COURSE SYLLABUS
RT 1243 – RADIOGRAPHIC EXPOSURE / PHYSICS II

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

CATALOG COURSE DESCRIPTION: This course is the second of a two-course sequence in the fundamentals of radiographic science and physics. The complete sequence provides the opportunity for a thorough understanding of the nature and production of 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. This course will include the following topics: the factors that govern and influence the production of the radiographic image using radiographic film; the importance of proper operation and care of radiographic equipment; tomography; and radiation protection and health physics. Laboratory experiments are used to demonstrate clinical applications of the theoretical principles and concepts.

ENTRY LEVEL STANDARDS: A grade of "C" or better in RT 1143 – Radiographic Exposure / Physics I is essential for success in this course. Having met the objectives of the first course in the sequence, the student should demonstrate knowledge of the nature and production of x-ray film and intensifying screens, creation of the invisible and manifest image, film processing equipment and quality control, prime factors and x-ray interaction with matter and the use of x-ray to produce diagnostic quality images at minimal radiation exposure to patients. The student should also demonstrate an ability to read and comprehend word problems and solve them algebraically. In addition, the student should demonstrate a responsible attitude toward attendance, independent learning activities, class and laboratory participation and preparation.

PREREQUISITE: RT 1143, RT 1130

COREQUISITE: None

TEXTBOOK(S) AND OTHER REFERENCE MATERIAL BASIC TO COURSE:
1. Radiologic Science for Technologists, Stewart C. Bushong
2. Radiologic Science Workbook and Laboratory Manual, Stewart C. Bushong
3. An Analysis of Radiographic Quality, Donohue

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# 8 Demonstrate the ability to solve mathematical problems and/or make adjustments in technique to accomplish the following: (II)

1. optimal penetration of structures
2. optimal density
3. optimal contrast
4. optimal sharpness
5. minimal radiation exposure
6. correction for patient factors, equipment changes and macroradiography

CSLO# 9 Demonstrate knowledge of the derivation of exposure factors to make an x-ray exposure guide. (I, II, III)

CSLO# 13 Understand the influence of filtration of the following and describe the various types of filtration used in radiography: (II, IV, IX)

1. x-ray emission spectrum
2. exposure rate
3. x-ray beam quantity/quality
4. contrast, density
5. minimum wavelength
6. patient exposure
7. HVL

CSLO# 15 Understand the operation of a fluoroscopic video system and trace the flow of information from the x-ray remnant beam through the image-intensifier tube to the video monitor and image receptors. (VII, VIII, IX)

CSLO# 16 Demonstrate an understanding of the three cardinal principles of radiation protection and demonstrate guidelines. (IV, VII, VIII, IX)

CSLO# 18 Be familiar with the fundamental laws of electromagnetism, electrostatics, electrodynamics and magnetism and solve elementary problems involving those laws. (VIII)

PSLO#3. Apply knowledge of human anatomy, physiology, pathology, positioning and radiographic technique to demonstrate anatomical structures on a radiograph or other imaging receptor utilizing equipment and accessories while maintaining the overall diagnostic quality of radiographs.

CSLO# 11 Explain the purpose, limitations and exposure adjustment for the various used grids. (II, III, IV, VII)

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# 1 Recognize an image of radiographic quality as one that possesses sharpness and visibility of the recorded body structures. (III)

CSLO# 2 Associate geometric properties of a radiograph with sharpness of structural details. (III)

CSLO# 3 Associate photographic properties of a radiograph with visibility of structural details. (III)

CSLO# 4 Associate those factors which control or influence recorded detail or distortion with the sharpness of details in a radiographic image. (III)

CSLO# 5 Associate those factors which control or influence density or contrast with the visibility of details in a radiographic image. (III)

CSLO# 6 Explain the controlling and influencing affects of each of the factors which effect each of the radiographic qualities. (I, II, III)

CSLO# 7 Define and discuss the following and state the factors which influence them. (II, III)

1. sharpness of details (geometric properties)
2. visibility of details (photographic properties)
3. density
4. contrast
5. recorded detail
6. distortion
7. magnification
8. macroradiography

CSLO# 10 Describe the significance of limiting the irradiated field of coverage and explain the influence of beam restricting devices on the density and contrast of the image. (II, III)

CSLO# 12 Understand the importance of proper calibration and operation of the x-ray machine to assure proper emission of the x-ray tube, image quality and minimum patient exposure. (II, III, IV, VII, VIII, IX)

CSLO# 14 Be able to discuss the conditions which results in overheating of the x-ray tube and demonstrate the correct use of thermal rating charts to avoid tube failure. (VII, VIII, IX)

CSLO# 17 Demonstrate knowledge of the basic tomographic and stereoradiographic principles and understand the diagnostic significance of their application. (I, II, III, VII, VIII)

Other Learning Indicators or Objectives (optional):
The student will be able to:

RADIOGRAPHIC QUALITY OR DEFINITION (A-K) – 75% Minimum Mastery Level Required

1. Describe the important attributes and radiographic balance achieved by a film that is of radiographic quality.
2. Explain what is meant by the visibility of the structures within a radiographic image.
3. Explain what is meant by the sharpness of the structures within a radiographic image.
4. Of the four major factors contributing to radiographic quality, identify the factors that are referred to as the geometric properties of the radiographic image and provide reasons for your choice.
5. Of the four major factors contributing to radiographic quality, identify the factors that are referred to as the photographic properties of the radiographic image and provide reasons for your choice.
6. Describe the significance of the relationship between the sharpness of the recorded details and their visibility as it relates to radiographic quality.
7. Define the following terms:
    a. sharpness of details

b. visibility of details
c. recorded detail
d. distortion
e. size distortion
f. shape distortion
g. density
h. contrast
i. scale of contrast
j. short scale
k. long scale
l. film contrast
m. film latitude
n. exposure latitude
o. subject contrast

SHARPNESS OF DETAILS – RECORDED DETAIL (B, D, F, G, H) – 75% Minimum Mastery Level Required

1. Explain what is meant by the geometric qualities of a radiograph.
2. Define line pair.
3. State the average visual acuity of the human eye relative to the ability of the viewer to discriminate line pairs.
4. Name the three factors which influence the degree of unsharpness recorded in the image.
5. Identify the single most detrimental factor contributing to a lack of image sharpness.
6. Differentiate voluntary and involuntary motion.
7. State the methods which may be employed to control motion.
8. State the most effective method which may be used to control all motion problems.
9. Describe the adjustment in the following exposure factors to effect a reduction in time to control motion, and yet, maintain the radiographic density of the image.
    a. mA/time
    b. intensifying screens speeds
    c. FFD
    d. kVp/mAs
10. State the three major factors influencing material unsharpness.
11. Define modulation transfer function; define line spread function.
12. Compare and contrast the terms, sharpness and resolution.
13. Describe film's contribution to material unsharpness.
14. Describe screen's contribution to material unsharpness.
15. Compare the unsharpness effected by motion to the unsharpness effected by intensifying screens.
16. Describe the influence of film-screen contact on material unsharpness, and thus, sharpness of the image.
17. Considering that screens contribute to material unsharpness, explain why they are used in radiography.
18. Define parallax; print through.
19. Compare image sharpness using direct exposure with image sharpness using intensifying screens.
20. Compare image sharpness using slow intensifying screens with image sharpness using fast intensifying screens.
21. Define quantum mottle and describe the set of factors which causes it.
22. Given the unsharpness in millimeters contributed by each of the following factors – film, intensifying screen and film-screen contact, calculate the total unsharpness.
23. Describe the method used to identify poor film-screen contact.
24. Identify the three major factors which control geometric sharpness.
25. State the geometric unsharpness formula.
26. Define penumbra; define umbra.
27. Explain why unsharpness is measured instead of sharpness.
28. Explain the influence of each of the following factors on the sharpness or recorded detail of the image.
    a. focus size (FS)
    b. object-film-distance (OFD)
    c. focus-film-distance (FFD)
29. Concerning the line-focus principle define the following terms.
    a. actual focus
    b. effective focus
30. Assess the influence on expected focus size considering the following:
    a. manufacturer's assessment

b. increasing milliamperage
c. smaller target angle
d. anode side of tube as opposed to the cathode side

31. Identify the unsharpness factor over which the technologist has very little control.
32. State the methods which may be employed to help eliminate structural shape unsharpness.
33. Having investigated the three major factors that affect the sharpness of the image – motion, material and geometric unsharpness, when given a list of the factors which influence these factors, arrange them in decreasing order of importance.
34. Given all factors of unsharpness which may be measured and evaluated, calculate the total unsharpness what will result from the effect of all of the factors together.
35. Given technical factors which produced a satisfactory radiograph. indicate the effect, if any, changes in each factor would make on the sharpness of the recorded detail if the changes are made one by one without compensation.

SHARPNESS OF DETAILS – DISTORTION (B, D, F, G, H) – 75% Minimum Mastery Level Required

1. Define distortion, size distortion and shape distortion.
2. State the two factors which control size distortion and describe their control.
3. State the formula which enable one to determine the degree of magnification in a recorded image.
4. State the formula which enables one to determine the percentage of magnification.
5. Using the formulas for degree of magnification and percentage of magnification, calculate the percentage of magnification when given the object size, the focus-film distance and the object-film distance.
6. Define macroradiography.
7. State three radiologic applications of macroradiography.
8. When microradiographic techniques are employed, state the factors which must be used to offset the image sharpness loss.
9. Discuss macroradiography relative to the use of a grid and to patient exposure.
10. Describe at least two radiographic studies where magnification calculations must be made to determine the interpretative results of the examination.
11. State the factors which influence distortion and explain how those factors are applied in order to minimize their effects.
12. Give two reasons for purposely creating shape distortion and give examples of each.
13. Given technical factors which produce a satisfactory radiograph, indicate the effect (if any) changes in each factor would make on the distortion of the structures in terms of size or shape if the changes are made one by one without compensation.

VISIBILITY OF DETAILS – DENSITY (A, C, E, F, G, H, I) – 75% Minimum Mastery Level Required

1. Explain why of all the major factors influencing radiographic quality, density is the basic property and probably the most important.
2. State the mathematical relationship of each of the following factors has to density.
    a. mA
    b. time (sec)
    c. kVp
    d. distance
3. State the exposure increase which is necessary to effect a visible change in radiographic density.
4. Explain why changing kVp to effect a change is density may alter other image qualities.
5. Explain the importance of a caliper to the correct selection of exposure factors to effect a desired radiographic density.
6. Identify the patient factors which deal with varying quantities of tissue and explain the exposure adjustment to produce a desired radiographic density.
7. Identify the patient factors which deal with varying opacities of tissue and explain the exposure adjustment to produce a desired radiographic density.
8. Integrate the knowledge of the anatomical and pathological conditions of the patient and apply it to the proper selection of exposures which will produce a diagnostic radiograph.
9. Describe the exposure adjustment which is necessary to correct for the addition of an orthopedic cast to a body part, and explain why there is a different exposure adjustment for a wet as opposed to a dry cast.
10. Given the speed of intensifying screen-film combinations, properly calculate the exposure adjustment which is necessary to maintain radiographic density.

11. Associate milliamperage or time adjustments in exposure with the change in quantity of radiation.
12. Given any mAs value, be able to calculate a time and milliamperage to suit a specific problem.
13. State the relationship between time and milliamperage to maintain film density.
14. Describe the relationship between density and distance for a given set of radiographs.
15. Distinguish between the mAs distance formula and inverse square law.
16. Explain why kilovoltage is often referred to as the quality factor of the beam,
17. Explain the need to select the kilovoltage necessary to penetrate the part.
18. Describe the problem associated with kV adjustment to correct for density.
19. Explain the relationship between kilovoltage and contrast.
20. Associate the 15% rule with the adjustment in kVp to either effect an increase by 2 or decrease by ½ in density.
21. Apply the knowledge of mathematical applications to the determination of a specific set of exposure factors.
22. State, in progression, the body tissues that absorb the most radiation to those which absorb the least.
23. Explain the importance of the proper kVp selection for contrast and non-contrast procedures.
24. Explain the function of cones and collimators and describe their influence on the primary beam.
25. State the correction in exposure factors necessary to maintain density when one changes from a 14" x 17" field of coverage to an 8" x 10" field of coverage.
26. Describe the influence of filtration of density relative to its affect on the primary beam.
27. Explain the use of compensating filters in radiography.
28. Describe the influence of the angle of the target on the uniformity of the intensity of the x-ray beam.
29. Recognize the anode-heel effect's influence on radiographic density and explain how it can be used to advantage.
30. Describe the exposure adjustment which must be made when moving from a single phase to a three phase x-ray unit. Explain.
31. Compare an x-ray beam produced with single-phase, x-ray equipment with that produced with three-phase, x-ray equipment.
32. Explain the significance of focus-film distance, length of body part, and film size in terms of taking advantage of the anode-heel effect.
33. Explain the purpose of grids.
34. Describe a grid's construction.
35. Concerning changes in grid ratio, describe the exposure adjustment which would be necessary to maintain radiographic density.
36. Given technical factors which produced a satisfactory radiograph, indicate the effect (if any), changes in each factor would make on the density of the image if the changes are made one by one without compensation.
37. Given increases in development time, temperature or activity of development, describe the affects on the overall density of an image.

VISIBILITY OF DETAILS – CONTRAST (A, C, E, F, G, H, I, J, K) – 75% Minimum Mastery Level Required

1. Define radiographic contrast.
2. Properly express the relationship between contrast and visibility of detail.
3. Define subject contrast and identify the exposure factor which may be used to manipulate and control it.
4. Explain the influence of patient factors such as density and opacity of tissue on radiographic contrast.
5. Identify areas of the body which have high subject contrast and areas of the body which have low subject contrast and explain. Explain the purpose of a contrast medium.
6. Explain the influence of kVp or quality of radiation on subject contrast.
7. Explain what is meant by scale of contrast.
8. Properly relate scale of contrast to film latitude and exposure latitude.
9. Describe a film exhibiting high contrast relative to scale of contrast and latitude.
10. Describe a film exhibiting low contrast relative to scale of contrast and latitude.
11. Associate latitude with both scale of contrast and margin for error.
12. Associate low kVp-high mAs with short scale, high contrast and narrow latitude.
13. Associate high kVp-low mAs with long scale, low contrast and wide latitude.
14. Describe filtration's effect on the following:
    a. exposure rate
    b. quality and quantity of x-ray beam
    c. minimum wavelength
    d. density
    e. contrast

15. Define film contrast and film latitude.
16. Properly associate film contrast with scale of contrast and film latitude.
17. Explain the affect of development on film contrast.
18. Describe the affects of screen exposure on the contrast of the image.
19. Define fog.
20. Describe the sources of radiographic fog.
21. Explain the importance of scatter radiation control to the enhancement of radiographic contrast and control of radiation fog.
22. Identify the two devices which are used to improve contrast by controlling scatter radiation.
23. Describe a cone's method of scatter control.
24. Describe a grid's method of scatter control.
25. Contrast the use of a grid with the use of a cone for the control of scatter radiation and the reduction in patient radiation exposure.
26. Explain the purpose, imitations and exposure adjustment for the various routinely used grids.
27. Describe the influence of the following factors relative to the production of scatter radiation and radiographic fog.
    a. tissue
        1) volume
        2) thickness
        3) opacity
    b. object-film distance
    c. kVp/mAs relationship
28. Identify the two main methods of reducing radiation fog.
29. Describe the following beam restriction devices and the advantages and disadvantages of their use.
    a. aperture diaphragms
    b. cones
    c. collimators
    d. lead blockers
30. Given the distance from the tube focus to the bottom of a beam limiting device; the diameter or size of the opening of the beam limiting device; and the FFD; determine the beam size that would result.
31. Describe the purpose and operation of a positive beam limiting (PBL) device.
32. Explain what is meant by cone cut off.
33. Describe the operation and effectiveness of a grid relative to the following factors:
    a. design's linear or crosshatched rhombic crosshatch
    b. type: parallel or focused
    c. ratio
    d. number of lines per inch
    e. use: stationary or moving
34. Describe image changes which will occur if the various types of grids are used improperly. Example:
    a. parallel grid – short FFD
    b. parallel grid – CR off-centered
    c. parallel grid – CR angled perpendicular to grid lines
    d. crosshatch grid – CR angled
    e. focused grid – CR off-centered
    f. focused grid – FFD too much or too little
    g. focused grid – reversed, tube side down
35. Define grid ratio.
36. Define grid frequency.
37. Define lead content.
38. Explain how kVp can influence grid efficiency.
39. Explain the significance of properly following grid use recommendations.
    a. 8:1 – effective up to 85 kVp
    b. 12:1 – effective up to 100 kVp
    c. 16:1 – effective beyond 100 kVp
40. Relative to the functional characteristics of a grid, define the following:
    a. selectivity
    b. contrast improvement factor

41. Define grid cup-off; grid clean up.

Electricity and Magnetism (R)-- 75% Minimum Mastery Level Required

1. List the four principal laws of electrostatics
2. Describe electricity and state its units
3. Discuss the degrees of magnetism
4. Identify naturally occurring magnetic material
5. State the basic laws of magnetism
6. Solve problems involving the laws of electrostatics and magnetism

Electromagnetism (R)-- 75% Minimum Mastery Level Required

1. Describe the relationship between electricity and magnetism
2. Identify the electromagnetic effect
3. Examine electromagnetic induction and its application to radiologic equipment
4. Distinguish between electrical motors and electrical generators
5. State the transformer law and apply it to a high-voltage generator

THE IMPORTANCE OF PROPER CARE AND USE OF X-RAY EQUIPMENT (L) – 75% Minimum Mastery Level Required

1. Name the two types of x-ray produced by an x-ray tube and plot a typical x-ray emission spectrum identifying the portion of the graph which represents each x-ray type, the coordinate which represents energy and the coordinate which represents the number of photons produced.
2. Given a diagram of a curve which represents AC, DC, half-wave AC, full-wave AC, three phase AC, 6 pulse-three phase or 12 pulse-three phase, correctly identify each.
3. Correctly state the number of impulses per second going through an x-ray tube energized by:
    a. single phase, half-wave rectified current
    b. single phase, full-wave rectified current
4. State the percent of ripple noted in the wave of:
    a. single phase, half-wave rectified current and
    b. single phase, full-wave rectified current
5. State the percent of ripple noted in the wave of:
    a. three phase, 6-pulse rectified current and of
    b. three phase, 12-pulse rectified current
6. Compare single phase, powered x-ray equipment with three phase, powered x-ray equipment relative to the following:
    a. emission spectrum
    b. quantity of x-ray produced
    c. quality of x-ray produced
7. Compare the emission spectrum of a single phase, half-wave powered x-ray unit with the emission spectrum of a single phase, full-wave powered x-ray unit.
8. Given the mAs or kVp of an exposure using a single phase unit, correctly adjust the mAs/kVp to maintain density using a three phase unit.
9. Correctly identify the selectors, meters and x-ray unit components which are mounted or located in the x-ray control console.
10. State the reason for placing the electric circuits connecting the meters and controls located on the operating console at low voltage.
11. Considering that the mA meter is located in the high voltage circuit, state how one is protected from electrical shock.
12. Explain how the emission spectrum is affected by a) a line surge and b) a line drop. Identify the control which adjusts for this problem thereby assuring proper x-ray emission.
13. Describe the affect on the density of an image with the following conditions:
    a. a line drop without compensation
    b. a line surge without compensation
14. Describe an autotransformer relative to the following:
    a. its location
    b. type of device
    c. principle of operation
    d. major purpose

15. Correctly calculate the voltage inputed to the high voltage transformer if the autotransformer primary tap windings and secondary windings are given and the autotransformer is supplied with 240 volts.

16. Relative to the following factors, explain the result of improper calibration of kVp such that the actual voltage obtained is higher than expected:
    a. intensity (quantity) of x-ray output
    b. energy of the beam
    c. density of the image
    d. contrast of the image
17. State the purpose of the high voltage section of the x-ray circuits.
18. Identify the principle circuit components which are located in the high voltage section of an x-ray unit.
19. Describe the high voltage transformer of an x-ray circuit relative to the following:
    a. its location
    b. type of device
    c. principle of operation
    d. major purpose
20. Calculate the secondary voltage and amperage supplied to the x-ray tube if the turns ratio of the high voltage transformer and supply voltage and amperage are given.
21. If given the necessary data, calculate the output intensity of an improperly calibrated x-ray unit.
22. Explain why the filament transformer is placed in the high voltage section of the x-ray circuit.
23. Describe the function of the filament transformer relative to the following factors:
    a. power to the filament
    b. heat of the filament
    c. current in the x-ray tube
24. If the turns ratio of the filament transformer is given, calculate the current and voltage flowing through the primary coil if the voltage and amperage to the x-ray filament are 10 volts and 6 amps.
25. Give the term which expresses the ionization of the filament upon heating it.
26. Identify the two principle exposure factors which are selected to control the number of electrons crossing from cathode to anode.
27. Explain the relationship of mAs or tube current to the heat of the filament and the number of electrons crossing from cathode to anode.
28. Describe the affect on the x-ray emission spectrum if the mA controls are out of calibration.
29. Define rectification and explain the purpose for it in the production of x-rays.
30. Explain how rectification of AC current in an x-ray circuit is accomplished.
31. Describe the function of a space charge compensator.
32. Describe what happens to mA if focus size is increased and why.
33. Give the relationship of the quantity of x-rays produced to:
    a. the kVp selected
    b. the mA selected
    c. the time selected
34. Describe a 1) rheostat 2) choke coil or 3) saturable reactor relative to the following characteristics:
    a. type of device
    b. principle of operation
    c. location in x-ray circuit
    d. mA control
    e. x-ray tube current control
35. Explain the main purpose of a timer.
36. Describe each of the following timing devices in terms of their principle of operation, location in the circuit and limitations.
    a. mechanical timer
    b. synchronous timer
    c. electronic timer
    d. mAs timer
    e. phototimer or ionic timer
37. Describe ways which may be used to check the accuracy of a timer and explain the limitations of the various methods.
38. Describe the mode of operation of a manual spinning top and contrast its mode of operation with that of a synchronous spinning top. Describe the images which are obtained with each method.

39. Given a power supply to an x-ray unit, identify the timer evaluation method which would adequately evaluate the accuracy of the timer and describe the image obtained.
40. Describe the principle of operation of a meter and describe a meter placement in a 41. Describe the influence of the target material on the x-ray emission spectrum.

X-RAY TUBE (L, N) – 75% Minimum Mastery Level Required

1. Name the two primary parts of an x-ray tube and describe the type of tube an x-ray tube is.
2. Explain why the filament of an x-ray tube is usually made of thorigated tungsten.
3. Explain what is meant by a "double focus" x-ray tube.
4. Describe the problem which could result from vaporization of the filament of an x-ray tube and explain how the vaporization of the filament can be reduced.
5. The filament of an-ray tube is connected to both a low voltage supply and a high voltage supply. Explain the purpose of each supply.
6. Name the four functions of an x-ray tube.
7. Identify the area of the anode which is struck by the electrons from the cathode.
8. State the purpose of alloying the tungsten of the anode with rhenium.
9. Name the three main reasons why tungsten is the material of choice for the anode.
10. Explain how the heating capacity of the anode can be increased.
11. Explain the four major factors which contribute to the effectiveness of the focusing cup.
12. Describe the type of motor which is used to turn the anode of a rotating anode tube.
13. Explain why rotor bearing design and balance of the rotor is so important in a rotating anode tube.
14. Explain why the short exposure rating of an x-ray tube decreases as the target angle increases.
15. Define focal spot and describe the effect on the following if a smaller focal spot is chosen:
    a. recorded detail (sharpness)
    b. heel effect
16. Explain the effect on focus size and heel effect if the target angle is reduced.
17. Define:
    a) actual focus
    b) effective focus
    c) line-focus principle
18. Calculate the total target area of a rotating anode x-ray tube if the focal spot dimension and the diameter of the anode disk from the mid-target area are given.
19. Calculate the effective focus size if the target angle and actual focus size are given.
20. Define heel effect and describe the intensity of radiation from anode to cathode.
21. Explain the significance of focus-film distance and film size when attempting to use anode-heel effect.
22. Explain the purpose of the protective housing of the x-ray tube.
23. Define leakage radiation and give the permissible emission of this radiation.
24. Explain the purpose of the glass envelope of an x-ray tube.

FILTRATION (M) – 75% Minimum Mastery Level Required

1. State the purpose of filtration and describe the effects of filtration on radiation received by the patient.
2. Identify the metal usually employed as filters for diagnostic x-ray units and explain why it is employed.
3. Explain the influence of filtration on the quality and quantity of the x-ray beam.
4. Define the following and identify the materials which comprise each:
    a. inherent filtration
    b. added filtration
    c. total filtration (radiography and fluoroscopy)
    d. compensating filtration
5. State the minimum total filtration requirements for x-ray units operating at the following kVp levels:
    a. below 50 kVp
    b. between 50-70 kVp
    c. above 70 kVp
6. Differentiate the purpose of filters for therapy x-ray units as opposed to diagnostic x-ray units.
7. Describe the influence of filtration on each of the following factors:
    a. quantity of the x-ray beam
    b. quality of the x-ray beam
    c. HVL
    d. minimum wavelength

e. effective energy

8. Describe the inherent filtration equivalent thickness of a typical x-ray tube and explain how this thickness often increases with extended and improper use of the x-ray tube.
9. Describe the placement of the added filtration relative to the tube, collimator and patient.
10. Describe the influence of a variable aperture, light localizing collimator on filtration of the x-ray tube and state the usual amount it contributes.
11. Define HVL and explain the influence on HVL when a change is made in either filtration or kVp.
12. Calculate the exposure from an x-ray tube when additional filtration is added if original filtration, exposure and HVL is known.
13. Describe the influence of added filtration on the emission spectrum of the x-ray beam and on the quality of the x-ray image.
14. State the total minimum filtration thickness which must be used for all general purpose diagnostic x-ray units.
15. Identify the dentist who introduced the use of x-ray collimation and filtration.
16. Describe several compensating filters and state their purpose.
17. Relative to filtration used in mammographic x-ray units, describe and explain the following:
    a. minimum filtration – no less than 0.5 mmA1
    b. tungsten targeted tube – added filtration should be aluminum
    c. molybdenum targeted tube – added filtration should be molybdenum of approximately 30 micrometers
    d. molybdenum-tungsten alloy target – aluminum or molybdenum may be used
18. Explain why the added filtration of the x-ray tube is never zero.

X-RAY TUBE THERMAL CAPACITY (N) – 75% Minimum Mastery Level Required

1. Discuss the efficiency of x-ray production relative to percentage of projectile electron kinetic energy conversion to x-ray or heat energy.
2. Explain the set of circumstances which occur in the target after interaction with projectile electrons that generate extreme heat.
3. State the relationship between heat generated in an x-ray tube upon being energized to produce x-ray and each of the following:
    a. mA
    b. time
    c. kVp
4. Describe the relationship between efficiency of x-ray production and each of the following:
    a. changes in tube current
    b. changes in kVp
5. Describe an appropriate method of extending x-ray tube life and explain the role of the technologist in trying to accomplish this.
6. State three primary causes of tube failure.
7. Describe the damage to the anode when the temperature of the anode is excessive during a single exposure. Describe the effect on the radiographic image and on tube operation when the anode is damaged by excessive temperature increases.
8. Explain how abuse of the x-ray tube can result in increased filtration.
9. Explain why maximum radiographic techniques should never by applied to a cold anode. Explain why this caution is particularly important when using three phase equipment.
10. Explain how maintaining the anode at elevated temperatures for prolonged periods can cause rotor-bearing damage.
11. Describe the probably reasons for tube failure during fluoroscopy.
12. Identify the most frequent cause of x-ray tube which most often is responsible for filament failure.
13. Describe the condition of operation of an x-ray tube which most often is responsible for filament failure.
14. Describe the guides which can help the technologists to use x-ray tubes and avoid damage to them.
15. Describe the following tube rating charts and explain their use:
    a. radiographic rating chart
    b. anode cooling chart
    c. housing cooling chart
16. Demonstrate the ability to correctly analyze a tube rating chart.
17. Demonstrate the ability to correctly calculate the following:
    a. heat units (single phase operation of x-ray tube)
    b. heat units (three phase – 6 pulse operation of x-ray tube)

c. heat units (three phase – 12 pulse operation of x-ray tube)

18. Describe typical maximum heat capacities for each of the following:
    a. x-ray tube anodes
    b. x-ray tube housings
19. Explain the importance of determining whether a set of tube rating charts are applicable for a given x-ray tube and describe the proper assessment procedure.
20. Compare and contrast cine, serial and fluoroscopic tube rating and cooling charts with a standard rating and cooling chart.

FLUOROSCOPY (O) – 75% Minimum Mastery Level Required

1. Name the inventor of the fluoroscope and the year he invented this important tool of radiology.
2. State the primary function of the fluoroscope.
3. Compare and contrast image-intensified fluoroscopy with conventional fluoroscopy.
4. Identify the principal parts of the eye and show how they influence human vision and visualization of the fluoroscopic image.
5. Compare the mA used with conventional fluoroscopy with that used for image-intensified fluoroscopy.
6. Compare the mA used for radiography with that used for fluoroscopy.
7. Define the following terms and explain their importance to fluoroscopy:
    a. automatic brightness control (ABC)
    b. automatic brightness stabilization (ABS)
    c. automatic exposure control (AEC)
    d. automatic gain control (AGC)
8. Identify the units of measurement which are used to designate illumination levels or image brightness.
9. Identify the part of the eye which is first to intercept light incident on the eye and is also the part most likely to suffer radiation damage.
10. State the function of the iris of the eye.
11. Define photopic vision and identify the cells of the eye that are used for this vision; define scotopic vision and identify the cells of the eye that are used for this vision.
12. Identify the cells of the eye which are more sensitive to light and are used during dim light situations; identify the cells of the eye which are less sensitive to light and are used during bright light situations.
13. Identify the central area of the retina where the cone cells of the eye are concentrated.
14. Define visual acuity and identify the vision cells of the eye which have more visual acuity.
15. Compare and contrast rod and cone vision relative to the following factors:
    a. contrast perception
    b. color detection
    c. visual acuity
16. In general, state the preferred exposure technique for fluoroscopy and explain.
17. Give the benefits of image-intensified fluoroscopy relative to the following topics:
    a, patient exposure “dose”
    b. image quality
    c. diagnostic accuracy
    d. speed of examination
    e. audience viewing
    f. alternative image receptor possibilities
    g. adaption of examiners eyes
    h. illumination of the examination room
18. Identify those factors which influence brightness of the fluoroscopic image.
19. List the imaging components associated with fluoroscopy and the order in which they appear in the information chain.
20. Given a diagram of an image-intensifier tube, trace the flow of information-carrying units through it.
21. Describe an image-intensifier tube and explain the function and makeup of the following image-intensifier components:
    a. input phosphor
    b. photocathode
    c. electrostatic focusing lenses
    d. anode
    e. output phosphor

22. Describe the image at the input phosphor compared to the image of the output phosphor relative to the following:
    a. size
    b. brightness
    c. number of photons
23. Define photoemission and compare it to thermionic emission.
24. Give the practical definition of brightness gain and calculate brightness gain when given the minification gain and the flux gain.
25. Define the following and explain how each may be increased:
    a. minification gain
    b. flux gain
26. State the brightness gain capability of most image intensifiers.
27. Explain what is meant by a "multifield" image intensification tube and explain what happens to the following as a result of switching to the smaller diameter:
    a. electron focal point
    b. size of image
    c. brightness level of image
    d. patient exposure
    e. field of view
    f. noise and contrast
    g. image resolution
28. Define vignetting.
29. Compare brightness and sharpness in the periphery of an image intensifier with brightness and sharpness in the center of the image.

MONITORING OR VIEWING THE FLUOROSCOPIC IMAGE (O) – 75% Minimum Mastery Level Required

1. Explain what is meant by a "mirror-optics system"; describe the two primary disadvantages of this image monitoring system.
2. Explain how a television is employed for image monitoring and describe the advantages of using this method instead of the "mirror-optic system".
3. Explain he type of tube described by each of the following:
    a. vidicon
    b. plumbicon
    c. image orthicon
4. Describe a typical TV camera tube and give the function and purpose of the following TV camera tube components:
    a. glass envelope
    b. cathode
    c. electron gun
    d. electrostatic grids
    e. target assembly
        i. face plate
        ii. signal plate
            a) window
            b) target
5. Define photoconductive and explain this term relative to the function it serves and its makeup.
6. Identify the two methods most often used to couple or attach the TV camera tube to the output phosphor of the image-intensifier tube.
7. State the principle advantage of using a fiber optic coupling. State the principle disadvantage of using this type of coupling.
8. Identify the coupling system which is necessary if one desires to use cine or a spot film camera to record the fluoroscopic image. Describe a precaution which must be taken in the use of this coupling method.
9. Identify the point of beginning and the point of ending of a closed circuit television system.
10. Identify the most important component in a television monitor.
11. Compare and contrast a TV camera tube with a cathode ray tube.
12. Name the weakest link in an image-intensified fluoroscopic system using a TV monitor.
13. Identify the component of the TV monitor that converts the video signal into a visible image.

14. Define the following:
    a. active trace
    b. horizontal retrace
    c. television field
    d. interlace
    e. television frame
15. Explain what is meant by a 525-line system; vertical resolution, bandpass/bandwidth and horizontal resolution.
16. Relative to vertical and horizontal resolution, what is the main objective of television designers.
17. Describe a television frame relative to television fields.
18. State the frame rate for fluoroscopic television.
19. Describe common frame rates for cinefluorography and explain why they are increments of 60.
20. Identify the most common film formats used for spot film and cinefluorography and compare each format relative to radiation exposure to the patient and quality of the image.
21. Explain why all present cinefluorographic systems are synchronized.
22. Compare radiation exposure to the patient using a 7.5 cine framing frequency with radiation exposure using a 60 frames per second frequency.
23. Describe the advantages of using large format spot film cameras instead of cassette loaded spot films.

RADIATION PROTECTION-FLUOROSCOPY (P) – 75% Minimum Mastery Level Required

1. Relative to the following x-ray apparatus, give the appropriate design requirements:
    a. fluoroscopic, source-to-tabletop distance
        i. stationary fluoroscopes
        ii. mobile fluoroscopes
    b. primary protective barrier
        i. image-intensifier assembly capable of operating above 125kVp
        ii. image-intensifier assembly and fluoroscopic tube
    c. filtration
        i. minimum equivalent requirement
        ii. definition of total filtration
        iii. HVL
    d. collimation
        i. requirements for manual collimator
        ii. requirements for automatic collimator
    e. exposure switch type
    f. bucky slot cover – minimum lead equivalent
    g. protective curtain – minimum lead equivalent
    h. cumulative timer
        i. required type
        ii. purpose
    i. x-ray intensity
        i. maximum exposure rate for each mA or operation above 80kVp
        ii. maximum allowable exposure rate for fluoroscopy under all conditions

TOMOGRAPHY (Q) – 75% Minimum Mastery Level Required

1. List three methods of separating superimposed images through modification of ordinary radiography.
2. Describe the three basic principles of tomography.
3. Define the term tomographic section and describe the basic principles of tomography.
4. Explain the influence of exposure angle and focus-film distance on section thickness.
5. Using the formula $h = \frac{s}{\tan 1/2}$, calculate the section a thickness when (h) is the maximum permissible unsharpness, (s) is 0.5 mm and the exposure angle (a) is:
    a. 10 degrees
    b. 20 degrees
    c. 40 degrees
6. List and diagram five types of tomographic motion.
7. Define the term zonography.
8. Define the term autotomography.

9. Compare the radiation exposure received in tomography to that received in conventional radiography.
10. Discuss the formation of a tomographic image; i.e. - Is it cumulative or is it made all at one time?
11. Compare zonographic images with tomographic images relative to:
    a. thickness of section
    b. contrast
    c. detail
    d. blurring of overlying and underlying structures
12. Explain what is meant by unidirectional and pluridirectional motion.
13. For linear movement of the tube in tomography, describe the ideal relationship between the structure and motion of the tube.
14. Describe several clinical applications of tomography and discuss specific tomographic procedures relative to the following topics:
    a. examination part
    b. position of structure
    c. central ray position
    d. tomographic levels and thickness of sections
    e. other positioning or procedural considerations
15. Identify pararadiologic imaging procedures which are often used in the place of general tomography.
16. Define Digital Tomosynthesis System (DTS)
17. Define:
    a. axial transverse tomography
    b. panoramic tomography

STEREORADIOGRAPHY (Q) – 75% Minimum Mastery Level Required

1. Describe the advantages and disadvantages of stereoradiography and discuss its current use.
2. With respect to the following topics, discuss the criteria which must be met to ensure good stereoradiography:
    a. patient position and immobility
    b. film position and immobility
    c. total tube shift and direction of shift
3. Discuss the purpose and typical construction of a stereoscope.
4. Describe the correct method of viewing stereoradiographs.

RADIATION PROTECTION / HEALTH PHYSICS (P) – 75% Minimum Mastery Level Required

1. Define health physics
2. Name the three cardinal principles of radiation protection and explain.
3. Define point source
4. Explain what isoexposure lines represents.
5. Explain why in fluoroscopy, the technologist should remain as far from the examining table as practical.
6. Define half-value layer (HVL) and tenth-value layer (TVL).
7. Define TVL relative to HVLs.
8. Explain the ratio $\frac{1.2R}{\text{mA-min}}$
9. Define dose limits.
10. Identify the categories of the population for which MPD is specified. Identify the type of exposure which is not specified.
11. Give the dose limits for a radiation worker:
    a. per week/per year
    b. per week/year who is pregnant
    c. per week/year when permitted by DL
    d. per week/year if under age 18
12. Associate DL values with dose-limiting recommendations.
13. Define somatic response; define genetic response.
14. Define threshold dose; define linear, nonthreshold dose response.
15. Identify the dose response relationship that DLs have been based on.
16. Give the formula which determines cumulative DL for occupationally exposed persons.
17. Properly associate the following radiologic units:
    a. activity-Becquerel (Curie)

b. absorbed dose-Gray (rad)
c. dose equivalent-Sievert (rem)
d. exposure-Coulomb per kilogram (roentgen)

18. Give the DL per year:
    a. for the nonoccupationally exposed person
    b. for the population as a whole
19. Define whole body exposure and elaborate on the individual parts of the body included in this definition.
20. Define what is meant by:
    a. prospective annual DL
    b. retrospective annual DL
21. Know DL for selected organs of the body; i.e. hands, forearms and describe appropriate radiation monitors used to determine exposure to these areas of the body.
22. Define leakage radiation and state the acceptable R/min at 1 meter.
23. Describe the design specifications for the control panel.
24. Describe appropriate radiation protection standards relative to the following: (radiographic equipment)
    a. source-to-image receptor distance (SID/FFD)
    b. collimation
    c. filtration
    d. beam alignment
    e. positive beam limitation (PBL)
    f. personnel shield
    g. portable x-ray unit
    h. reproducibility
    i. linearity
25. Describe appropriate radiation protection standards relative to the following: (fluoroscopic equipment) Refer to Part VI, Fluoroscopy – Radiation Protection Objectives
26. Define the following and give the minimum lead equivalent thickness of each:
    a. primary protective barrier
    b. secondary barrier
27. List the factors which must be considered when barrier thickness is being calculated.
28. Define the following and give the appropriate radiation protection unit and symbol for each:
    a. occupancy
        i. controlled area
        ii. uncontrolled area
            a) full occupancy
            b) partial occupancy
            c) occasional occupancy
    b. work load
    c. use factor
    d. penetrability
29. Associate pulse mode operation with radiation detection and integrate mode with measurement of the intensity or exposure of radiation.
30. Define the following terms:
    a. dosimetry
    b. dosimeter
31. Identify the four basic types of radiation detection devices used in diagnostic radiology and describe their characteristics and uses.
32. In reference to radiation detection devices, differentiate the term accuracy and the term sensitivity.
33. Give the phrase which is described by the acronym ALARA.
34. Identify the three procedures in radiography which result in the highest occupational exposure of x-ray personnel.
35. Identify a procedure in radiography which usually contributes minimally to patient and personnel exposure.
36. Identify the three ways that patient dose is generally reported.
37. Describe the use of the nomogram in estimating skin dose and give the percentage of accuracy assumed with this type of procedure.
38. Define he following:
    a. mammographic skin/midline dose
    b. CT scanning dose

c. genetically significant dose (GSD)

39. Describe the criteria used to determine the necessity of using personnel monitoring devices.
40. Discuss the advantages and disadvantages of using the following personnel monitoring devices:
    a. film badges
    b. thermoluminescent dosimeter
    c. pocket ionization chamber
41. Describe appropriate placement of radiation monitoring devices for:
    a. a fluoroscopist
    b. pregnant technologist
    c. special procedure or nuclear medicine technologists
42. Discuss radiation protection rules for x-ray personnel relative to the following considerations:
    a. protective apparel
    b. position during fluoroscopy
    c. patient holding
    d. portable (mobile radiography)
43. Discuss appropriate measures which can be taken to reduce unnecessary patient exposure.
44. Discuss appropriate precautions which should, if possible, be taken to reduce exposure of a pregnant technologist.
45. Discuss appropriate measures which should be taken to avoid exposure of a pregnant patient.

Required Assessments:

Assessment Names and Descriptions:

A. Testing Procedures: An examination directly related to the instructional objectives will follow completion of the following units:
    1. Radiographic Quality or Definition (Test I)
    2. Recorded Detail (Test I)
    3. Distortion (Test I)
    4. Density (Test II)
    5. Contrast to include: (Test III)
        a. production and control of scatter radiography
        b. grid performance
        c. grid selection and use
        d. beam restricting devices
        e. grid characteristics
    6. Electricity and Magnetism/Electromagnetism
    7. X-Ray Equipment Circuit and Calibration (Test IV)
    8. X-ray Tube (Test IV)
    9. Filtration (Test V)
    10. Tube Rating Charts (Test V)
    11. Conventional/Image Intensified Fluoroscopy (complete objectives)
    12. Tomography (complete objectives)
    13. Stereography (complete objectives)
    14. Health Physics/Radiation Protection (Test VI)

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 selection and manipulation of exposure factors to adjust for recorded detail, contrast, density and distortion.

CSLO/Assessment Alignment:

Course	CSLO 1	CSLO 2	CSLO 3	CSLO 4	CSLO 5	CSLO 6	CSLO 7	CSLO 8	CSLO 9	CSLO 10
RT 1243	Test 1 WB quiz Final exam	Test 1 WB quiz Final exam	Test 1 WB quiz Final exam	Test 1 WB quiz Final exam	Test 2 WB quiz Final exam	Test 2 Test 3 WB quiz Final exam	Test 1-3 WB quiz Final exam	Test 1-3 WB quiz Final exam	Test 1-3 WB quiz Final exam	Test 2-3 WB quiz Final exam
	CSLO 11	CSLO 12	CSLO 13	CSLO 14	CSLO 15	CSLO 16	CSLO 17	CSLO 18	CSLO 19	CSLO 20
	Test 3 WB quiz Final Exam	Test 4 WB quiz Final Exam	Test 5 WB quiz Final exam	Test 4 WB quiz final exam	Objective complete	Test 6 WB quiz final exam	Objective complete	Test 4 WB quiz final exam	NA	NA

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 workbook assignments.

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

Excused days absence = 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.

Chattanooga State Community College
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)
4. Math 1710 if required

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