COURSE SYLLABUS
RT 1143 – RADIOGRAPHIC EXPOSURE / PHYSICS I

CLASS HOURS: 4  CREDIT HOURS: 4
LABORATORY HOURS: 3

CATALOG COURSE DESCRIPTION: This course is the first of a two course sequence in the fundamentals of radiologic science and x-ray physics. The complete sequence provides the opportunity for a thorough understanding of the nature and production of x-rays, x-ray exposure, image formation, film processing, x-ray equipment / film processor quality analysis and the physical phenomena associated with x-ray production. In addition, special imaging methods, radiation protection and health physics are discussed. Topics covered in the first course include the nature and production of x-rays, x-ray film and intensifying screens, creation of the invisible and manifest image, film processing equipment and quality control, the prime factors of radiography and x-ray interaction with matter. Laboratory experiments are used to demonstrate clinical applications of the theoretical principles and concepts.

ENTRY LEVEL STANDARDS: High school and college achievement, ACT scores and a personal interview designed to determine the level of the student’s skills in communication and problem solving, relevant work experience and true desire to become a radiologic technologist shall be consistent with the Radiologic Technology program admission requirements. Proficiency in math and chemistry is required for success in this course.

PREREQUISITES: Admission to the Radiologic Technology Program, CHEM 1010 or High School Chemistry; MATH 1710

COREQUISITES: RT 1130

TEXTBOOK(S) AND OTHER REFERENCE MATERIAL BASIC TO COURSE:

1. Radiologic Science for Technologists, Bushong
2. Radiologic Science Workbook and Laboratory Manual, Bushong

Required Student Learning Outcomes (Program Student Learning Outcomes and Course Student Learning Outcomes):
(PSLO 1-9 are covered in different courses. If a PSLO is not identified here it is not addressed in this course.)

PSLO#2. Apply the principles of x-ray production, x-ray interactions with the body, and the biological effect of exposure to ionizing radiations in the performance of medical imaging procedures to protect the patient, self and others.

CSLO # 1  Given an explanation of the nature of our surroundings, demonstrate an understanding of the concepts of radiation. (VIII)

CSLO # 2  Demonstrate knowledge of the fundamental concepts of matter and energy and understand the significance of this knowledge to the study of radiologic science. (VII, VIII)

CSLO # 3  Demonstrate a solid foundation in the basic concepts of mathematics and exhibit proficiency at working each type of problem presented in Bushong. (VIII)

CSLO # 4  Demonstrate an understanding of the composition of matter, atomic structure, combinations of atoms and fundamental particles, and demonstrate knowledge of atomic nomenclature. (VIII)

CSLO # 5  Demonstrate an understanding of the production and properties of x-rays. (VIII)

CSLO # 6  State the two categories of ionizing radiations and describe their origins. (IV, VIII)

CSLO # 7  Accurately describe the properties and behavior of electromagnetic radiation. (IV, VIII)

CSLO # 8  Identify the exposure factors which control the numbers of x-rays (quantity) reaching the imaging media and explain their influence; identify the exposure factors which control the penetration (quality) of the x-ray beam and explain their influence. (I, III, IV, VII, VIII)

CSLO # 9  Understand radiographic and photographic terminology and be able to use the terms properly. (I-IX)

CSLO # 10  Know the composition of x-ray film and describe the effects of light and radiation on the film (Formation of the Latent Image). (VII, IX)

CSLO # 16  Demonstrate knowledge of the following aspects of image intensification using intensifying screens: (II, III, IV, VII, VIII, IX)
1. Screen construction
2. Luminescence
3. Screen characteristics
   a. resolution
   b. speed
4. Screen-film combinations (spectral matching)
5. Screen care and cleaning
6. Fluoroscopic screens

CSLO # 17  Identify the prime factors of radiography and describe their influence on the radiographic image. (II, III, IV, VIII, IX)

CSLO # 18  Given an explanation of the interaction of radiation with matter, demonstrate an understanding of how the interactions of x-ray with body structures contribute to the radiographic quality of an image. (I, II, III)

PSLO#4. Apply quality assurance principles and perform quality control tests in order to maintain equipment and perform procedures with appropriate positioning and image quality.

CSLO # 14  Understand the need for standardization of film processing and explain the use of sensitometry as the mechanism to control or monitor film processing quality in an x-ray department. (III, VII, VIII, IX)

PSLO#5. Process x-ray films according to established protocol for double or single emulsion film and operate imaging plate readers, technologist workstations and PACS systems.

CSLO #11  Understand the importance of good darkroom procedure and proper darkroom construction. (VII, IX)

CSLO # 12  Describe the conversion of the latent image to the manifest (visible) image. (VII, IX)

CSLO # 13  Identify the film processing solution ingredients and describe their function and affect on image quality. (III, VII, VIII, IX)

CSLO # 15  Demonstrate knowledge of the various systems of an automatic processor and describe the chemical and electrical safety precautions to be followed in the use of the processor. (III, VII, VIII, IX)

Other Learning Indicators or Objectives (optional):

The student will:

FUNDAMENTALS OF PHYSICS (C) – 75% Minimum Mastery Level Required
1. Perform simple arithmetic manipulations required in radiology.
2. Apply scientific notation to manipulations of very large and very small numbers.
3. Identify the basic and special quantities of the SI system.
4. State Newton’s three laws of motion.
5. Distinguish between power and work.
6. Perform simplistic applications of mechanics.
7. List the three measures of thermal energy and relate the respective values of each for boiling and freezing water.
8. Solve linear algebraic equations.
9. Solve numerical problems containing exponents.
10. Graph linear and logarithmic functions.
11. State appropriate prefixes and their respective numerical values for measurements of radiation.
13. State the physical units of heat and accurately distinguish between heat and temperature.

CONCEPTS OF RADIATION (A, E) – 75% Minimum Mastery Level Required
1. Given that all things visible and invisible can be classified as matter or energy, demonstrate an understanding of the concepts of radiation by defining and identifying examples of the following:
   a. matter
   b. mass
   c. weight
   d. energy
     1) potential
     2) kinetic
     3) chemical
     4) electrical
5) thermal

6) nuclear

7) electromagnetic energy

2. Distinguish the difference between the weight of an object on earth and the weight of an object on the moon.

3. Differentiate between the term mass and the term weight.

4. Describe how both PE (Potential energy) and KE (Kinetic energy) depends on the mass of an object.

5. Given an x-ray machine’s operating voltage and the number of joules per KeV, calculate at what fraction of the velocity of light that the operating voltage electrons travel.

6. Describe the characteristics of electromagnetic radiation and give examples of the radiation.

7. Define the following terms:
   a. speed of light
   b. frequency
   c. wavelength
   d. photon (quantum)
   e. Angstrom (Å)
   f. eV (electron volt)

8. State the formula which proves that frequency is inversely proportional to wavelength.

9. State the unit of frequency; the units of wavelength.

10. Discriminate between x-rays and visible light.

11. Describe the interaction of electromagnetic radiation with matter as a function of wavelength.

12. Define the following terms related to light:
   a. refraction
   b. transmission / transparent
   c. attenuation
   d. translucent
   e. absorption / opaque

13. Define the following terms related to x-ray:
   a. radiopaque
   b. radiolucent
   c. radiopaque

14. List and be able to recognize the properties of x-rays.

15. State the inverse square law and be able to compute the intensity of the x-ray beam when the distance is changed.

16. Describe the speed with which all electromagnetic waves travel.

17. Properly associate the terms wavelength, frequency, energy and penetration.

**THE ATOM (D, F) – 75% Minimum Mastery Level Required**

1. Relate the important milestones in the development of the modern description of the atom.

2. Identify the basic characteristics of atoms and molecules.

3. List the relative magnitudes of material objects from smallest to largest in the metric system.

4. Identify the fundamental particles and their characteristics.

5. Apply the terms “atomic number”, “atomic mass” and “nuclei”.

6. Distinguish between stable and radioactive material.

7. List the various types of ionizing radiation and identify their distinguishing characteristics.

**ELECTROMAGNETIC RADIATION (G) – 75% Minimum Mastery Level Required**

1. Describe the physical features of a photon and identify those that are of importance to radiology.

2. Examine the electromagnetic spectrum and describe the windows in the spectrum that allow us to image the human body.

3. Formulate the relationship between energy and matter.

4. State the wave equation and apply it to a diagnostic x-ray.

5. State the wave equation in three different ways.

6. Identify the difference between x-rays and gamma rays.

**X-RAY TUBE (E) – 75% Minimum Mastery Level Required**

1. Given a diagram of an x-ray tube, identify and explain the function of the following parts:
   a. protective housing
b. evacuated glass envelope

c. cathode
   1) filament
   2) focusing cup
d. anode
   1) target
e. high voltage supply

2. Explain the meaning of isotropic emission of x-rays.
3. Define useful beam.
4. Define leakage radiation
5. Name four functions of an x-ray tube housing.
6. Describe the problems associated with the incorrect handling of an x-ray tube housing.
7. Discriminate between a Crooke's tube and the Coolidge hot filament tube.
8. Define thermionic emission and state what type of process it is.
9. Describe the characteristics of tungsten which made it an ideal filament and target material.
10. Explain the addition of 1% to 2% thorium to the tungsten filament of an x-ray tube.
11. Identify the factors which determine a focusing cup's effectiveness in focusing the electron beam to pin point area of the target.
12. Discriminate between a stationary and rotating anode tube.
13. Describe the three functions of an x-ray tube anode.
14. Explain the significance of the invention of the hot cathode tube (by Dr. W. D. Collidge) to the independent control of kV and mA.
15. Define inherent filter; define added filter; define total filtration.
16. Discriminate between single and dual focus rotating anode tubes.
17. Define the term space charge effect.
18. Identify the primary cause of off-focus (stem radiation).
19. State the main advantage of using a small focal spot.

X-RAY PRODUCTION (E, H, I) – 75% Minimum Mastery Level Required
1. Explain the importance of each of the four conditions which are necessary for the production of x-rays; describe how they are accomplished.
   a. separation of electrons
   b. production of high speed electrons
   c. focusing of electrons
   d. interaction of high speed electrons with the target
2. Define the term Bremsstrahlung radiation.
3. Define the term characteristic radiation.
4. Define ionization.
5. Discriminate between homogeneous and heterogeneous x-ray beam.
6. Define x-ray beam quantity, identify the technical factors which are used to control it; and describe how each of the factors control it.
7. Define x-ray beam quality; identify the technical factors which are used to control it; and describe how each of the factors control it.
8. Express by using a formula, the relationship of x-ray exposure to the following:
   a. mA
   b. time
   c. mAs
   d. kVp
   e. distance
9. Define each of the following radiographic or photographic terms:
   a. central ray (CR)
   b. focal spot (FS)
   c. focus-film distance (FFD)
   d. kilovoltage (kV)
   e. milliamperes (mA)
   f. milliampere-seconds (mAs)
   g. object-film distance (OFD)
h. primary radiation  
i. scatter radiation  
j. time in sec(s)  
k. screens  
l. collimators  
m. grid  
n. density  
o. contrast  
p. detail  
q. distortion  

RADIOGRAPHIC FILM (J) - 75% Minimum Mastery Level Required  
1. Define remnant radiation.  
2. Explain what is meant by imaging media.  
3. Differentiate between x-ray film and regular photographic film.  
4. Describe the quality control used in the manufacture of radiographic film’ explain the need to avoid radioactive contamination of the manufacturing process.  
5. Describe the basic construction of x-ray film and describe the function of each component part.  
6. Explain the meaning of duplitized and describe the positive and negative aspects of it.  
7. Explain the importance of having the film base be radiolucent.  
8. Explain the significance of the blue dye which is added to the film base.  
9. Discuss the historical development of x-ray film base material.  
10. Distinguish between a cellulose triacetate base and a polyester base.  
11. Explain why gelatin is the material of choice for the emulsion portion of a film.  
12. Explain the use of a silver halide in the emulsion of x-ray film.  
13. Name two often used silver halides.  
14. Explain the role of sulfur traces in the emulsion of x-ray film; identify the source of sulfur.  
15. Define the term digestion (film manufacturing term).  
16. Define the terms:  
   a. blue sensitive  
   b. orthochromatic  
   c. panchromatic  
   d. x-ray sensitive  
   e. infrared radiation  
17. Explain how the manufacturer of radiographic film sensitizes it to a specific portion of the light or electromagnetic spectrum.  
18. Explain how the imaging property of a silver halide crystal is dependent on imperfections in the crystal.  
19. Define sensitivity speck.  
20. Identify the emulsion characteristics which make a film suitable for radiography.  
21. Define the following terms which are often used to describe emulsion characteristics.  
   a. speed (sensitivity)  
   b. latitude  
   c. contrast  
   d. resolution  
22. Explain how emulsion characteristics are varied and controlled by the manufacture of radiographic film.  
23. Identify at least 4 different types of x-ray film.  
24. Distinguish between screen-type film and direct exposure type film.  
25. Explain the affects of the following on x-ray film:  
   a. age  
   b. humidity  
   c. temperature  
   d. light  
   e. pressure  
   f. ionizing radiations  
   g. finger prints, scratches, dirty intensifying screens and crinkle marks  
   h. chemical fumes  
26. Distinguish between sensitized artifacts and non-sensitized artifacts and give examples of each.  
27. Describe the controls used in the handling of x-ray film to avoid static discharge.
28. Distinguish between film sensitivity before exposure (“raw”) as opposed to after exposure.

29. Define spectral sensitivity.
30. Explain the importance of using the correct safelight filter.
31. Explain the significance of correct installation of safelight filter.
32. Explain the importance of correct bulb wattage selection for safelights.
33. With respect to safelight use, discuss the affect of time, distance, and shielding to their proper use.
34. Describe the method used to analyze proper safelight use.
35. Describe the ill affects to the radiographic image when safelights are used improperly.
36. Explain the purpose of a film exposure holder.
37. Describe the two principal types of film holders.
38. Distinguish between a direct exposure holder and a cassette with screens in terms of:
   a. exposure of the film
   b. exposure to the patient
   c. time of exposure
39. Define latent image.
40. State the photographic effect formula.
41. Describe a silver halide crystal relative to charge, arrangement of silver ions and halide ions, and location of sensitivity speck.
42. Associate the formation of the latent image with the Gurney Mott theory.
43. Describe the ionization phase of latent image formation.
44. Describe the entrapment stage of latent image formation.
45. Describe the latent image state of the Gurney Mott theory.

PROCESSING RADIOGRAPHIC FILM – CREATION OF THE VISIBLE IMAGE (K, L, M, N) – 75% Minimum Mastery Level Required

A. The Importance of Good Darkroom Procedure and Proper Darkroom Construction
1. Determine when is the best time to decide on a location for a processing room.
2. Determine the best location for a processing room, if asked to design an entire radiology department.
3. Concerning the design and function of a darkroom, state the rationale for the following:
   a. plumbing and electrical service should be accessible
   b. windows should be avoided
   c. processing room walls should be lead lined when adjoining x-ray rooms
   d. all entrance doors must be made absolutely light-tight and have an inside lock
   e. darkroom walls and floors should be covered with chemical resistant material
   f. cleanliness of bench tops, accessories and equipment should be maintained
4. Name and describe the three basic types of processing room entrances.
5. Explain the need for proper ventilation in a processing room.
6. Explain why the ventilating system should be completely light-proof.
7. Explain the need for pass boxes and their mechanism of use.
8. Name three types of illumination needed in a processing room. Explain the purpose of each.
9. Explain the meaning of darkroom.
10. Describe the proper safelight operation in terms of:
    a. time of film exposure to safelight
    b. type and condition of filter used
    c. maintaining the proper distance away from them
    d. using the proper intensity of bulb
11. Describe the spectral emission-spectral sensitivity concepts of safelight operation.
12. Describe the function of the following accessory equipment:
    a. film bins
    b. storage bins
    c. shelves
    d. handers and racks
    e. water temperature
    f. thermometers
    g. timers
    h. pass boxes
    i. identification printer
    j. manual processing tanks
    k. stirring paddles
    l. dryer
    m. replenishment storage tanks
13. Discuss daylight processing with regard to the efficient handling of x-ray film in room light and the efficient and effective use of time, space and personnel.
B. Film Processing
   1. Explain why the latent image is invisible.
   2. List in the proper order, the steps involved in the processing of radiographic film and give a general explanation of what occurs in each step.

C. Creation of the Visible Image
   1. Using a chemical formula, state the reaction that occurs in the development of radiographic film.
   2. Define the following terms:
      a. reduction
      b. oxidation
      c. reducing agents
      d. oxidizing agents
      e. oxidation-reduction reaction
   3. Describe the action of the reducing agents on the exposed silver ions (latent image) to change them to black metallic silver.
   4. Discuss the importance of giving proper attention to time, temperature and activity in the development of x-ray films.
   5. Explain the relationship between time of development and the temperature of development based on a specific activity of the developer.
   6. Explain what happens to the bromide portion of the silver halide crystal during the creation or development of the manifest (visible) image.
   7. Define bromide drag and describe its affects on the density of the image.
   8. Explain the need to maintain the activity of the developer through:
      a. proper agitation
         i. rollers moving
         ii. recirculation system (3-5 gallons per minute)
      b. replenishment (an average of 70 cc per 14 inches of film)
   9. Identify the individual developer solution ingredients and describe their function in the solution.
   10. Define pH.
   11. Define specific gravity.
   12. Explain the importance of pH and specific gravity measurements to determine proper activity of the developer solution.
   13. Describe the instruments used to check pH and specific gravity.
   14. Identify four common contaminants of the developer solution and explain how each interferes with the development process.
   15. Define chemical fog.
   16. Correctly explain the function of the developer starter solution.
   17. Explain the need to choose the correct starter solution base on the type of developer used.

D. Basic Sensitometry-Radiographic Quality
   1. Correctly define the following terms:
      a. sensitometry
      b. densitometry
      c. sensitometer
      d. gradient
      e. average gradient
      f. gamma gradient
      g. speed point
      h. density
      i. contrast
   2. Correctly list and explain the four factors involved in sensitometry.
   3. Explain the need for standardization of film processing and explain the use of sensitometry as a mechanism to control or monitor film processing quality in an x-ray department.
   4. Correctly explain the anatomy of the sensitometric curve and define the following terms which are used in the interpretation of the curve:
      a. base plus fog
      b. D-Min.
      c. D-Max.
      d. average gradient
5. Correctly describe a good quality radiograph.
6. Distinguish between film contrast and subject contrast.
7. Identify the density point(s) on the characteristic curve that one should evaluate to determine:
   a. contrast
   b. speed
   c. latitude
8. Define latitude.
9. Correctly describe a film exhibiting:
   a. wide latitude
   b. narrow latitude
10. Describe the affects the following have on base fog.
    a. developer activity
    b. developer time
    c. developer temperature
    d. inappropriate safelights or film storage
11. Identify the factors which may cause the following:
    a. increased contrast
    b. decreased contrast
    c. increased film speed
    d. decreased film speed
12. Given that the developer activity is low due to under-replenishment, discuss the following:
    a. hydroquinone level
    b. bromide level
    c. film contrast and speed
13. Given that the developer activity is high due to over-replenishment, discuss the following:
    a. hydroquinone level
    b. bromide level
    c. film contrast and speed

E. Fixation-Wash-Dry
1. List three functions of fixation.
2. List the basic ingredients of a fixing solution and describe the function of each ingredient.
3. Explain the importance of pH and specific gravity measurements to determine proper activity of the fixer solution.
4. Explain how one would determine clearing time; fixing time.
5. Given that the fixer activity is low due to under-replenishment, discuss the following:
   a. contamination by developer solution
   b. pH
   c. silver content
6. Given that the fixer activity is high due to over-replenishment, discuss the following:
   a. pH
   b. silver content
   c. fixer precipitation
7. Explain the function of wash water in film processing.
8. Properly associate hypo retention with archival quality of processed radiographic film.
9. Describe the standard for temperature control of the wash water.
10. Explain the need of water exchange in the wash tank to be at least 2.5 gallons per minute.
11. Explain the need to properly dry a film before handling.

F. Safety- Electrical and Chemical
1. Explain the need to wear eye protectors and protective clothing when working around processors.
2. Explain the need to cut off the incoming power source when working on a processor. Describe the method used to reduce the possibility that the power will be inappropriately turned on.

G. Silver Recovery (N, O)
1. Explain why the recovery of silver is desirable.
2. Explain what happens to the silver contained in the emulsion of a film during the processing of the film.
3. Name the three basic methods of silver recovery.
4. Describe the principle of operation of the metallic replacement silver recovery method. Describe the advantages of using this method.

5. Describe the principle of operation of the electrolytic silver recovery method. Describe the advantages and disadvantages of using this method.

6. Describe the principle of operation of the chemical precipitation silver recovery method. Describe the advantages and disadvantages of using this method.

7. Describe the principle of operation of the ion exchange silver recovery method.

8. Describe the principle of operation of the reverse osmosis or dialysis silver recovery method.

THE BASIC SYSTEMS OF AN AUTOMATIC PROCESSOR (L, M, N, O) – 75% Minimum Mastery Level Required

A. Chemical System – (Discussed in preceding sections)

B. Transport System
   1. Correctly state the two basic functions of the transport system.
   2. Correctly name the two subsystems of the transport system.
   3. Correctly list or identify specific component parts of a roller sub-system and identify functions assigned to each.
   4. Identify transport artifacts and explain the proper cleaning techniques and adjustment to eliminate transport system artifacts.
   5. Explain how the speed of the drive motor is reduced.
   6. Correctly describe the method used to control transport speed.
   7. Show an ability to properly associate gears, sprockets to chains, pulleys to belts.

C. Tempering System
   1. State the function of the tempering system and explain its influence on film sensiitometry.
   2. Identify the mechanisms which control temperature in the processor and describe their function and operation.
   3. Correctly explain the difference between a thermostat and thermometer.
   4. Explain why all display thermometers should be calibrated according to a standard thermometer.
   5. Be able to evaluate the use of an alcohol thermometer or bimetallic-type standard calibrated thermometer versus the use of a mercury thermometer in monitoring chemical temperatures.
   6. Describe the positive and negative aspects of cold water processing.
   7. Explain the need to regulate water temperature relative to developer temperature.

D. Replenishment System
   1. Correctly list 4 reasons for the need of chemical regeneration through chemical replenishment.
   2. Differentiate replenishment and regeneration.
   3. Correctly state the two functions of the replenishment system.
   4. Correctly explain the relationship between time, location, height and cleanliness of the replenishing tank and proper maintenance of replenishment system.
   5. Explain the purpose of a floating lid and dust cover for replenishing storage tanks.
   6. Correctly define replenishment rate and explain how rate is established.
   7. Explain the meaning of high volume, low volume and normal volume processing and describe how the use factor of a processor influences replenishment rates.
   8. Explain the relationship between under or over-replenishment and sensiitometry and cost containment.
   9. Correctly list or identify the 4 types of replenishing pumps and describe the function of each.
   10. Explain the need for higher replenishment rate in the fixer than in the developer.

E. Circulation / Filtration System
   1. Correctly state the basic function of the circulation / filtration system.
   2. Correctly list 4 functions performed by circulation pumps.
   3. Explain the result of improper agitation and list or identify 5 causes of inadequate agitation.
   4. Correctly explain where and what size filters are needed on a processor.
   5. List or identify and explain 2 reasons for not using filters in the fixer.
   6. Explain why filters are not required for the wash tank.
   7. Given a particular filter, identify the type of material which can be successfully filtered using it.

F. Drying System
   1. Correctly explain the two basic functions of the dryer system.
   2. Explain the relationship between proper drying and visualization of the image.
   3. Correctly list or identify the components of the dryer system and explain the function of each component.
   4. List frequently encountered problems relating to the drying system and explain their causes.

G. Electrical System
1. State the main function of the electrical system.
2. Explain the reason for the lock-tag-test safety principles when working on electrical equipment.
3. Define schematic.
5. Give examples of electrical switching devices in an automatic processor.

INTENSIFYING SCREENS (K) – 75% Minimum Mastery Level Required
1. Explain why there is less patient exposure, less motion problems and less stress on an x-ray tube using screens as opposed to direct-exposure radiography.
2. Describe the overall construction of a typical x-ray intensifying screen, including approximate layer thicknesses.
3. Describe the protective coating layer of an intensifying screen and state its functions.
4. List or identify the ideal characteristics of an intensifying screen phosphor and state its primary purpose.
5. Describe the reflective layer of an intensifying screen and describe its primary function.
6. Explain the purpose of adding dyes to the phosphor layer of intensifying screens and describe their influence on the speed of the screens exposure needed to effect a desired density and resolution of the image.
7. Describe the base of an intensifying screen and explain its function.
8. Discuss the physical qualities that a material must possess to be used as a screen base material.
9. Discuss the two types of luminescence and how they are associated with intensifying screens and fluoroscopic screens.
10. Define or otherwise identify the following:
    a. afterglow
    b. lag
    c. isotropically
    d. resolution
    e. phosphor
    f. emission spectrum
    g. sensitivity spectrum
    h. luminescence
    i. fluorescence
    j. phosphorescence
    k. intensification factor
    l. screen speed
11. Explain the phenomenon of luminescence.
12. List or identify the intrinsic and extrinsic factors which control the speed of intensifying screens. Explain their control and affect on resolution and speed.
13. Given the type of an intensifying screen, state or otherwise identify the screen characteristics relative to color of emission, approximate speed and resolution.
14. Given the exposure without screens and the exposure with screens, calculate the intensification factor.
15. Discuss the importance of spectral emission matching of screens and films.
16. Describe the composition of rare earth screens.
17. Explain the purpose of terbium activation of a rare earth.
18. Distinguish between a rare earth and calcium tungstate screen relative to speed, absorption and conversion efficiency.
19. Describe a system for proper maintenance and care of intensifying screens.
20. Describe the method used to test screen-film contact and explain why there should be good film-screen contact.
21. List or otherwise identify common causes of poor film-screen contact.
22. State the difference between a conventional fluoroscopic screen and a radiographic intensifying screen.
23. Explain why the front surface of a cassette, the side facing the tube, should be made of a material with a low atomic number (Z#).
24. Give 4 examples of ideal or appropriate cassette front material.
25. Explain the need for compression of one screen on another and give 3 examples of appropriate compression methods.
26. Explain the need for using heavy metal as the back cover of a screen.
27. Explain the influence of backscatter radiation on image quality, explain how it can be minimized; and how it can be recognized.
28. Distinguish between carbon fiber and aluminum or plastic as cassette or table top material.
29. List or otherwise identify the advantages and disadvantages of screen use.

PRIME FACTORS OF RADIOGRAPHY (Q) – 75% Minimum Mastery Level Required
A. Milliamperage
1. Define milliamperage.
2. Explain the relationship between current to the filament and temperature of the filament, temperature of the filament, temperature of the filament and electrons emitted from the filament, electrons emitted from the filament and x-ray tube current, x-ray tube current and number of x-rays produced and the numbers of x-rays produced and the radiographic density.
3. Describe the method used to select tube current.
4. State the ratio which correctly describes the relationship of x-ray quantity and mA.
5. Explain why the mA meter is placed in series with the secondary winding of the step-up or high voltage transformer.
6. Explain why the mA meter is grounded at the center tap of the high voltage transformer
B. mAs or Time x mA
1. Given any mAs value, be able to calculate a time and milliamperage to suit a problem.
2. Associate the total number of x-rays reaching the film with the x-ray tube current and time.
3. Given a mA value and time value, calculate mAs.
4. Express the relationship of mA and time for the control and maintenance of radiographic density.
5. Identify the ratio which correctly describes the relationship of x-ray quantity and time or mAs.
C. Kilovoltage
1. Identify the factors which are affected by a change in kV.
2. Identify the ratio which correctly describes the relationship of x-ray intensity (quantity) to kVp.
3. Explain why kVp can influence both quality and quantity of radiation.
4. Associate the x-ray quality influence of kVp with the contrast of the image.
5. Associate the x-ray quantity influence of kVp with the density of the image.
6. Describe the fundamental criteria to be used in the selection of kVp for any radiologic examination.
7. State the rule which describes the relationship of kV to x-ray output intensity and resultant density of an image.
D. Focus-Film Distance
1. Identify the ratio which correctly describes the relationship of intensity or exposure to distance.
2. Explain the decrease in intensity (quantity of x-ray photons) as the distance from a point source is increased.
3. Given the distance of a point source of radiation and the area of coverage of radiation on a surface, calculate the square area of coverage on that surface if the point source is moved. Given the same information, calculate the intensity of radiation if the point source is moved.
4. Given the distance of a point source of radiation and the intensity of radiation at that distance, calculate the exposure adjustment necessary to maintain density of an image if the point source is moved.
E. X-Ray Quantity and Quality
1. State the three calculable factors that affect x-ray quantity (image density) and describe the influence.
2. State the factors which control beam quality (penetration) and describe how beam quality is measured.
3. Associate HVL (half-value layer) with x-ray beam quality.

X-RAY INTERACTION WITH MATTER (R) – 75% Minimum Mastery Level Required
1. State the 5 interactions that can occur between a photon and matter.
2. Of the 5 basic interactions of x-ray with matter, identify the interaction which are more likely to occur when the energy of the x-rays are within the diagnostic radiology range.
3. Identify the 2 interactions most critical to diagnostic radiology.
4. Describe the processes which occur within an atom upon interaction with an incident photon to produce secondary and/or scatter radiation by the following methods:
   a. Thompson (classical) scattering
   b. Compton effect
   c. Photoelectric effect
5. Relative to the interaction of radiation with matter, describe the influence of atomic number and energy of the x-ray beam on the interaction by Compton and photoelectric effect.
6. Compare the contributions of photoelectric effect and Compton effect to the making of a radiograph.
7. Define differential absorption and show how it varies with kVp, mA, and atomic number and density of the absorber.
8. Examine the nature of a contrast examination and show why it is helpful.
9. State what is meant by exponential attenuation.

**Required Assessments:**

**Assessment Names and Descriptions:** *(Use more detailed descriptions here, consistent with the format we used for the database, indicating the PSLO and CSLO with which they are associated).*

A. Testing Procedure: An examination directly related to the instructional objectives will follow completion of the following units:

1. Fundamentals of Physics
2. Concepts of Radiation
3. The Atom
4. X-Ray Tube
5. X-Ray Production
6. Radiographic Film
7. Creation of the Manifest Image and Sensitometry
8. Automatic Processor System
9. Intensifying Screens
10. Prime Factors of Radiography
11. Interaction of Radiation with Matter

Mastery level for each unit must be 75% or greater. In addition, an objective type comprehensive final examination will be given and a 75% mastery is required.

B. Laboratory Expectations: Laboratory exercises which relate to the concepts of radiation, the production and properties of x-rays, the exposure and processing of radiographic film, the properties of intensifying screens and the prime factors of radiography will be completed.

**CSLO/Assessment Alignment:**

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**Grading Scale or Policy, Weekly Outline, Topics, or Instructional Activities:**

1. 60% of the mean average of the unit examinations
2. 20% of the mean average of the final examination
3. 20% of the mean average of the homework, laboratory and worksheet assignments

There will be 2 points deducted from the final grade for each absence exceeding the formula:

Excused days absence = \(\frac{1}{15}\) (class hours) (number of weeks per semester)

Because promptness is as important as attendance, a combined frequency of tardiness of 50 minutes will equal one day’s absence.

One hundred percent (100%) attendance will be rewarded with 5 points added to the final grade.
Radiologic Technology Program
Statement of Understanding

**Disabilities Statement**
Students who have educational, psychological, and/or physical disabilities may be eligible for accommodations that provide equal access to educational programs and activities at Chattanooga State.

These students should notify the instructor immediately, and ideally should contact Disabilities Support Services (S-113, phone 697-4452) within the first two weeks of the semester in order to discuss individual needs. The student must provide documentation of the disability so that reasonable accommodations can be requested in a timely manner. All students are expected to fulfill essential course requirements in order to receive a passing grade in a class, with or without reasonable accommodations.

**Disruption Statement**
Disruption or obstruction of teaching, research, administration, disciplinary proceedings, other college activities, including its public service functions on or off campus, or other authorized non-College activities, when the act occurs on College premises, is subject to disciplinary sanctions.

The terms classroom disruptions means behavior a reasonable person would view as substantially or repeatedly interfering with the conduct of a class. A student who persists in disrupting a class will be directed by the faculty member to leave the classroom for the remainder of the class period. The student will be told the reason(s) for such action and given an opportunity to discuss the matter with the faculty member as soon as possible. Prompt consultation will be undertaken by the faculty with the Department Dean and the College Judicial Officer.

If a disruption is serious, and other reasonable measures have failed, the class may be adjourned and the campus police summoned.

**Pagers and Cell Phones** – Activated pagers and cell phones are strictly prohibited when class is in session.

The **RADIOLOGY TECHNOLOGY PROGRAM** is a competency-based program. The goal of each instructor is to have students complete the competency requirements of each course. Completion of set competency areas of a course is greatly affected by student’s ability to progress through the material. If competencies are not mastered in a specific course, a subsequent course will be structured to assure competency attainment of those areas.

Each topic in each syllabus will indicate a mastery level for the objectives that correlate to the topic. Evaluation is criterion-referenced to the objectives for each topic. **Mastery level criteria for each topic must be met.** Remediation is permitted with restrictions. The first remediation test grade will be averaged with the original test grade. A second remediation will result in ten points being subtracted from the specific topic grade. Subject to the discretion of the instructor, further remediation and testing may result in a reduction of one letter grade for the course for each occurrence, which may lead to failure of the course.

A grade of “C” or better in the following courses is required for progression:

1. All RT prefixed courses
2. Human Anatomy & Physiology I, II (BIOL 2010, BIOL 2020)
3. Radiobiology and Radiation Protection (RT 2543)
I hereby acknowledge that I have read the syllabus and understand the policies regarding objectives, grading, performance, participation, absenteeism, tardiness, and conduct.

I understand the policy on NO activated cell phones or pagers during class time and agree to keep these devices enclosed in a container (such as a purse or backpack) so that they are not visible to anyone in the classroom.

Chattanooga State is committed to promoting a mode of individual conduct based on the principles of honesty, fairness, trust, respect and responsibility. I understand that academic integrity is demanded in ALL records, exercises, assignments and tests in the classes. Those who falsify records, copy other work or share such information inappropriately will receive an F in the course.

I understand that most courses in this program offer supplemental websites which are required on a routine basis. Computers with web access are readily available on campus and may be used to access this required component of the course.

My signature documents my agreement to abide by all policies and conditions stated in the course syllabus, as well as all program policies.

____________________________________    __________________________
Name in print                                                       Date

____________________________________
Signature