STUDENT COURSE INFORMATION

FANSHAWE COLLEGE OF APPLIED ARTS AND TECHNOLOGY
HEALTH SCIENCES
JANUARY 2010

RADL-1007 -- RADIATION PROTECTION & RADIOBIOLOGY

Duration: 30 total course hours **Credit Units:** 2.00

*NOTE: The hours may vary.

This course is a prerequisite for:

RADL-5009	RADIATION PROTECTION & RADIOBIOLOGY

Prerequisite(s) for this course:

RADL-1002	DIAGNOSTIC IMAGING 1
RADL-1003	MEDICAL RADIATION SCIENCES 1

Co-requisite(s) for this course:

NO COURSES

Course Description:

Course material includes types, sources and biologic effects of ionizing radiation. This course provides the necessary knowledge concerning methods of limiting radiation exposure to patients, public and workers when administering diagnostic x-rays.

Vocational Learning Outcomes:
Upon successful completion of this course, the student will be able to:

1. Explain biological effects of radiation.
2. Explain methods used to reduce radiation levels to patients, public and operators.

Essential Employability Skills Learning Outcomes:

	Essential Employability Skills Learning Outcomes	**Taught**	**Reinforced**	**Assessed or evaluated**
1.	Communicate clearly, concisely and correctly in the written, spoken and visual form that fulfills the purpose and meets the needs of the audience.	☐	☒	☐
2.	Respond to written, spoken or visual messages in a manner that ensures effective communication.	☐	☒	☐
3.	Execute mathematical operations accurately.	☐	☒	☐
4.	Apply a systematic approach to solving problems.	☐	☒	☐
5.	Use a variety of thinking skills to anticipate and solve problems.	☐	☒	☐

6.	Locate, select, organize and document information using appropriate technology and information systems.	☐	☒	☐
7.	Analyze, evaluate and apply relevant information from a variety of sources.	☐	☒	☐
8.	Show respect for the diverse opinions, values, belief systems and contributions of others.	☐	☒	☐
9.	Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.	☐	☒	☐
10.	Manage the use of time and other resources to complete projects.	☐	☒	☐
11.	Take responsibility for one's own actions, decisions and consequences.	☐	☒	☐

Detailed Content:

Lesson 1 - Review of Ionizing Radiation
References:
Statkiewicz-Sherer
The student must be able to:

1. define ionizing radiation, electromagnetic, and particulate.
2. list the sources of natural (background) and man-made radiation.
3. briefly explain the production of x-rays within the x-ray tube.
4. explain the differences between fluoroscopy and radiography, and explain the functions of the image intensifier during fluoroscopy.
5. explain the basic interactions of x-radiation with matter and define the following terms; PE absorption, Compton scatter, secondary radiation, and attenuation.
6. discuss how radiation damage occurs on an atomic scale, and possible results.
7. define the following radiation units:
   - **Roentgen (R) & Coulomb/kg**
   - **Rad & Gray (Gy)**
   - **Rem & Sievert (Sv)**
   - **Curie (Ci) & Becquerel (Bq)**
8. convert between the older units and SI units.

Lesson 2 - The Cell, DNA and Chromosomes
References:
Statkiewicz-Sherer
The student must be able to:

1. describe the basic composition and components of a typical cell.
2. state the physical, and chemical composition of **DNA**.
3. differentiate between **DNA, genes**, and **chromosomes**.
4. define; **chromosome, homologues**, and **chromatids**.
5. define: **diploid (2n), haploid (n), gamete**, and **zygote**.
6. define **somatic** and **genetic (reproductive) cells** and give examples.
7. identify and discuss 4 phases of the **cell cycle**.
8. discuss the similarities and differences between **mitosis** and **meiosis**, and give examples of cells where they occur.

Lesson 3 - Principles of Radiation Biology
References:
Statkiewicz-Sherer

The student must be able to:

1. list and explain three radiation energy transfer determinants.
2. define **ionization**, and **excitation** with reference to the absorption of energy.
3. define **radioresistant** and **radiosensitive**.
4. explain the **target theory** of radiation biology with reference to DNA, LET, direct and indirect hits.
5. differentiate between **direct** and **indirect** radiation effects. Which effect is more prevalent and why?
6. discuss in detail; the **radiolysis of water**, the products, and consequences.

Lesson 4 - Radiation Effects on DNA, Chromosomes, and Cells
References:
Statkiewicz-Sherer
The student must be able to:

1. discuss the basic DNA damage due to radiation: **DNA mutations**.
2. discuss common structural changes (visible DNA damage) in chromosomes caused by radiation.
3. differentiate between **chromosome** and **chromatid** aberrations.
4. discuss the consequences to the cell of the chromosome structural changes with reference to; **restitution, deletion** (acentric fragments), **chromosome distortions** (ring, dicentric chromosomes), and **mutations** (**translocations** and **inversions**).
5. discuss the fate of irradiated cells with reference to **division delay, interphase death (apoptosis),** and **reproductive failure**.
6. explain the consequences of mutations for **somatic** cells and **reproductive** cells.
7. define **organ systems** and state the major organ systems of the body.
8. discuss **differentiation** with reference to **stem (immature, precursor, undifferentiated)cells**, **transit cells**, and **mature (differentiated, functional) cells** and give examples.
9. explain the **Law of Bergone and Tribondeau**.
10. discuss dose response relationships with reference to the terms **linear, threshold**, and **non-threshold**.
11. describe the dose-response relationship most applicable to diagnostic radiology, and the class of effects involved with this relationship.
12. explain **RBE**. With reference to the target theory, explain how the following physical factors affect radiosensitivity of tissue: **dose rate, fractionation of dose, LET, cell cycle and OER**.

Lesson 5 - Early Effects of Radiation (from doses greater than the diagnostic range)
References:
Statkiewicz-Sherer
The student must be able to:

1. define **total body exposure, acute exposure**, and **chronic exposure**.
2. define and give examples of **stochastic** and **non-stochastic** radiation effects.
3. define **acute radiation syndrome** and the **3 stages** of it.
4. explain the relation between length of each stage and dose.
5. compare the **haematologic syndrome, gastrointestinal syndrome**, and **central nervous system syndrome** with reference to; ***symptoms, threshold dose, length of stages, mean survival time***, and the ***ultimate cause of death***.
6. define $LD_{50/30}$.
7. define the terms: **erythema, epilation, desquamation, necrosis, atrophy**, and **impaired fertility**.
8. name the organs responsible for production of blood cells (haematopoietic system).
9. name **2 cell types** of the body considered the most radiosensitive.
10. define the **3 stages of fetal development**.
11. state the principle effects of irradiation of the fetus during these stages.
12. state why the fetus becomes more **radioresistant with age**, and why **congenital** abnormalities are more prevalent if irradiation occurs from the second to sixth week rather than during the **pre-implantation** stage.

13. state which **trimester** of pregnancy is the most radiosensitive

Lesson 6 - Late Effects of Radiation (doses within the diagnostic range)
References:
Statkiewicz-Sherer
The student must be able to:

1. state the principle **late effects** of irradiation in diagnostic radiology.
2. name the dose-response relationship upon which our radiation protection guides are based.
3. state the late effect of radiation on **blood forming organs**, and the **lens of the eye**.
4. state the dose-response relationship for radiation induced **leukemia**.
5. indicate the significance of the following to our current understanding of the effects of radiation:
   - **early radiation workers**
   - **radium miners**
   - **luminous dial painters**
   - **atomic warfare**
   - **radiation therapy for enlarged thymus**
   - **radiation therapy for ankylosing spondylitis**
   - **power plant accidents**
6. define genetic effects.
7. state the dose-response relationship for suspected genetic effects of radiation on humans.
8. state the significance of mutations to a population.
9. define **doubling dose**.

Lesson 7 - Principles of Radiation Protection
References:
Statkiewicz-Sherer
The student must be able to:

1. discuss why radiation protection is so important even in relatively low-level radiation environments such as diagnostic radiology.
2. state the **four main aspects** of the radiation safety problem.
3. state and discuss the **cardinal principles** of radiation protection.
4. discuss the concept of **maximum permissible dose (MPD)** and why it does not apply to patient exposure, or background exposures.
5. state the MPD for individual members of the public and occupationally exposed.
6. state why all unnecessary radiation exposure should be avoided with reference to the reasons for MPD.
7. explain the **ALARA Principle**.
8. explain the latest policy of the ICRP concerning MPD with reference to **dose** and **pregnant workers**.
9. state the specifications, and, or recommendations for MPD concerning **women of reproductive capacity, trainee technologists**, and **individual organs**.
10. state the criteria for deciding which hospital workers require personnel dosimeters.
11. State the level of overexposure to an occupationally exposed worker that would warrant investigative action.

Lesson 8 - Minimizing Exposure to the Patient
References:
Safety Code - 20A, pg. 31-40
Statkiewicz-Sherer
Bushong, Part 5
The student must be able to:

1. explain 'risk vs. benefit'.
2. define **Genetically Significant Dose (GSD)** and the importance of reducing gonadal dose.
3. discuss the importance of effective communication and immobilization.

4. explain the proper use and effects on patient exposure of the following:
    - beam limitation devices
    - grids
    - protective filtration, k-edge filters
    - protective shielding
    - processing, exposure factors, system speed, FFD
5. explain what fluoroscopy is relative to radiography.
6. describe exposure reduction under the following fluoroscopic terms:
    - image intensification
    - intermittent fluoroscopy
    - beam limitation
    - exposure factors
    - filtration
    - source to skin distance
    - cumulative timing device
    - fluoro exposure switch (foot switch)
7. explain why cine filming is considered a high exposure procedure.
8. explain ESE (**entrance skin exposure**), and entrance skin exposure rate and the methods of obtaining these measurements.

Lesson 9 - Minimizing Exposure to Personnel
References:
Safety Code - 20A, pg. 27-31
Statkiewicz-Sherer
Bushong, Chpt. 31, pg. 567-570, Chpt. 32, pg. 583-588
The student must be able to:

1. define **controlled** and **uncontrolled** areas, and state their maximum permissible levels of radiation exposure.
2. explain why scatter radiation should be the main contributor to the radiographer's occupational exposure.
3. discuss the types of shielding (structural, aprons, etc.) and their use.
4. explain how exposure reduction to the patient (initial exposure, repeats) reduces exposure to the radiographer.
5. describe the devices for operator protection that should be installed on a fluoroscopic machine.
6. discuss, in general terms, additional radiation protection provided for the pregnant radiographer.

Note: Specific Canadian safety regulations will be studied in RADL5001

Lesson 10 - Shielding Guides for Diagnostic X-ray Installations
References:
Safety Code - 20A, sect. 7.3, pg. 27, pg. 14-15, 44-67
Bushong, Chpt. 31, pg. 555-559
Statkiewicz-Sherer
The student must be able to:

1. state the role of the radiation protection officer (**RPO**) in the design of new, or renovation of existing x-ray facilities.
2. define and state the significance of **3 types of radiation** that are considered when designing **protective barriers**.
3. define the two types of protective barriers (**primary** and **secondary**)
4. define and state the significance of the following factors affecting barrier thickness:
    - **occupancy factor (T)**
    - **controlled and uncontrolled areas**
    - **workload (W)**
    - **use factor (U)**
    - **tube potential (kVp)**

- control booth
- film storage areas

5. list common barrier materials.
6. compute barrier thickness required from the essential raw data using the **primary** barrier equation;
   - $K = Pd^2/WUT$

Teaching/Learning Methodology:

Lecture, Demonstration (80%)
Study/Lab assignments (20%)

Required Learning Resources:

Text:
Statkiewicz-Sherer et al (2006). Radiation Protection in Medical Radiography, (5th Ed), St. Louis: Mosby Elsevier (original work published 1983) ISBN: 0-323-03600-7

Method Of Evaluation:
The final mark/grade for this course will be determined as follows:

The final mark for this course will be determined as follows:
Three tests of multiple choice and short answer format

Method	**Percentage**
Test 1 (Week 6)	30%
Test 2 (Week 12)	30%
Test 3 (Week 15) comprehensive	40%
TOTAL	**100%**

At the end of the semester, a minimum grade of 60% (total of all tests) must be achieved to pass the course. A comprehensive supplemental test may be granted at the discretion of the program faculty should the student fail this course. Pass or fail is based entirely on the comprehensive supplemental. To be eligible for a comprehensive supplement test the student must accumulate a 50% or greater average prior to test 2, 50% or greater on test 2, and not have failed any other course in this semester. A mid semester warning will be issued to any student who is not meeting the minumum standards of the course.

NOTE: Test and assignment due dates, etc. will be provided by the professor at the beginning of the course.

Consult the Program Division Policy for additional information on course evaluation and progression.

Grade	Range	Comment	Grade Point
A+	90-100	Distinguished	4.2
A	80-89		4.0
B+	75-79		3.5
B	70-74		3.0
C+	65-69		2.5
C	60-64		2.0
D+	55-59		1.5
D	50-54	Marginal	1.0

F	0-49	Unsatisfactory	0
P	greater than 50	Pass	N/A
I	N/A	Incomplete	N/A
N	N/A	No Credit Achieved	N/A
W	N/A	Withdrawn	N/A
X	N/A	Audit	N/A

CHEATING - All forms of cheating are considered an academic offence and the College has a clear policy on cheating. Please refer to Policy 2-G-04 on Fanshawe Online or in the Student Handbook.

PLAGIARISM - Plagiarism is cheating and an appropriate penalty will be applied and a report will be placed in the student's file in conformance with College Policy 2-G-04 on cheating. Plagiarism (the intellectual dishonesty resulting from a student's failure to acknowledge indebtedness to sources used) is a serious academic offence that shall result in appropriate penalties, to be determined at the discretion of the course professor in consultation with the Divisional Chair. Plagiarism includes, but is not limited to, submitting the same work to more than one professor for credit in different courses without prior written permission from the professors. Penalties shall range from failure of an assignment to possible failure of the course.

REWRITES - Students cannot make the assumption that any provision will be made by the professor to permit a student to rewrite failed assignments or tests.

Turnitin.com
As part of Fanshawe College's commitment to fostering excellence in student assignments, this course may require students to submit their papers to Turnitin.com. This Web service is designed to help students understand the importance of identifying borrowed work in their essays, and how to correctly cite research sources. Instructions for how to use Turnitin.com will be provided by the professor, and additional information is available at www.Turnitin.com.

Additional Information:
Consult your Program Outline for information concerning the minimum passing grade needed for this course.

The following are not allowed in class at any time without permission from the instructor;
- recording devices
- cell phones
- laptops

Prepared By:
B. Howell, BSc

The following applies for course offerings consistent with the Standard Academic Calendar:

Internal/External Course Credit Application Deadline
Applications for Internal/External Course Credit are available from the Office of the Registrar. Check college calendar for deadlines.

Course Add/Drop Deadline
You may withdraw from a course without academic penalty during the first 70% of the course duration. Application is made through the Office of the Registrar.

Academic Assistance
The primary resource for students experiencing difficulty with course material is the course professor. In addition, students who wish to attend study skills workshops or who require further assistance, can

contact the Learning Centre in A2019 (519 452 4265) for one-to-one tutoring from staff in math, physics, chemistry and english, or they can contact Counselling and Student Life in F2010 (519 452 4282) for information about receiving peer tutoring.

Student Success Advisors are available to assist students with academic concerns or other problems they may face while at Fanshawe. They can either assist you directly, or refer you to the appropriate resource on campus to get the help you need. Contact information for your Student Success Advisor can be found on the Web at http://www.fanshawec.ca/EN/ssa/14317/advisors.asp.

Students who have been identified as having (or who wish to be assessed for) a specific learning disability, should contact Disability Services F2010 (519 452 4282) in Counselling and Student Life for information about available support services.

Re-taking a Course:
Subject to meeting any pre-requisite or co-requisite requirements, a student may retake a course. The second re-take must be approved by the Academic Manager or designate and will be granted based on extenuating circumstances and with recommended interventions such as counselling or a learning contract. Subsequent re-take opportunities will only be available as part of an overall success strategy developed in consultation with the student, program co-ordinator and the Academic Manager. The best grade achieved will be used in calculating the cumulative GPA.

Related Policies
Course Grade System - See College Policy 2-C-04
Prior Learning Assessment and Recognition - See College Policy 2-A-10
Evaluations - See College Policy 2-C-02
Academic Standing - See College Policy 2-C-05
Student Appeal of a Grade or Other Academic Decision - See College Policy 2-G-02
Academic Withdrawal and Termination - See College Policy 2-C-06
Academic Offences - See College Policy 2-G-04
Student Code of Conduct Policy - See College Policy 2-G-01
Respectful College Community Policy - See College Policy 1-B-46

Authorized By:  **Date:** JANUARY 2010