RADIATION BIOLOGY (RADR 2313)

Credit: 3 semester credit hours

Pre-requisite: RADR 2305 Principles of Radiographic Imaging II

Course Description: Effects of radiation exposure on biological systems, includes typical medical exposure levels, methods for measuring and monitoring radiation, and methods for protecting personnel and patients from excessive exposure.

Textbook and Materials:

- Statkiewicz, Mary & Visconti, Paula, *Radiation Protection In Medical Radiography*, 8th edition, Multi-Media Publishing, Inc., 2011. ISBN#978-0-323-44666-2
- #882 Scan-trons and pencils

Reference Books: (these publications can be checked out from Mrs. Barrow)

- Bushong, Stewart C. *Radiologic Science for Technologists*, 11th edition, ISBN: 978-0-323-35377-9, Elsevier, Mosby Publishing 2017.
- NCRP # 116 Limitation of Exposure to Ionizing Radiation.
- NCRP # 102 Medical X-ray, Electron Beam, and Gamma-Ray Protection.
- NCRP #160 Ionizing Radiation Exposure of the Population of the United States.
- NCRP # 105 Radiation Protection for Medical & Allied Health Personnel.
- NCPR # 54 Medical Radiation Exposure of Pregnant and Potentially Pregnant Women.
- CFR-21 Code of Federal Regulations #21

Course Objectives:

A. Describe the biophysical mechanisms of radiation damage on humans
B. Indicate typical dose ranges for routine radiographic procedures
C. Describe basic methods and instruments for radiation monitoring, detection, and measurement
D. Implement appropriate radiation protection practices
E. List and describe the quantities and units of radiation
F. State the NCRP Effective Dose Limits for patient exposure, technologist exposure, and equipment standards
G. Discuss the use of radioisotopes and radioactive materials

SPRING 2019 - RADR 2313
Course Syllabus

Course Outline:

I. ***Introduction to Radiation Protection***
- A. Explain the need for radiation protection procedures
- B. Define ionizing radiation
- C. Determine who is responsible for radiation protection
  1. radiologist
  2. primary physician
  3. radiographer
- D. Define ALARA
- E. Define BERT

II. ***Radiation: Types, Sources, & Doses***
- A. Identify the different sources of ionizing radiation
  1. natural
     a. Terrestrial
     b. Human Body
     c. Atmosphere
  2. artificial
     a. Medical
     b. Other

III. ***Interactions of X-radiation with Matter***
- A. Distinguish parts of the x-ray beam
  1. primary
  2. remnant
  3. scatter
  4. attenuation
- B. Describe the different types of interactions that occur between ionizing radiation and matter
  1. coherent
  2. compton
  3. photoelectric
  4. pair production
  5. photodisitegration
- C. Visualize the steps that take place during interaction between the x-ray photon and the matter in each type of interaction

IV. ***Radiation Quantities and Units***
- A. Describe the history of radiation quantities and units
- B. Identify the different SI and Traditional radiological units for the following quantities
  1. exposure
  2. absorbed dose
  3. equivalent dose
  4. activity
  5. air kerma

C. Convert from SI to Traditional units using mathematical calculations
D. Define linear energy transfer

V. ***Radiation Monitoring***

A. State why personal radiation monitors should be worn
B. Identify the appropriate location on the radiographer's body to wear a monitoring device
1. personal monitor
2. fetal monitor
C. List the characteristics of a personal monitoring device
D. Compare and contrast various personnel monitoring devices
1. pocket ionization chamber
2. film badge
3. thermoluminescent dosimeter
4. luxel badge
E. Explain the use various radiation survey instruments for area monitoring
1. ionization chamber
2. ionization chamber with rate meter
3. cutie pie
4. proportional counter

VI. ***Overview of Cell Biology***

A. Explain the need to understand cell composition and function as a foundation for radiation biology
B. Describe the functions of the organic and inorganic compounds in a cell
C. Describe the structure of DNA and explain how it functions in a cell
D. Describe the function of the components of a cell
E. Distinguish between the two types of cell division
1. Mitosis
2. Meiosis

VII. ***Molecular and Cellular Radiation Biology***

A. Discuss various radiation energy transfer determinants
1. physical factors
a. LET
b. RBE
c. fractionation
d. protracted
2. biologic factors
a. sex
b. age
c. OER
3. misc. factors
a. dose
b. stress
c. area exposed
d. weight
B. Distinguish between the different effects of ionizing radiation
1. direct effect

2. indirect effect
C. Describe the effects of ionizing radiation on various parts of a cell
D. Describe the target theory
E. State the Law of Bergonie and Tribondeau
F. Discuss cell radiosensitivity
1. radiosensitive cells
2. radioresistant cells

VIII. ***Early Radiation Effects on Organ Systems***

A. Draw diagrams of various dose-response relationships
1. linear vs nonlinear
2. threshold vs non-threshold
B. Discuss the early somatic effects of ionizing radiation
1. prodromal stage
2. latent period
3. manifest illness
a. hematopoietic
b. gastrointestinal
c. CNS
4. recovery or death

IX. ***Stochastic & Late Radiation Effects on Organ Systems***

A. Demonstrate knowledge of the late somatic effects of ionizing radiation
1. cancer
2. cataract formation
3. life span shortening
4. teretogenic effects
B. Describe the genetic effects of ionizing radiation
1. Mueller & Russell studies
2. Chernobyl
C. Given a specific dose of radiation the student should evaluate and organize the information and determine what acute symptoms will probably occur

X. ***Dose Limits for Exposure to Ionizing Radiation***

A. Identify different regulatory agencies that evaluate radiation
1. state agencies
2. federal agencies
B. Discuss the Radiation Control for Health and Safety Act of 1968
C. Discuss the ALARA concept
D. Discuss the Consumer Patient Radiation Health and Safety Act of 1981
E. Determine cumulative effective dose limits using the NCRP formula using mathematical calculations
F. List the annual dose limits for occupational and non-occupational exposure to ionizing radiation
1. annual occupational dose to whole body
2. annual occupational dose to hands

3. life time dose
4. annual dose to student radiographer
5. annual dose to public
    a. frequent exposure
    b. infrequent exposure

XI. ***Equipment Design for Radiation Protection***

A. Describe the types of beam limiting devices
1. aperture diaphragm
2. cone and cylinder
3. collimator
4. automatic collimator

B. Describe the function of x-ray beam filtration in diagnostic tubes

C. Describe how high speed screen/film combinations reduce patient exposure

XII. ***Management of Patient Radiation Dose During Diagnostic X-ray Procedures***

A. Understand why the radiographer is responsible for reducing the patient's exposure

B. State the reason for reducing the number of repeat radiographs

C. Understand the need for effective communication between the radiographer and patient

D. Understand the benefit of immobilizing patient during diagnostic exam

E. State the reason for gonadal shielding and discuss the types used
1. flat contact shield
2. shaped shield
3. shadow shield
4. specific area shield

F. Discuss the value of proper processing techniques

G. List the proper exposure factors to use to reduce patient absorbed dose
1. high kVp
2. low mAs

H. Selects which combination of technique and equipment will decrease patient exposure

I. Discuss the ways a repeat analysis program can benefit a radiology department

J. List some unnecessary radiological exams
1. routine pre-op chest
2. pre-employment exams
3. mass screening for TB

K. Discuss the relationship between digital imaging and patient exposure

L. Understand the methods used to protect a patient during mobile radiologic exams
1. shield
2. collimate
3. technique

M. Understand the methods used to protect a patient during fluoroscopic exams
1. intermittent fluoroscopy
2. automatic brightness stabilization
3. five minute cumulative timer
4. collimation

5. last image hold

N. Describe the danger of High Level Control Interventional Procedures

O. Be familiar with the methods used to determine patient dose: organ dose, skin dose, and entrance skin exposure

P. Discuss recommendations from NCRP #54 on "Medical Radiation Exposure of Pregnant & Potentially Pregnant Women"

Q. Discuss patient exposure in other areas: mammography, computed tomography, and pediatrics

XIII. ***Safety in Computed Tomography and Mammography***

A. Methods of Reducing Patient Dose in CT
1. CT skin dose
2. shielding
3. pitch ratio
4. dose parameters

B. Methods of Reducing Patient Dose in Mammography
1. dose reduction
2. screening
3. filtration

XIV. ***Management of Imaging Personnel during Diagnostic X-ray Procedures***

A. List the three cardinal principles of radiation protection
1. time
2. distance
3. shielding

B. Distinguish between types of barriers
1. primary
2. secondary

C. Discuss the factors that determine a barrier's thickness
1. kVp
2. time of occupancy
3. use
4. workload
5. distance

D. Describe the methods of reducing technologist exposure during diagnostic procedures
1. use of shielding
    a. barriers
    b. protective apparel
2. distance
3. equipment

E. Describe the methods of reducing technologist exposure during fluoroscopic procedures
1. protective apparel
2. distance for patient
3. Inverse Square Law
4. stand behind radiologist

F. Describe methods of reducing technologist exposure during mobile procedures

1. protective apparel
2. distance for patient

G. Distinguish where each type of warning sign should be posted
1. Caution Radiation Area
2. Caution High Radiation Area
3. Caution Radioactive Particles Area

XV. ***Radioisotopes and Radiation Protection***

A. Define radioisotope
B. Discuss the use of radioisotopes in radiation therapy
1. brachytherapy
2. iodine 125
3. iodine 131
4. strontium 89
C. Discuss the use of radioisotopes in nuclear medicine
1. iodine 123
2. technetium 99
D. Discuss the use of radioisotopes and protection in PET
1. fluorine 18
E. Describe the potential use of radioactive materials as terrorist weapon
1. dirty bomb
F. Describe clean up from radioactive contamination
1. internal contamination
2. surface contamination

XVI. ***Design of a Radiology Facility***

A. Discuss recent trends in radiography department designs
B. Define ergonomics
C. Describe methods of reducing workplace injuries

Grade Scale: Numeric Letter to Grade Conversion

A = 93 - 100
B = 84 - 92
C = 77 - 83
D = 60 - 76
F = 0 - 59

*** A minimum of 77% is required for successful completion of this course!**

Course Evaluation:

Written Exams (3).....20% each
Quiz average….....20%
Comprehensive Final Exam.....20%

COURSE POLICIES:

- No food, drinks, or use of tobacco products in class.
- Phones, headphones, and any other electronic devices must be turned off while in class.

- Recording devices may be used except during test reviews and when otherwise stated by the instructor.
- Lap top computers, I-pad… may be used to take notes during class but may not be used to "surf" the internet, look-up answers, nor anything not directly related to note taking.
- It shall be considered a breach of academic integrity (cheating) to use or possess on your body any of the following devices during any examination unless it is required for that examination and approved by the instructor: Cell phone, smart watch/watch phone, laptop, tablet, electronic communication devices (including optical), and earphones connected to or used as electronic communication devices.
    - *This is a violation of the Radiologic Technology Student Handbook and will result in dismissal from the program.*

  Students with special needs and/or medical emergencies or situations should communicate with their instructor regarding individual exceptions/provisions. It is the student's responsibility to communicate such needs to the instructor.
- Do not bring children to class.
- **Attendance Policy:** Class attendance is important to ensure that a student receives the knowledge and skills necessary to be successful in the Radiologic Technology program. Students are expected to be in class on time. If a student is tardy they may enter only if they do so quietly.

  When it becomes necessary to miss a session, it is the responsibility of the *student* to contact the instructor and to inquire about assignments. I will *not* distribute the PowerPoints missed. The student must get the notes from a classmate. If a major test is missed, the test will be administered at the first day the student returns to class or at a time designated by the instructor. There will be a **ten (10) point** reduction for make-up exams.

Technical Requirements (for courses using Blackboard)

The latest technical requirements, including hardware, compatible browsers, operating systems, software, Java, etc. can be found online at: https://help.blackboard.com/enus/Learn/9.1_2014_04/Student/015_Browser_Support/015_Browser_Support_Policy A functional broadband internet connection, such as DSL, cable, or WiFi is necessary to maximize the use of the online technology and resources.

Disabilities Statement

The Americans with Disabilities Act of 1992 and Section 504 of the Rehabilitation Act of 1973 are federal anti-discrimination statutes that provide comprehensive civil rights for persons with disabilities. Among other things, these statutes require that all students with documented disabilities be guaranteed a learning environment that provides for reasonable accommodations for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Special Populations Coordinator at (409) 880-1737 or visit the office in Student Services, Cecil Beeson Building. You may also visit the online resource at http://www.lit.edu/depts/stuserv/special/defaults.aspx

Student Code of Conduct Statement

It is the responsibility of all registered Lamar Institute of Technology students to access, read, understand and abide by all published policies, regulations, and procedures listed in the *LIT Catalog and Student Handbook*. The *LIT Catalog and Student Handbook* may be accessed at www.lit.edu or obtained in print upon request at the Student Services Office. Please note that the online version of the *LIT Catalog and Student Handbook* supersedes all other versions of the same document

Starfish

LIT utilizes an early alert system called Starfish. Throughout the semester, you may receive emails from Starfish regarding your course grades, attendance, or academic performance. Faculty members record student attendance, raise flags and kudos to express concern or give praise, and you can make an appointment with faculty and staff all through the Starfish home page. You can also login to Blackboard or MyLIT and click on the Starfish link to view academic alerts and detailed information. It is the responsibility of the student to pay attention to these emails and information in Starfish and consider taking the recommended actions. Starfish is used to help you be a successful student at LIT.