COURSE SYLLABUS
RT 2440- Introduction to Digital Imaging and Radiation Therapy

CLASS HOURS; 4 **CREDIT HOURS: 4**
LABORATORY HOURS: 0

CATALOG COURSE DESCRIPTION: Introduction to subspecialties of diagnostic radiology and basic radiation therapy principles; focus is placed on the following digital imaging modalities: digital fluoroscopy and radiography, bone densitometry, computed tomography, nuclear medicine, positron emission tomography, diagnostic ultrasound, magnetic resonance; radiation therapy and digital imaging modalities discussed in reference to comparison to conventional radiology physical principles, equipment and methodology, historical development, selected clinical applications, and biological effects. **This course presents a survey of the subspecialties. Detailed coverage requires additional course work and clinical experiences**.

ENTRY LEVEL STANDARDS: A grade of "C" or greater in all previously taken radiography courses is required for progression to this course. Since the imaging and therapeutic modalities are discussed in reference to conventional radiography and fluoroscopy, a good understanding of the principles and concepts of radiography is essential for success. In addition, the student should demonstrate a responsible attitude toward attendance, class participation, and course preparation.

PREREQUISITES: All first-year course work.

COREQUISITES: RT 2430, RT 2420, RT 2433, and RT 2442

TEXTBOOK AND OTHER REFERENCE MATERIAL BASIC TO COURSE:
Merrill's Atlas of Radiographic Positions & Radiologic Procedures, Volume III, Ballinger and Frank, Latest Edition
Radiologic Science for Technologists-Physics, Biology, and Protection, Bushong, Latest Edition

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 With regards to physical principles, equipment and methodology, demonstrate knowledge of conventional fluoroscopy. (I, II, III, VI)
- CSLO #3 Demonstrate knowledge of the physical principles, equipment, and imaging methodology of digital fluoroscopy, digital radiography and computed radiography. (I, II, III, VI)
- CSLO #5 Be able to compare and contrast each digital imaging modality and radiation therapy with conventional radiology. (I, II, III, VI)
- CSLO #6 With regards to physical principles, equipment and methodology, demonstrate knowledge of each digital imaging modality and radiation therapy. (I, II, III, VI)
- CSLO #8 Understand the role of radiation therapy versus the role of each digital imaging modality. (I, II, III, VI)
- CSLO #9 Be able to discuss the biological hazards associated with each conventional/digital imaging modality and radiation therapy. (I, II, III, VI)

PSLO#8. Input prepackaged software programs into a computer and performs data entry and information retrieval.
- CSLO #2 Demonstrate an understanding of computer applications in the Radiologic sciences related to communication and image capture, display, storage, and distribution. (I, II, III, VI)

- CSLO#9. Perform a full range of radiologic procedures on children and adults in all areas of the profession while performing basic functions of specialty areas within the profession.
- CSLO #4 For each of the following digital imaging modalities and radiation therapy, demonstrate knowledge of historical development:
  a. Computed Tomography
  b. Dual Energy X-ray Absorptiometry
  c. Nuclear Medicine
  d. Positron Emission Tomography

e. Radiation Therapy
f. Diagnostic Medical Sonography. (I, II, III, VI)

CSLO #7 Identify clinical applications of each digital imaging modality and describe the diagnostic advantages and limitations of each modality. (I, II, III, VI)

Other Learning Indicators or Objectives (optional): The Student will be able to:
Conventional Fluoroscopy (A, I) – 80% Minimum Mastery Level Required

1. Identify the inventor of the first fluoroscope and state when he invented this important tool of radiography.
2. State the primary function of the fluoroscope.
3. Identify the method of image display for each of the following:
    a. conventional fluoroscopy
    b. image-intensified fluoroscopy
4. State the principle advantage of image-intensified fluoroscopy over conventional fluoroscopy.
5. Identify the principal parts of the eye and describe how they influence human vision.
6. Define the following terms:
    a. photopic vision
    b. scotopic vision
    c. visual acuity
    d. contrast perception
7. Explain why it was necessary to dark adapt the eyes before using the conventional fluoroscope.
8. State the maximum tube current which may be used for fluoroscopy and compare this current with the typical mA used for image-intensified fluoroscopy.
9. Discuss radiation exposure during fluoroscopy versus radiation exposure from standard radiography.
10. State the purpose of an automatic brightness control (ABC), sometimes referred to as the automatic gain control (AGC).
11. State the influence of KVp and mA on the quality of the fluoroscopic image and state the ideal KVp and mA settings for fluoroscopy and explain.
12. State the main purpose of an image-intensifier tube.
13. List/Identify the imaging components associated with fluoroscopy and the order in which they appear in the information chain.
14. Diagram an image-intensifier tube and trace the flow of information-carrying units through it.
15. Understand the operation of a fluoroscopic video system and trace the flow of information from the image-intensifier tube to the video monitor.
16. Be able to calculate the following:
    a. brightness gain
    b. minification gain
    c. flux gain
17. 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
18. Define vignetting.
19. Compare brightness and sharpness in the periphery of an image intensifier with brightness and sharpness in the center of the image.
20. Explain what is meant by a “mirror optics system”: describe the two primary disadvantages of this image monitoring system.
21. Explain how a television is employed for image monitoring and describe the advantages of using this method instead of the “mirror optic system”.
22. Explain the type of tue described by each of the following:
    a. vidicon
    b. plumbicon
    c. image orthicon

23. 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
            (1) window
            (2) target
24. Define photoconductive and explain this term relative to the function it serves and its make-up.
25. Identify the two methods most often used to couple or attach the TV camera tube to the output phosphor of the image-intensifier tube.
26. State the principle advantage of using a fiber optic coupling; state the principle disadvantage of using this type of coupling.
27. 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.
28. Identify the point of beginning and the point of ending of a closed circuit television system.
29. Identify the most important component in a television monitor.
30. Compare and contrast a TV camera tube with a cathode ray tube.
31. Name the weakest link in an image-intensified fluoroscopic system using a TV monitor.
32. Identify the component of the TV monitor that converts the video signal into a visible image.
33. Define the following:
    a. active trace
    b. horizontal retrace
    c. television field
    d. interlace
    e. television frame
34. Explain what is meant by a 525-line system; vertical resolution, bandpass/bandwidth and horizontal resolution.
35. Relative to vertical and horizontal resolution, state the main objective of television designers.
36. Describe a television frame relative to television fields.
37. State the frame rate for fluoroscopic televisions.
38. Describe common frame rates for cinefluorography and explain why they are increments of 60.
39. Identify the most common film formats use for spot film and cinefluoroscopy and compare each format relative to radiation exposure to the patient and quality of the image.
40. Explain why all present cinefluorographic systems are synchronized.
41. Compare radiation exposure to the patient using a 7.5 cine framing frequency with radiation exposure using a 60 frames per second frequency.
42. Describe the advantages of using large format spot film cameras instead of cassette-loaded spot film.
43. In comparison to digital imaging, describe the limitations of conventional radiography and fluoroscopy.

Introduction to Computer Science (B - 75% Minimum Mastery Level Required

1. Describe the historical development of the computer
2. Define the following:
    a. Transistor
    b. Integrated circuit
    c. Large scale Integration
    d. Very large scale integration
    e. Computer
    f. Micro-, mini-, mainframe, and super- computer
    g. Microcontroller
    h. Motherboard
    i. System clock
    j. Modem
    k. Algorithms
    l. Macros
3. Describe computers used in radiology and their application.

4. Identify various terms related to computer fundamentals and components.
5. Define hardware.
6. Define software.
7. Describe major functions and individual components of the following:
    a. Hardware
    b. Software
8. Give examples of various types of memory.
9. Give examples of various types of storage.
10. Given exam volume of a radiology department, calculate digital archival needs of the department.
11. Differentiate the various input and output devices.
12. Discuss teleradiology relative to methods of data transfer and physical medium of transfer.
13. Discuss transmission speed as it relates to teleradiology.
14. Describe major functions of the central processing unit (CPU).
15. Discuss applications of various types of software.
16. Define the following:
    a. Image matrix
    b. Pixel number and size
    c. Dynamic Range
    d. Image storage capacity
    e. Bit
    f. Bytes
    g. Word
    h. Nibble
    i. Chomp
    j. Encode
    k. Analog-to-Digital Converter
    l. Digital-to-Analog Converter
17. Name two classifications of software.
18. Define system software; application software.
19. Define digital imaging and communication in medicine (DICOM & DICOM2)
20. Describe computer care and preventative maintenance.
21. Explain computer operation.
22. Explain the following computing applications as they relate to radiology:
    a. Radiology information system (RIS)
    b. Hospital information system (HIS)
    c. Picture archiving and communication system (PACS)
23. Discuss Fourier transformation and filtered back projection as they relate to imaging.
24. Given a binary number, convert to the decimal equivalent.
25. Given a decimal value, convert to binary number.
26. Define image compression addressing Lossy compression and Lossless compression.
27. Define the following terms:
    a. Compression ratio
    b. Decompression
    c. Compression Tolerance
28. Discuss the impact the Internet has on the distribution of health information.
29. Discuss computer use in medicine as it relates to the following:
    a. Environmental conditions
    b. Computer catastrophes
    c. Ethical/legal concerns
    d. Preventative maintenance
    e. Quality assurance
    f. Security- password, limited access, firewalls, Intranet vs. Internet
30. Given radiology applications of digital imaging, identify the commonality of each modality.

Digital Imaging, Radiography and Fluoroscopy (A, B, C, E, G, I) – 75% Minimum Mastery Level Required

1. Relate the research and development of digital imaging.
2. Discuss the development of digital imaging giving particular attention to how innovations in computer technology have impacted on this important modality in radiology.

3. Distinguish between a conventional video or radiographic image and a digital image.
4. Distinguish between image formation in conventional radiography/fluoroscopy and digital imaging.
5. Give the most common matrix sizes found in digital imaging equipment.
6. Given image intensifier input diameter or field of view and image matrix size, calculate spatial resolution of the digital image.
7. Discuss the use of digital modalities in today's imaging department.
8. Explain the characteristics of digital images, specifically the following:
    a. Image matrix
    b. Pixel size and number (picture elements)
    c. Voxel (volume elements)
    d. Dynamic range (grey scale range)
    e. Spatial resolution (high contrast resolution)
    f. Low contrast resolution
    g. Windowing including level and width
    h. Binary numbering system
    i. Analog to digital conversion (electricity to discrete values)
    j. Hounsfield unit (HU)
9. Discuss the components and use of a digital radiography system including the following:
    a. Scanned projection radiography
    b. Computed radiography
    c. Direct-capture, flat panel radiography
        1) Cs I and a-SI
        2) a-Se
    d. Charged-coupled device
    e. Digitizer for analog images
10. Identify the developer of Scanned Projection Radiography and its primary application.
11. Describe the basic components of SPR.
12. Describe the x-ray beam in SPR and explain the design benefits.
13. Evaluate the collimators used in SPR.
14. State the principal advantage(s) and disadvantage(s) of SPR.
15. Explain the role of the detector array and the speed of translation in the control of resolution.
16. Discuss the x-ray tube and detector assembly requirements for SPR including the following:
    a. Tube capacity
    b. Imaging time
    c. Detector efficiency
        1) Scintillation crystals used
        2) Photodiode semiconductor(s) used
17. Discuss the use of an area beam in digital radiography versus a fan beam including the following:
    a. Acquisition time
    b. Scatter radiation (noise)
    c. Approaches to the use of an area beam
    d. Post-processing capabilities
18. Define the following:
    a. Transistor
    b. Thin-film transistor (TFT)
    c. Active Matrix Array (AMA)
    d. Amorphous
    e. Electron hole-pairs (EHP)
    f. Detection quantum efficiency (DQE)
    g. Fill factor
19. Describe the construction of a cesium iodide-amorphous silicon flat panel image receptor.
20. Describe the construction of an amorphous selenium flat panel image receptor.
21. Evaluate each of the following approaches to direct capture, flat panel digital image receptors:
    a. Cs I and a-Si
    b. a- Se
22. Describe the latent image stored in the following digital radiography approaches:
    a. Charged couple devices
    b. Photostimulable phosphor (Computed Radiography)

c. Cs I and a-Si
d, a-Se

23. Evaluate a digital radiographic approach for spatial resolving capabilities, i.e. CR, CCD, Cs I-a Si, a-Se.
24. Discuss the construction of a charged couple device.
25. Describe how electronic noise is reduced using charge couple devices.
26. Discuss thallium activation of digital radiography systems using cesium iodide.
27. Evaluate the crystalline structure of the cesium iodide used in both CCD and flat-panel image receptors relative to affect on spatial resolution.
28. Discuss the use of the following in both radiography (static) and fluoroscopy (dynamic) imaging.
    a. Charged couple devices
    b. Direct capture, flat panel
29. In comparison to a TV camera tube and a film-screen imaging receptor, evaluate a charged couple device used both for static imaging and dynamic imaging addressing the following:
    a. Spatial resolution
    b. Signal-to-noise ratio
    c. Detection quantum efficiency
    d. Warm up requirements
    e. Image lag or blooming
    f, Spatial distortion
    g. Maintenance
    h. Life expectancy
    i. Affect on system by magnetic fields, rough handling, etc.
    j. Response to light
    k. Radiation dose
30. Define pincushion or barrel artifact as it applies to conventional fluoroscopy.
31. Discuss the methods used for coupling of a charged couple device to either an intensifying screen in digital radiography or an image intensifier in digital fluoroscopy.
32. Discuss digital imaging relative the following:
    a. Security of data and confidentiality of patient records
    b. Picture archiving and communication (PAC)
    c. Archiving back up systems given equipment failure or power failure
    d. Tele-radiography Considerations
        1) Security of data
        2) Primary interpretation vs. double read
        3) Compression software used
    e. Connection to Hospital and Radiology information system
33. Define the acronym DICOM.
34. Evaluate the DICOM standard requirements and DICOM2 standard requirements.
35. Discuss Fuji Photo Film Co. Ltd. Role in developing computed radiography.
36. Compare analog imaging to computed radiography imaging relative to the following:
    a. Imaging receptor
        1) Cassette including front and back
        2) Imaging plate and photostimulable phosphor
            a) Base
            b) Phosphor layer
            c) Protective layer (fluorinated polymer material)
            d) Supporting layer
            e) Backing layer
            f) Bar code identifier
            g) Memory capability
            h) Dynamic range
            i) Response to background radiation and external shock
            j) Durability of cassette and plate
    b. Latent image
    c. Sensing, displaying and storing data
    d. Operational components
37. Describe the function of the image reader in computed radiography elaborating on the following:
    a. Purpose

b. Laser
c. Light guides
d. Photomultiplier tubes
e. Analog to digital conversion

38. Describe the role of Spatial Frequency Response and Graduation Processing in the display of images obtained in computed radiography.
39. Explain how raw data from imaging plate in CR is converted to image.
    a. Image reader
    b. Red helium-neon (633 nm) laser beam
    c. Visible-light semiconductor (680 nm) laser beam
    d. Sequentially scanned
    e. Light guides
    f. Photomultiplier tubes
    g. Amplifier
    h. Analog-to digital converter
    i. Computer (data set related spatially and is proportionally)
40. Discuss post processing capabilities in computed radiography.
41. Define image reconstruction in the default mode.
42. Discuss final display of CR images relative to the following:
    a. Hardcopy
    b. Softcopy
43. Detail the benefits of an electronic workstation.
44. Outline the components needed for an interpretation workstation addressing the following:
    a. Number of monitors
    b. Types of monitors
    c. Resolution capabilities
        1) 1K X 1K
        2) 2K X 2K
        3) 4K X 4K/acquisition capabilities
    d. Cost
    e. Speed in handling large amounts of data
44. Detail the benefits of electronic storage of images.
45. Evaluate the design of electronic image archive devices to address the following:
    a. Flexibility
    b. Interface with desired modalities
    c. Expandability
    d. Adequacy of storage space for volume of data
        1) Size of storage unit
        2) Number of units on line
        3) Ratio of data compression
46. State the capacities of the following electronic storage medium:
    a. Magnetic tape
    b. DVD
        1) Single side
        2) Double side
    c. Optical disk
        1) 5.25 inch single disk
        2) 5,25 inch dual disk
        3) Multiple-platter optical jukebox
47. State the storage needs of a typical large radiology department based on exams done annually and over a five year span of time.
48. Convert 10 to 16 terabytes to gigabytes and to megabytes.
49. Identify factors directly responsible for computed radiography image resolution.
50. Given the factors affecting the resolution of computed radiographic images, explain how resolution can be maximized.
51. Describe how demographic information (patient name, birth date, sex, ID number, and examination order can be transferred to the computed radiography processor.
52. Describe the hybrid benefit of computed tomography (use of conventional x-ray equipment).
53. Describe the exposure latitude possible using computed radiography.

54. Using computed radiography, explain how technical corrections are achieved and related to an agreed-on subjective H&D curve of the anatomic structures.
55. Explain how the image on the CR plate is erased.
56. Describe the expected life span of the CR imaging plates.
57. Explain the benefits of the following and how each is accomplished:
    a. Dynamic range control
    b. Energy subtraction
58. Elaborate on quality assurance concerns using computed radiography addressing the following:
    a. Dirty plates
    b. Mechanical damage of plates
    c. Grids
    d. Collimation
    e. AEC calibration
    f. X-ray penetration requirements
59. Describe artifacts seen in computed tomography and identify possible causes.
60. Describe in detail the many benefits of computed radiography.
61. In comparison to 400 speed imaging systems, describe the exposure requirements of CR imaging plates and repeat rates of individual projections.
62. Evaluate a picture archiving and communication system (PACS) detailing advantages and disadvantages.

Digital Fluoroscopy (Specific Objectives) – 75% Minimum Mastery Level Required

1. Describe the parts of a digital fluoroscopy (DF) system and their functions.
2. Name the distinct advantages of DF over conventional fluoroscopy.
3. Describe the significance of the Hounsfield Unit in digital radiography and fluoroscopy.
4. Associate the standard water as being "0" Hounsfield unit.
5. Describe the mode of operation of the x-ray tube in DF.
6. Given a pulse rate, calculate total frames and total exposure time.
7. Define the following:
    a. interrogation time
    b. extinction time
8. Describe the x-ray generator capabilities for DF including appropriate interrogation and extinction time.
9. Relative to the video system, define the following:
    a. Signal
    b. Noise
    c. Progressive mode
10. Evaluate the video signal read in the progressive mode compared to the interlace mode with regard to the following:
    a. Spatial resolution
    b. Flicker
    c. Signal-to-noise ratio
    d. Lines of data, e.g. 1000-line system
11. Compute pixel size (spatial resolution) given either field of view (FOV) or image intensifier output diameter in mm and matrix size.
12. Identify the type of computer widely used in DF systems.
13. Explain the relationship between computer capacity and each of the following:
    a. Image quality
    b. Manner and speed of image acquisition
    c. Image processing and manipulation
    d. Matrix size
    e. Dynamic range
    f. Image acquisition rate
14. Calculate image acquisition rate if image matrix is doubled.
15. Define image subtraction and its importance in DF.
16. Define temporal subtraction.
17. Define energy subtraction.
18. Define hybrid subtraction.
19. Name two types of temporal subtraction and describe the application of each.
20. Outline the procedures for temporal subtraction and energy subtraction.
21. State the two methods which have been devised for energy subtraction.

22. Explain the importance of an exposure at 32 keV and 34 keV respectively to enhance the differential between iodine and soft tissue.
23. Compare radiation dose with DF with the radiation dose in conventional fluoroscopy.
24. Compare radiation dose with static imaging in DF with static images in conventional fluoroscopy.
25. Explain why patient dose savings may disappear with digital spot films using DF.
26. State the three principal components of PACS.
27. Define the following terms:
    a. Edge enhancement
    b. Windowing
    c. Highlighting
    d. Landscaping
    e. Road maping
    f. Pan
    g. Scroll
    h. Zoom
    i. Network
    j. Node
28. Given images having a set matrix size and a defined bit dynamic range, calculate computer capacity required to store the images.
29. Describe the purpose of an analog-to-digital converter and a digital-to- analog converter in digital fluoroscopy.

Computed Tomography (B, D, E, F, G, I) – 75 % Minimum Mastery Level Required

1. Discuss the concepts of transverse tomography, translation, and reconstruction of images.
2. List and describe the various generations of computed tomography (CT) imaging.
3. Relate the CT system components and their function.
4. Describe CT image characteristics of image matrix and Hounsfield unit.
5. Analyze image reconstruction (filtered back projection)
6. Discuss image quality as it relates to spatial resolution, contrast resolution, noise, linearity, and uniformity.
7. Explain the spiral imaging principles of interpolation, pitch, index and section sensitivity.
8. Discuss the design features that make spiral computed tomography (CT) possible.
9. Recognize the differences between step-and-shoot and spiral CT x-ray tubes.
10. Describe the technique selection for spiral CT.
11. Discuss the concept of Z-axis resolution.
12. Describe multislice CT.
13. List the advantages of spiral CT.
14. List the limitations of spiral CT.
15. Define the following:
    a. Bow tie filter
    b. Rotate-nutate
    c. Electron beam CT
16. Given a CT system, describe the individual components and their functions.
17. Assess the requirement of a x-ray tube used for conventional and spiral computed tomography.
18. Compare and contrast scintillation detectors and gas detectors.
19. Identify the purpose of the pre-patient and pre-detector collimators used in CT imaging.
20. Describe the requirements of the following components of CT imaging:
    a. Generator
    b. Couch
    c. Computer
    d. Operating consoles
21. Describe CT operating parameters:
    a. kVp
    b. mA
    c. Slice thickness
    d. Indexing of patient couch
    e. Operating console
    f. Image storage
22. Relative to image characteristics define the following:
    a. Matrix (typical)

b. Pixel size
c. Field of view
d. Voxel size
e. Widowing
f. CT number for air
g. CT number for water
h. CT number for bone
i. Filtered back projection

23. Identify the factors influencing spatial resolution in CT imaging.
24. Relative to spatial resolution, define the following:
    a. Edge response function
    b. Modulation transfer function
    c. Spatial frequency
    d. Limiting resolution
25. Discuss CT quality control procedures for the following:
    a. Spatial resolution
    b. Contrast resolution
    c. Noise
    d. Linearity
    e. Uniformity
26. Describe the features of spiral and multislice computed tomography which present both advantages and limitations of their use.
27. Relative to spiral CT, define the following:
    a. Pitch
    b. Section sensitivity profile
28. Define slip ring.
29. Describe slip ring design in CT spiral imaging and what components it serves.
30. Describe the x-ray tube, detectors and generator requirements in spiral CT imagers.
31. Relative to technique selection in spiral CT imaging, discuss the following:
    a. Examination time.
    b. Z-axis resolution
    c. Image reconstruction
32. Identify two distinguishing features of multislice computed tomography.
33. Discuss patient and personnel radiation protection concerns in regards to the following:
    a. Conventional CT
    b. Spiral CT
    c. Multislice CT
34. State the formula for the following applications:
    a. Single slice; pitch
    b. Multislice; beam pitch
    c. Multislice; slice pitch
    d. Slice Acquisition Rate (SAR)
35. Given the following, calculate Z-axis coverage:
    a. Number of slices acquired
    b. Rotation time
    c. Slice width
    d. Imaging time
    e. Beam pitch
36. Discuss the application of the following multiplanar reformation algorithms:
    a. Maximum intensity projection
    b. Shaded surface display
    c. Shaded volume display

Bone Densitometry (B, D, E, F, G, I) – 75% Minimum Mastery Level Required

1. Define bone densitometry.
2. Explain the purpose of bone measurement values.
3. Analyze dual energy absorptiometry (DXA) relative to its use to assess bone mass density.
4. Summarize the basic principles of dual x-ray energy absorptiometry.

5. State the purposes of the skeleton.
6. Differentiate the two types of bone.
7. Define bone resorption.
8. Define bone formation.
9. Describe the role of osteoclasts in bone remodeling.
10. Describe the role of osteoblasts in bone remodeling.
11. Discuss bone mass as it applies to age of a person.
12. Define osteoporosis, osteopenia and osteomalsia.
13. State primary risk factors for osteoporosis.
14. Given the description of a patient's health status who has been diagnosed with osteoporosis, classify as to type of osteoporosis.
15. Discuss osteoporosis relative to prophylaxis and therapy.
16. Discuss the impact of osteoporosis as the disease applies to a patient and to society in general.
17. Outline universal recommendations to improve bone health throughout life.
18. Describe the two primary methods used in dual energy x-ray absorptiometry.
19. State the basic requirement of all bone densitometry systems.
20. Calculate bone mineral content if given bone mass density and area in cm^2.
21. Calculate bone mass density if given bone mineral content and area in cm^2.
22. Analyze the advantages and limitations of the following:
    a. pencil beam
    b. array beam
23. Discuss the concept of accuracy and precision as it relates to bone densitometry.
24. Identify the referenced population for assessing bone mass density.
25. Define Z-score.
26. Define T-score.
27. Assess radiation protection practices for personnel and patients.
28. Discuss the care and management of the patient relative to the following:
    a. Education
    b. History
    c. Insurance information
    d. Medicare qualifiers for bone densitometry
    e. Reporting
    f. Confidentiality
    g. Record keeping
    h. Scan storage.
29. Discuss measures to ensure the quality of bone mass density measurement using dual energy x-ray absorptiometry.
30. Evaluate correct positioning of the spine and hip for assessment of bone mass density using DXA.

NUCLEAR MEDICINE (B, D, E, F, G, I) – 75% Minimum Mastery Level Required

1. Identify the man who is credited with the discovery of radioactivity.
2. Discuss the work of Marie Curie relative to her contribution to nuclear medicine and conventional radiology.
3. Discuss the first medical use of radioactivity and identify the year it was first used.
4. Discuss the following developments relative to helping nuclear medicine to move into a position of prominence as a medical speciality.
   a. use of first reactor to control the fission of uranium, 1942
   b. development of first nuclear (rectilinear) scanner-Benedict Cassen, 1958
   c. development of scintillation camera-Hal Anger, 1958
   d. computer technology
5. Name three factors which are responsible for the dynamic growth of nuclear medicine.
6. Distinguish between nuclear medicine and radiology giving attention to each of the following factors:
   a. source of radiation
   b. detection of radiation
7. Discuss the primary/supportive role of nuclear medicine and radiology in the diagnosis of disease.
8. Identify the four particles that provide the basis for the science of nuclear medicine.
9. Define the following terms:
   a. alpha particle
   b. beta particle
   c. positron

d. neutrino
e. gamma
f. radioactivity
g. Curie
h. Becquerel
i. half-life
j. effective half-life
k. radionuclide
l. radiopharmaceutical
m. tracer
n. labeled compound
o. biological half-life
p. physical half-life
q. isotope

10. Identify the man who observed the unique phenomenon of radioactive elements, half- life.
11. State the characteristics of an ideal radiopharmaceutical.
12. Identify the two forms of radiopharmaceuticals commonly produced to provide tracer compounds.
13. Give the advantages of using the "kit" form of radiopharmaceutical.
14. Identify the most frequently used radiopharmaceuticals and demonstrate knowledge of their diagnostic use.
15. Identify the two principal types of instruments used to detect radiation.
16. Distinguish between a Geiger-Muller counter and a scintillation probe.
17. Identify the component parts of a scintillation instrument and describe the function of each component.
18. Name the two basic types of image detectors and describe the basic operation of each type.
19. Define the following terms:
    a. imaging (nuclear medicine)
    b. non-imaging in vivo studies
    c. in-vitro radioassay
20. For nuclear medicine examinations of the thyroid gland, brain, lungs, liver and spleen, kidney, bone and heart demonstrate knowledge of the procedure relative to the following topics.
    a. rationale for use
    b. indication for use
    c. procedure
        1) function
        2) static imaging
        3) therapy
        4) dynamic
    d. radionuclide used
    e. results
        1) function
        2) static images
        3) dynamic study
21. Demonstrate knowledge of the radiation protection factors which are unique to nuclear medicine.
22. Discuss the possible biologic hazards associated with nuclear medicine.

POSITRON EMISSION TOMOGRAPHY (B, D, E, F, G, I) – 75% Minimum Mastery Level Required

1. Define positron emission tomography (PET).
2. Name the three most important factors of PET imaging which distinguish it from other modalities.
3. Relative to the following factors, compare PET scanning to MRI imaging and CT imaging.
    a. resolution
    b. technique
    c. harmful effects
    d. use
    e. number of examinations per day
    f. ability to evaluate physiologic and anatomic aspects of structures
4. Discuss PET imaging from the standpoint of the medium injected to obtain the image and compare this medium to contrast medium used in radiographic techniques.
5. Identify the researcher who first conceived the use of positron-emitting radiopharmaceuticals for medical purposes.
6. Discuss the role of each of the following developments to the development of PET scanning.

a. scintillators
b. Wrenn's localization of a brain tumor with positron emitting radioisotopes
c. instrumentation developed by G. L. Brownell
d. clinical use of CT by G. Hounsfield
e. computer technology, scintillator design and photomultiplier tubes
f. M.M. Ter-Pogossian and M.E. Phelps-first closed-ring transverse positron tomogram

7. Since 1975, developments on two fronts have accelerated the use of PET. Name the two areas.
8. Identify the four primary functional areas of tomography and discuss their multidisciplinary ramifications.
9. Define a positron and describe its characteristics.
10. Name four positron-emitting radioisotopes which can be use in PET. Explain why they are appropriate for studying body function or physiology.
11. Explain why fluorine-18 is used as a substitute for hydrogen.
12. Describe what is necessary for the production of positron-emitting radionuclides.
13. Identify the two important radiopharmaceuticals presently used in many PET studies and explain how they work.
14. Define Huntington's disease and discuss the value of PET to provide an early diagnosis of this disease.
15. Discuss the clinical use of PET today and elaborate on applications of its use in the future.
16. Discuss the possible biologic hazards associated with PET.

RADIATION THERAPY (B, D, E, F, H, I) – 75% Minimum Mastery Level Required

1. Define the following terms:
   a. radiation therapy
   b. radiotherapy
   c. radiation oncology
   d. radiation therapy technologist
   e. radiation oncologist
   f. surgical oncologist
   g. medical oncologist
2. Explain the need for a coordinated "team approach" to the diagnosis, care and treatment of cancer patients.
3. Explain the meaning of the following:
   a. definitive treatment
   b. palliation
   c. adjunct treatment
4. Define the following terms:
   a. teletherapy
   b. brachytherapy
   c. fractionation
   d. protraction
   e. field
   f. particulate
   g. nonparticulate
5. Describe the emergence of radiation therapy when it was observed that radiation administered for diagnostic purposes caused biologic changes.
6. Define the following terms:
   a. epilation
   b. erythema
7. Describe the first applications of radiation for therapy of surface lesions and deep lesions.
8. Discuss the first reported case of a patient treated with radiation and cured.
9. Given the following persons who have contributed to the evolvement of radiation therapy into a medical specialty, identify events and dates.
   a. W.C. Roentgen
   b. E. Grubbe
   c. A.H. Becquerel
   d. M. and P. Curie
   e. C.E. Skinner
   f. J. Bergonie and L. Tribondeau
   g. E.O. Lawrence
   h. F. Joliot and I. Joliot-Curie
   i. E.O. Lawrence and R.S. Stone

j. D.W. Kerst

10. Explain the relationship between the amount of energy deposited within tissue/the condition of the biologic system and the biologic effectiveness of ionizing radiation.
11. Define the following terms:
    a. LET (linear energy transfer)
    b. RBE (relative biologic effectiveness)
12. Describe the three entities of a biologic system which affect the radiosensitivity of a tissue.
13. Explain what is meant by a direct effect of irradiation; indirect effect of irradiation of tissues.
14. Give three reasons why greater cell damage will occur to abnormal cells than to normal cells for any given increment of radiation dose.
15. Describe five effects of irradiation of tissue which may result in cell destruction.
16. Categorize the following tumors according to their radiosensitivity.
    a. gonadal germ cell
    b. lymphoproliferative tumors
    c. embryonal tumors
    d. epithelial tumors
    e. glandular tumors
    f. mesenchymal tumors
    g. nerve tumors
17. Describe the use of drugs or oxygen to enhance the effectiveness of radiation.
18. Define the following terms:
    a. cancer
    b. carcinogen
    c. metastasis
    d. malignant
    e. benign
    f. proliferation
    g. anaplastic (dedifferentiated)
    h. dormant
    i. regression
    j. histology
    k. immunology
    l. cancericidal
19. Categorize the following tumors according to their tissue or origin:
    a. carcinoma
    b. adenocarcinoma
    c. osteosarcoma
    d. liposarcoma
    e. multiple myeloma
    f. erythroleukemia
    g. glioma
    h. neuroblastoma
    i. nephroblastoma
    j. seminoma
    k. thymoma
20. Explain how the TNM staging or classification of tumors is designed and describe its purpose.
21. Describe the factors which influence the effectiveness of radiation therapy to accomplish a cure of a malignant tumor.
22. Define therapeutic ratio (TR).
23. Describe an appropriate nonparticulate radiation beam for:
    a. lesions near the skin
    b. in-depth tumors
24. Explain why the skin-sparing effect is of importance clinically and describe the beam energy which results in less skin exposure and more skin-sparing effect.
25. Describe the positive benefits of using particulate irradiation.
26. Give the general rule used to determine the depth of tumor placement and depth of penetration in centimeters of a given beam of electrons.
27. Name two reasons why neutrons are of interest therapeutically.
28. Give the theory behind the use of brachytherapy.

29. Describe three approaches to delivering radiation by brachytherapy.
30. Give examples of the following brachytherapy applications:
    a. temporary application
    b. permanent application
31. Identify the variables which must be considered before implementing radiation therapy.
32. Define the following terms:
    a. dosimetry
    b. dosimetrist
    c. single field
    d. opposing field
    e. multifield
    f. rotational field
    g. wedge fields
    h. shaped fields
    i. isodose curve
    j. bolus
33. Identify diagnostic modalities which aid in radiation therapy treatment planing and follow-up.
34. Give several examples of new techniques which are being investigated with the objective of enhancing the effectiveness of cancer therapy.
35. Identify forms of cancer which if found early, have been shown to have a good cure rate.
36. Identify forms of cancer which are primarily treated for cure or palliation by radiation therapy.
37. Identify forms of cancer which often are treated with radiation and surgery and/or chemotherapy.
38. Demonstrate an appreciation for the importance of radiation therapy in the treatment of cancer by stating the percentage of new patients (diagnosed as having cancer) who receive radiation therapy.
39. Discuss the biologic hazards associated with treatment by radiation.

Diagnostic Medical Sonography (B, D, E, F, G, I) – 75% Minimum Mastery Level Required

1. Define ultrasonography.
2. Give the sound range (waves) for humans and the sound range for diagnostic ultrasound (beyond the audible range).
3. State the historical significance of each of the following eras or persons:
    a. Curie brothers
    b. Wilhelm Roentgen
    c. World War II
    d. 1947-Dussik
    e. 1948-Howry
    f. 1954-Hertz and Edler
    g. 1957-Brown and Donald
    h. Real-time imaging
4. Compare ultrasound to electromagnetic radiation addressing the following topics:
    a. Type of wave
    b. Method of transmission
    c. Velocity
5. Describe the nature of ultrasound relative to the following topics:
    a. Wave equation
    b. Frequency
    c. Amplitude
    d. Wavelength
6. State the frequency range of ultrasound used for Diagnostic Medical Sonography.
7. Associate each of the following as applying to ultrasound:
    a. High frequency transducer provides short wavelength, shallow penetration, better image resolution, and more directionality, better axial and lateral resolution
    b. Low frequency transducer provides long wavelength, deep penetration, less resolution, and less directionality
8. Relate amplitude of the wave to the intensity, gain or loudness of the sound.
9. Describe the affect on velocity of sound when it is transmitted through-
    a. soft tissue
    b. fat.
10. Define tissue interface and acoustic impedance, and explain their significance to the ultrasound image.
11. Discuss piezoelectric effect.

12. Identify the major components of an ultrasound transducer and describe their function.
13. Relative to power and area of the ultrasound beam, calculate the intensity.
14. Define destructive interference of sound waves.
15. Define constructive interference of sound waves
16. As related to ultrasound beam focusing, compare the near field (Fresnel zone) to the far field (Fraunhofer zone)..
17. Explain how the near filed can be lengthened and the far field divergence decreased.
18. State the unit for ultrasound intensity and describe its application.
19. Describe the use of amplification gain in an ultrasound study.
20. Define each of the following:
    a. absorption
    b. reflection
    c. scattering
21. Discuss the ultrasound transmission through bone or gas as opposed to soft tissue.
22. Explain the use of a coupling agent on the outer skin of a patient.
23. Discuss the use of fluids such as urine in the bladder to create an acoustic window.
24. Define each of the following terms:
    a. resolution
    b. axial resolution
    c. lateral resolution
25. Recognize axial resolution as being inherently better than lateral resolution.
26. Describe the influence of frequency on each of the following factors:
    a. axial resolution
    b. lateral resolution
27. Describe the transducer frequency used for the following regions of the body:
    a. Deeper, larger surface areas, e.g., abdomen
    b. Superficial, smaller areas, e.g., Thyroid, breast
28. Discuss possible biological hazards, if any, associated with diagnostic levels of ultrasound.
29. Define each of the following terms:
    a. thermal effects
    b. cavitation
    c. viscous stresses
30. State criteria used to identify each of the following:
    a. cystic
    b. solid
    c. combination of cystic and solid (complex)
31. Define real time, Doppler effect, and color flow Doppler.
32. In color flow Doppler, describe the typical color scale for a shift toward the transducer as opposed to a shift away the transducer.
33. Identify indications for each of the following:
    a. abdomen US
    b. retroperitoneal US
    c. gynecologic US
    d. obstetric US
    e. superficial tissue US
    f. neonatal US
    g. transvaginal US
    h.. transrectal US
    i. vascular US
34. Describe pre-procedure preparation for both abdominal and retroperitoneal ultrasound.
35. Discuss new developments in diagnostic medical sonography
36. Define the following terms:
    a. hypoechoic
    b. hyperechoic
    c. anechoic
    d. isoechoic
    e. echo
    f. heterogeneous
    g. homogeneous

h. sonic window

37. Outline advantages of ultrasound when compared to other imaging modalities.
38. Identify permanent storage used in ultrasound.

MAGNETIC RESONANCE IMAGING (B, D, E, F, G, I) – 75% Minimum Mastery Level Required

1. In general, compare MR imaging to radiographic imaging especially elaborating on the following:
    a. biologic hazards
    b. image parameters
    c. imaging planes
2. Discuss the contribution of Bloch and Purcell relative to the application of magnetic resonance for imaging and spectroscopy.
3. Discuss the contribution of Damadian relative to the application of magnetic resonance for imaging.
4. Discuss the contribution of Lauterbur relative to the application of magnetic resonance for imaging.
5. Explain why nuclei can appropriately be thought of as small, positively charged spinning tops.
6. Explain why nuclei can appropriately be thought of as a tiny spinning top with a north and south pole, just like a magnet.
7. Define the terms:
    a. magnetic dipole
    b. magnetic moment
8. Explain why a single nucleus of the body behaves like a magnet; and yet, the net magnetic moment (magnetism) of the body as a whole is zero.
9. Explain why a body part when placed in a strong magnetic field demonstrates a net total magnetic moment.
10. Associate the wobble of a spinning top with the term precession.
11. Explain why a spinning top wobbles and relate that to the wobble of a nucleus in the presence of a magnetic field.
12. Identify the two factors which determine the frequency of precession and associate the following:
    a. frequency of precession equals magnetogyric ratio times strength of magnetic field
    b. Larmor frequency equals magnetogyric ratio times strength of magnetic field
    c. both algebraical expressions are the Larmor equation
13. Explain how the magnetic property of the atoms of the body could be used to identify the nuclei present, indicate their relative abundance and provide an image of the interior of the body.
14. Define the following terms:
    a. resonant frequency
    b. resonance
    c. radio frequency (RF)
15. Give several examples of resonance.
16. Explain why the body when subjected to a reasonably strong magnetic field will respond to a specific radio frequency.
17. Describe what is meant by resonance of nuclei in the body.
18. Define the following terms:
    a. relaxation
    b. relaxation time
19. Identify the energy given off when resonating nuclei return to alignment with the external magnetic field.
20. Given the basic components of an MR scanner as follows, explain the function of each:
    a. primary magnet Bo
    b. radio transmitter
    c. RF receiver
    d. transceiver
21. Define the following terms:
    a. NMR spectrum
    b. resonance peak
    c. perturbed
    d. NMR spectroscopy
    e. RF pulse
    f. free induction decay (FID)
    g. Fourier
    h. nuclear magnetic resonance
22. Explain why that even though there are at least seven biologically important nuclei in the body, which demonstrate nuclear magnetic resonance, hydrogen is the nuclei presently used in imaging.
23. In reference to MR, define the term parameter and name the three parameters of NMR imaging.
24. Describe the relationship between the strength of an NMR signal and the number of hydrogen nuclei present.

25. Define the following terms:
    a. spin density
    b. relaxation time
    c. T1 spin-lattice relaxation time
26. Even though the processes are very different, explain the association of T1 relaxation time and radioactive decay constant (HL) and attenuation coefficient.
27. Explain what is meant by all regions of tissue being in phase.
28. Explain what is meant by dephasing.
29. Define T2 relaxation time and explain why it is referred to as the spin-spin relaxation time.
30. Explain the following statements: SD is determined by the initial signal strength before any of the decay processes have taken place. T1 and T2 relate to the response of the tissue after the spins have absorbed RF energy.
31. Explain why the MR image has better contrast for most tissues than the CT image and provides additional information about the biochemistry of the tissue.
32. Relative to time, describe the relationship of T1 and T2 in:
    a. any nuclear magnetic resonance situation
    b. solids
    c. liquids
33. Give the meaning of a linear gradient field.
34. Describe the formation of an MR image.
35. Define the term back projection reconstruction.
36. Discuss the similarities and differences of CT and MRI equipment.
37. Give three types of imaging magnets used in MRI at the present time.
38. Describe a resistive magnet typically used for MRI and discuss its design and the problems to be overcome with its use.
39. Define the following terms:
    a. superconductor
    b. cryogenic
    c. superconductor metal alloy
    d. Dewar
40. Describe a superconducting magnet and discuss the advantages and disadvantages of its use.
41. Explain the purpose of the outermost liquid nitrogen chamber of a superconducting magnet.
42. Explain the purpose of the innermost liquid helium chamber of a superconducting magnet.
43. Describe the advantages and disadvantages of using permanent magnets for MRI.
44. Explain why Larmor frequency for protons can be changed with a change in magnetic field strength.
45. Explain the purpose of applying a gradient magnetic field and describe how it is produced.
46. Explain the necessity of a gradient field when one desires to obtain images from a variety of projections (obliques, sagittal and coronal).
47. Unlike CT scanners, MRI scanners do not require moving parts to change projection angles or the plane of a scan, explain how this is accomplished.
48. Describe the location and construction of the RF transceiver coils.
49. Describe the room design for MRI and identify the term which is used to denote the cage-like shielding required.
50. Describe the appearance of an NMR image and discuss how it differs from a CT image.
51. Explain how higher spatial resolution can be obtained in MR imaging.
52. Explain why there are practical limitations to how strong a magnet can be used in an imaging environment.
53. Compare contrast resolution obtained with MRI to that obtained with CT.
54. Explain how adjustments made in the RF pulse sequence can alter the MRI imaging parameters, DS, T1, T2 and significantly change the appearance and contrast of the image.
55. Identify the appearance of bone or air in an MR image and explain this appearance.
56. Identify the appearance of fat or skin in an MR image and explain this appearance.
57. Explain the change in MR gray scale of a diseased lesion compared to the tissue surrounding it.
58. Describe typical scan times for MRI and compare these times to CT imaging.
59. Explain why reducing the time for MRI and compare these times to CT imaging.
60. Discuss the possible biologic hazards associated with MR imaging.
61. With reference to MRI, discuss the dose-response relationship and MPD (maximum permissible dose).
62. Identify the three physical agents associated with MRI that one might suspect of producing a biologic response and describe the standard of measurement used for each agent.
63. Discuss the following electrochemical changes in tissue which have been postulated to occur in the presence of a very strong magnetic field.
    a. membrane permeability

b. enzyme kinetics
c. nerve conduction
d. biopotentials

64. Discuss the following responses in tissue which are known to occur as a result of induced current density from varying magnetic fields which are several orders of magnitude above those employed in MRI.
65. Name the principal result of the interaction between a RF field and tissue.
66. Discuss the possible physical hazards associated with MR imaging.

Required Assessments:

Assessment Names and Descriptions:

A. Testing Procedures:

An examination directly related to the instructional objectives will follow completion of each topic or modality. Mastery level for each unit must be 75% or greater.

1) Image Intensified Fluoroscopy
2) Digital Fluoroscopy
3) Scanned Projection Radiography
4) Charged Coupled Devices
5) Flat Panel-Direct and Indirect Capture
6) Computer Science
7) Computed Tomography
8) Bone Densitometry

Minimum Mastery Level for each unit exam is 75%.

1) Nuclear Medicine
2) Position Emission Tomography
3) Radiation Therapy
4) Diagnostic Medical Sonography
5) Magnetic Resonance Imaging

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 2440	Test 1 final exam	Test 2 final exam	Test 4-6 final exam	Spec tests 1-5	Spec tests 1-6	Test 1-8; spec test 1-6 final exam	Spec tests 1-5	Spec test 1-5	Test 1-8; spec test 1-5 Final exam	NA

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

1. 60% of the mean average of the unit tests for:

1) Image Intensified Fluoroscopy
2) Digital Fluoroscopy
3) Scanned Projection Radiography
4) Charged Coupled Devices
5) Flat Panel-Direct and Indirect Capture
6) Computer Science
7) Computed Tomography
8) Bone Densitometry

Minimum Mastery Level for each unit exam is 75%.

2. 40% of the mean average of the unit tests for:

1) Nuclear Medicine
2) Position Emission Tomography
3) Radiation Therapy
4) Diagnostic Medical Sonography
5) Magnetic Resonance Imaging

There will be two (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.

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

_____