructor or Program Head or Chief Instructor, indicating the reason for the absence. Prolonged illness of three or more consecutive days must have a BCIT medical certificate sent to the department. Excessive absence may result in failure or immediate withdrawal from the course or program.

### Academic Misconduct:

Violations of academic integrity, including dishonesty in assignments, examinations, or other academic performances are prohibited and will be handled in accordance with the 'Violations of Standards of Conduct' section of Policy 5002.

### 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 their respective program.

### Accommodation:

Any student who may require accommodation from BCIT because of a physical or mental disability should refer to BCIT's Policy on Accommodation for Students with Disabilities (Policy #4501), and contact BCIT's Disability Resource Centre (SW1-2300, 604-451-6963) at the earliest possible time. Requests for accommodation must be made to the Disability Resource Centre, and should not be made to a course instructor or Program area.

Any student who needs special assistance in the event of a medical emergency or building evacuation (either because of a disability or for any other reason) should also promptly inform their course instructor(s) and the Disability Resource Centre of their personal circumstances.

## Assignment Details

To be discussed in class.

- There is one assignment in this course. It is based on a literature search and summary of one article from a journal of radiobiology/radiation protection/radiology/radiologic technology that is related to any topic covered in this course.
- This assignment is worth 10%. There is absolutely no reason why you should not score full marks.

## Schedule

Week	Material Covered	References
Term 3A	Predicted Order of Coverage	
1 (Jan 4-6)	<b>Detailed Description/Explanation of the Course Outline</b> <ul style="list-style-type: none"> <li>• Prerequisites</li> <li>• Course Description</li> <li>• Course Goals</li> <li>• Learning Outcomes</li> <li>• CAMRT Competencies — Radiation Health and Safety</li> <li>• Evaluation</li> <li>• Learning Resources</li> <li>• Assignment Description</li> </ul>	Euclid Seeram
2 (Jan 9-13)	<b>Module 1: A Rationale for Radiation Protection</b> <ul style="list-style-type: none"> <li>• Sources of Data on Biological Effects</li> <li>• Dose-Response Models</li> <li>• Biological Effects Overview</li> <li>• Framework for Radiation Protection</li> </ul>	Seeram – Chapter 1
3 (Jan 16-20)	<b>Module 1: Radiation Exposure</b> <ul style="list-style-type: none"> <li>• Sources of Radiation Exposure</li> <li>• Medical Radiation Exposure</li> <li>• Types of Radiation Exposure</li> </ul>	Seeram, Chapter 3
4 & 5 (Jan 23-Feb 3)	<b>Module 1: Radiation Exposure</b> <ul style="list-style-type: none"> <li>• Radiation Exposure <ul style="list-style-type: none"> <li>◦ Dosimetric Quantities and Units</li> </ul> </li> </ul>	Seeram, Chapter 3
	<b>Module 2: Concepts of Radiobiology</b> <ul style="list-style-type: none"> <li>• Definition of Radiobiology</li> <li>• Sequence of Events Leading to Bioeffects</li> <li>• Generalizations</li> <li>• Human Responses to Ionizing Radiation</li> <li>• History of Radiation Injury</li> <li>• Radiosensitivity</li> <li>• Dose-Response Relationships</li> </ul>	Chapter 4 by Travis in textbook by Euclid Seeram (relevant topics only).

Week	Material Covered	References
Term 3B	Predicted Order of Coverage	
6 (Feb 6-10)	<b>Module 3: Molecular and Cellular Radiobiology</b> <ul style="list-style-type: none"> <li>• Levels of Biologic Damage</li> <li>• Radiation Damage to DNA and Chromosomes</li> <li>• Radiolysis of Water</li> <li>• Direct and Indirect Action of Radiation</li> <li>• Target Theory</li> </ul>	Bushong, 2004,  Travis in Euclid Seeram, Chapter 4.
7 (Feb 13-17)	<b>Module 4: Early Effects of Radiation</b> <ul style="list-style-type: none"> <li>• Dose Magnitudes</li> <li>• Acute Radiation Lethality</li> <li>• Local Tissue Damage</li> <li>• Hematologic Effects</li> <li>• Cytogenetic Effects</li> </ul>	Bushong, 2004,  Travis in Euclid Seeram, Chapter 4.
7 (1 hour) Feb 22)	<b>MIDTERM EXAMINATION</b> <ul style="list-style-type: none"> <li>• Multiple Choice examination covering materials in Modules 1–4.</li> </ul>	
8 (Feb 20-24)	<b>Module 5: Late Effects of Radiation</b> <ul style="list-style-type: none"> <li>• Local Tissue Effects</li> <li>• Life Span Shortening</li> <li>• Risk Estimates</li> <li>• Radiation-Induced Malignancy</li> <li>• Radiation and Pregnancy</li> </ul>	Bushong, 2004,  Travis in Euclid Seeram, Chapter 4.
9-10 (Feb 27-Mar 10)	<b>Module 6: Radiation Protection Concepts</b> <ul style="list-style-type: none"> <li>• Risks and Benefits of Medical Exposure</li> <li>• Current Standards of Radiation Protection</li> <li>• Radiation Detection and Measurement</li> <li>• Personnel Dosimetry</li> <li>• Thermoluminescence Dosimetry</li> <li>• Optically Stimulated Luminescence</li> </ul>	Seeram, Chapter 5.  Bushong, 2004.
11 March 13-17	<b>SPRING BREAK – SPRING BREAK – SPRING BREAK</b>	(March 13-17)
12 (Mar 20-24)	<b>Module 7: Radiation Protection Organizations</b> <ul style="list-style-type: none"> <li>• International and National Organizations</li> <li>• Radiation Protection Bureau — Health Canada</li> <li>• Radiation Protection Partnerships – BC – RPB</li> <li>• Definition of Terms in SC 20A</li> </ul>	Seeram, Chapter 6.

Week	Material Covered	References
12 (Mar 20-24)	<b>Module 8: Dose Limitation</b> <ul style="list-style-type: none"> <li>History</li> <li>Categories of Exposed Individuals</li> <li>Canadian Recommended Dose Limits</li> <li>Occupational Exposure Trends</li> </ul>	Seeram, Chapter 7 Radiation Protection Bureau: Health Canada (SC-20A)
13 (Mar 27-31)	<b>Module 9: Factors Affecting Dose to Patients and Personnel</b> <ul style="list-style-type: none"> <li>Imaging Systems Components</li> <li>Clinical Factors</li> <li>Factors in Radiography</li> <li>Factors in Fluoroscopy</li> </ul>	Seeram, Chapter 8.
13 (Mar 27-31)	<b>Module 10: Patient Dose in Radiography</b> <ul style="list-style-type: none"> <li>Estimation of Patient Dose <ul style="list-style-type: none"> <li>&lt; Entrance Skin Exposure and Methods for Estimating It</li> <li>&lt; Mean Marrow Dose</li> <li>&lt; Genetically Significant Dose</li> </ul> </li> <li>Patient Doses in Special Exams</li> </ul>	Bushong, 2004.
14 & 15 (April 3-14)	<b>Module 11: Dose Reduction Methods</b> <ul style="list-style-type: none"> <li>Equipment Specifications</li> <li>Dose Reduction to Personnel</li> <li>Dose Reduction to Patients</li> <li>reduction of Gonadal Dose</li> <li>WCB of BC — Policy and Legislation</li> </ul>	April 14-Good Friday April 17-Easter Monday  Seeram, Chapter 9.
16 April 17-21	<b>FINAL EXAMINATION</b>	
	The final examination will be based on the entire course content but will be <i>heavily weighted</i> on Modules 5 to 11. The examination will be 2 hours long.	