Western Technical College

10605202 Medical Imaging Systems

Course Outcome Summary

Course Information

Description	This course provides an overview of medical imaging systems with emphasis on X-ray systems, components, and circuits. The basic theory of operation, safety concerns, and typical applications of major imaging modalities is investigated, including: X-Ray, Ultrasound, CT, MRI, Mammography, Mobil radiography, Fluoroscopy, Nuclear Medicine, Linear Accelerators, and some additional modalities. If available, a portion of the course labs will take place in a regional medical center. Introductory ideas related to preventative maintenance and repair are also discussed.
Career Cluster	Science, Technology, Engineering and Mathematics
Instructional Level	Associate Degree Courses
Total Credits	4
Total Hours	90

Textbooks

Principles of Radiographic Imaging: An Art and a Science. 6th Edition. Copyright 2020. Carlton, Richard R., Arlene M. Adler, and Vesna Balac. Publisher: Cengage Learning. **ISBN-13:** 978-1-337-71106-7. Required.

Learner Supplies

Safety glasses with side eye protection that meet Z87 OSHA guidelines. **Vendor:** Campus Shop. Required.

Success Abilities

1. Cultivate Passion: Enhance Personal Connections
2. Cultivate Passion: Expand a Growth-Mindset
3. Cultivate Passion: Increase Self-Awareness
4. Live Responsibly: Develop Resilience
5. Live Responsibly: Embrace Sustainability
6. Live Responsibly: Foster Accountability

7. Refine Professionalism: Act Ethically
8. Refine Professionalism: Improve Critical Thinking
9. Refine Professionalism: Participate Collaboratively
10. Refine Professionalism: Practice Effective Communication

Program Outcomes

1. Manage medical equipment and systems.
2. Identify the function and operation of various types of imaging equipment.
3. Problem-solve electronic circuits and systems.
4. Apply principles of anatomy, physiology, and medical terminology.
5. Demonstrate safety precautions and practices with medical equipment.
6. Demonstrate professionalism.

Course Competencies

1. Explain the physics concepts of the generation of X-ray radiation in nature and machines.

Assessment Strategies

1.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
1.2. Skill demonstration in simulated or actual situations.
1.3. Retention checks and quizzes.
1.4. Written objective tests.

Criteria

Performance will meet expectations when:

1.1. You describe the basic atomic components of the nucleus, orbital shells, protons, neutrons, and their relationships to each other.
1.2. You describe the overall structure, limitations, and advantages of the Bohr and Quantum models of the atom.
1.3. You describe the electromagnetic spectrum in terms of the different areas of the spectrum with their general frequency, wavelength, energy, and physical properties of interactions with matter.
1.4. You describe the generation of different bands of spectral emission from an atom based upon the movement of electrons between orbital shells and the conservation of energy.
1.5. You define the different energy levels of soft/hard X-Rays and their interactions with physical matter and tissue.
1.6. You list mechanisms of how X-Rays are produced in nature cosmically and radioactively and by imaging machines through Bremsstrahlung and/or Characteristic interactions.
1.7. Your explanation describes the specifics of the interaction of a fast-moving electron with the target in an X-ray tube and how that leads to either Bremsstrahlung or Characteristic X-ray radiation or other undesirable energy.
1.8. Your explanation compares the X-ray intensity vs energy plots for Bremsstrahlung and Characteristic X-Ray radiation and the subsequent applications for those energies.

Learning Objectives

1.a. Describe atomic structure.
1.b. Describe the Bohr and Quantum models of the atom.
1.c. Describe the electromagnetic spectrum.
1.d. Describe the generation of spectral emission.
1.e. Define soft/hard X-Rays.
1.f. List mechanism of how X-Rays are produced in nature and by machines.
1.g. Explain Bremsstrahlung radiation.
1.h. Explain Characteristic (Spectral) radiation.

2. Explain the theory of operation of X-ray tubes.

Assessment Strategies

2.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
2.2. Skill demonstration in simulated or actual situations.
2.3. Retention checks and quizzes.
2.4. Objective tests.

Criteria

Performance will meet expectations when:

2.1. Your explanation includes the identification and description of tube components: anode, cathode, filament, glass envelope, grids, and vacuum.
2.2. You relate the physical structure of each of the tube components to the job they perform.
2.3. You explain the operation of a tube by sketching and labeling current flows related to tube potentials on example schematics.
2.4. Your description of tube current includes tube potential relationship to unsaturated current and saturation current.
2.5. You compare the uni-directional saturated tube current to the operation of a diode.
2.6. You explain amplifier operation as the ability to modulate tube current with the tube potential and tube grids for unsaturated current flow.
2.7. Your describe cathode/filament heating in relation to filament current with direct and indirect circuits.
2.8. You describe the details of thermionic emission resulting from the atomic action of added heat energy in the filament circuit.
2.9. Your describe space charge created from thermionic emission including the behavior of the individual electrons in different circuit circumstances.
2.10. Your descriptions relates the amount of filament current for thermionic emission to the creation of the space charge and the subsequent tube current and its impact on X-ray production.
2.11. You describe CRT operation by labeling the CRT components on a sketch and stating the components function including relating those functions to raster, horizontal trace and blank, and vertical trace and blank.
2.12. Explain how the X-Ray tube in an X-Ray imaging system creates of the actual X-ray radiation.
2.13. Identify each of the major X-Ray tube components.
2.14. Explain the function of the major tube components related to their structure and application.
2.15. Compare a stationary anode X-ray tube to a rotating anode X-ray tube.

Learning Objectives

2.a. Explain the major tube components.
2.b. Explain the operation of a tube circuit.
2.c. Explain the chain of events from filament heating to tube current.
2.d. Explain the operation of a CRT.
2.e. Explain the purpose of the X-Ray tube in an X-Ray system.
2.f. Explain the major X-Ray tube components.
2.g. Compare a stationary anode X-ray tube to a rotating anode X-ray tube.

3. Explain the components of an X-Ray imaging system.

Assessment Strategies

3.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
3.2. Skill demonstration in simulated or actual situations.
3.3. Retention checks and quizzes.
3.4. Objective tests.

Criteria

3.1. Your description lists therapeutic and diagnostic applications.
3.2. Your description differentiates the various imaging system component variation based on specific applications such as: standard rad rooms, fluoroscopic rooms, mobile systems, dental systems, urologic systems, and more.
3.3. Your table description includes specific table design features based upon the imaging requirements.
3.4. Your tube supports description conveys the support design features needed for specific applications.

3.5. Your image receptor description conveys the design features needed for specific applications.
3.6. Your description of power system differentiates between those needed for high power, low power, or mobile applications.
3.7. You describe controls for mAs, kVp, and exposure timing.
3.8. You list display options.

Learning Objectives

3.a. Describe general X-ray imaging applications.
3.b. Describe table (patient support) systems.
3.c. Describe tube support systems.
3.d. Describe image receptor systems.
3.e. Describe power systems.
3.f. Describe control systems.
3.g. Describe image display systems.

4. Explain the theory of operation of different types of power generators in X-Ray systems.

Assessment Strategies

4.1. Participation in assigned activities including classroom discussions, observation of and responses to in class and out of class training, reading materials, and practice questions.
4.2. Skill demonstration in simulated or actual situations.
4.3. Retention checks and quizzes.
4.4. Objective tests.

Criteria

Performance will meet expectations when:

4.1. Your explanation lists the basic different types of power generation; traditional, high frequency, mobile; along with their applications.
4.2. You identify X-ray machine component blocks; input power source, tube supply, timing circuit, filament supply, and X-Ray tube; on equipment diagrams, in actual machines, and by function.
4.3. You include the definition of single phase and three phase power to explain the power capabilities and characteristics of a single phase and a three phase X-Ray machine.
4.4. You compare a traditional high voltage generator in an X-Ray machine to a linear power supply including their similarities and differences and types of component blocks with their functions.
4.5. You use a sketch to illustrate the number of pulses in different connections of single phase and three phase power to create 1, 2, 6, and 12 pulse waveforms including the relative advantages/disadvantages of each.
4.6. You trace schematics of a simple single phase X-Ray system identifying the component blocks and extracting the specific circuitry of each block.
4.7. You compare a high frequency generator to a traditional generator including advantages of increased efficiency related to the much smaller ripple and its improvement in the image.
4.8. You compare a high frequency generator in an X-ray machine to a switching power supply including their similarities and differences and types of component blocks with their functions.
4.9. You list the different types of systems; capacitor discharge and battery-operated; used for mobile power supplies in X-ray imaging systems including the advantages and disadvantages of each.
4.10. You describe the theory of operation of modern mobile battery discharge power systems.

Learning Objectives

4.a. Describe different types of X-ray machine power systems.
4.b. Define the blocks of a traditional X-ray power system.
4.c. Explain the operation of traditional power systems and their variations.
4.d. Explain the blocks of a high frequency X-ray power system.
4.e. Explain the operation of a high frequency X-ray power system.
4.f. Explain maintenance issues.
4.g. Trace schematics.

5. Define units related to imaging modalities.

Assessment Strategies

5.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
5.2. Skill demonstration in simulated or actual situations.

5.3. Retention checks and quizzes.
5.4. Objective tests.

Criteria

Performance will meet expectations when

5.1. You define the following quantities/units: Curie, Becquerel, Roentgen, Coulomb per kilogram, rad, Gray, Kerma, Air Kerma, rem, Sievert, Kerma, Air Kerma.
5.2. You differentiate the different concepts of equivalent and effective dose including: (Equivalent dose) HT, (Dose Equivalent) H, (Average-absorbed dose) (DT,R), (radiation) R, (radiation weighting factor) WR, (quality factor) Q, (Effective dose) E, (Effective equivalent) HE.
5.3. Your definitions include relationships between quantities/units.
5.4. Your definitions include how each quantity/unit is used in imaging.

Learning Objectives

5.a. Define both SI and Conventional units.
5.b. Define the concepts of different quantities/units and abbreviations if they have them.
5.c. Define the specific quantities/units along with their abbreviations if they have them.
5.d. Specify how specific quantities/units relate to each other.
5.e. Specify how the quantities/units are used in imaging.

6. Explain safety issues related to X-Ray radiation.

Assessment Strategies

6.1. Participation in assigned activities including classroom discussions, observation of and responses to in class or out of class training, reading materials, and practice questions.
6.2. Skill demonstration in simulated or actual situations.
6.3. Retention checks and quizzes.
6.4. Objective tests.

Criteria

Performance will meet expectations when:

6.1. You explain the tissue damage that is produced from exposure to X-rays from natural or man-made radiation emphasizing that dose and damage are cumulative, differentiating between stochastic and deterministic effects.
6.2. You use the law of Bergonie and Tribondeau to explain the sensitivity of different tissues to damage by X-Ray radiation.
6.3. You explain the use of field survey instruments in measuring ionizing radiation including Geiger-Mueller Survey Instruments, Scintillation Detection Devices, and Ionization Chamber Instruments.
6.4. You explain the use of personnel dosimeters including film badges, OSLs, TLDs, pocket dosimeters.
6.5. You include the meaning of the letters for TDS and how to limit X-Ray exposure following TDS rules.
6.6. You include the meaning of the letters for ALARA and how to limit X-Ray exposure following ALARA rules.
6.7. You include the role of the NRC, NCRP, and OSHA in providing safe occupational limits as well as mentioning or looking up other agencies.
6.8. You explain a variety of dose limits for specific situations, whole-body vs certain tissues or organs; and populations such as general public, and occasionally or occupationally exposed radiation workers.
6.9. Your explanation of limiting dose for workers and patients includes the description and use of a variety of structural or personal protective devices such as: shielding, and primary and secondary barriers.
6.10. Your explanation of limiting dose for patients also includes the description and use of a variety of techniques for taking X-ray images such as: beam limitation, technique settings, filtration, grids, projection, reduction of repeat images, equipment maintenance and equipment selection.
6.11. You explain filtration effects on the shape of the photon emission spectrum, beam hardening, patient dose, and technique adjustments required to maintain exposure.
6.12. You define Al/Eq and HVL, commonly used to express the amount of filtration.
6.13. You explain the different types of filtration including inherent, added, compound, compensation, and total.

Learning Objectives

6.a. Explain the physical effects of X-Ray radiation to biologic tissue.
6.b. Explain occupational safety limits of X-Ray radiation exposure.
6.c. Describe methods of monitoring exposure to X-Ray radiation.

6.d. Define TDS.
6.e. List a variety of groups establishing radiation protection standards.
6.f. Define ALARA.
6.g. Explain methods of limiting dose.
6.h. Explain Filtration.
6.i. Explain Half Value Layer, HVL.

7. Explain technique for X-ray imaging.

Assessment Strategies

7.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
7.2. Skill demonstration in simulated or actual situations.
7.3. Retention checks and quizzes.
7.4. Objective tests.

Criteria

Performance will meet expectations when:

7.1. You include terminology related to patient factors, image quality factors, and exposure-technique factors.
7.2. You explain the major technique controls of mAs, kVp, and distance in relation to the quality and quantity of X-rays produced by the system and their effect on the subsequent image density/IR-Exposure and contrast as dependent upon the subject being imaged.
7.3. Your explanation compares the operation of different exposure systems including fixed kV, variable kV, AEC, and APR including the required equipment and advantages/disadvantages of each.
7.4. You define image subject visibility concepts including density/IR-exposure, contrast, detail, and distortion and how they relate to an adequate diagnostic image.
7.5. You explain the use of collimation, beam restrictors, grids, and positioning in the control of scatter and the production of a diagnostic X-ray image.
7.6. Your explanations of system phenomenon include anode heel effect, umbra/penumbra, and scatter radiations effects on the image produces.
7.7. Your explanation includes the need for tube warm-up procedures in the prevention of tube failures.

Learning Objectives

7.a. Explain the operation of the major controls for X-ray imaging.
7.b. Explain different exposure control systems.
7.c. Explain the different standard methods of control for producing high quality images.
7.d. Describe a variety of X-ray imaging system phenomenon and their effect on X-ray images produced.
7.e. You describe basic X-ray system operational procedures and failures.

8. Explain the interactions of X-ray radiation with matter and tissue.

Assessment Strategies

8.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
8.2. Skill demonstration in simulated or actual situations.
8.3. Retention checks and quizzes.
8.4. Objective tests.

Criteria

8.1. Your explanation differentiates between X-rays that pass thru matter and are attenuated by matter thru scatter or absorption.
8.2. Your explanation includes the type of tissue and the relative binding energy of the electrons in the atom.
8.3. You describe the five types of X-ray energy interactions with atomic matter including: photoelectric absorption, coherent scattering, Compton scattering, pair production, and photodisintegration; including the relative energy values of the incident X-ray photon and which interactions are significant for X-ray imaging.
8.4. Your explanation includes the relative value of kVp, mAs, and atomic number of the subject to the likelihood of incident X-ray photon attenuation thru Compton scatter or photoelectric interactions and the resulting impact on image contrast, IR-exposure, and patient dose.

Learning Objectives

8.a. Explain X-ray interaction with matter.

8.b. Explain the different types of interactions X-ray energy has with atomic matter.
8.c. Explain technique selection as related to the different types of X-ray interaction with matter.

9. Explain methods of image capture and storage (PACS) for X-Ray systems.

Assessment Strategies

9.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
9.2. Skill demonstration in simulated or actual situations.
9.3. Retention check and quizzes.
9.4. Objective tests.

Criteria

Performance will meet expectations when:

9.1. You explain film systems including the cassette/intensifying system and development/film issues.
9.2. Your comparison of film systems to digital systems highlights the differences between having a physical copy of an image and having an electronic copy of an image including all the advantages/disadvantages of physical media and of electronic medical records..
9.3. Your explanation of computed radiography includes physical and functional description of the following parts: CR plate, latent image, reading laser light, waveguide, photomultiplier tube, signal processor, UV erase lamp, plate transport.
9.4. You include the advantages/disadvantages/maintenance issues of CR.
9.5. Your explanation of DR includes discussion of direct and indirect detector types and algorithms to create the image.
9.6. You include the advantages/disadvantages/maintenance issues of DR.
9.7. You define digital image data characteristics of matrix size, field of view (FOV), spatial resolution, pixel size, and gray-scale bit depth.
9.8. You describe digital imaging data manipulation of point operations including: applications of histograms, look-up tables (LUT), windowing, rescaling; local operations including: high-pass filtering/edge enhancement, low-pass filtering/smoothing, and convolution; and geometric operations allowing rotation, magnification, and more.
9.9. You define digital image quantities of resolution, noise, Detective Quantum Efficiency (DQE), and exposure.
9.10. You define digital storage concepts of PACS, and electronic medical records.

Learning Objectives

9.a. Explain film systems.
9.b. Compare film systems to digital systems.
9.c. Explain computed radiography, CR, systems.
9.d. Explain digital radiography / direct radiography, DR, systems.
9.e. Explain data manipulation of digital systems.
9.f. Describe film storage and digital storage (PACS) systems.

10. Explain X-ray imaging quality control.

Assessment Strategies

10.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
10.2. Skill demonstration in simulated or actual situations.
10.3. Retention checks and quizzes.
10.4. Objective tests.

Criteria

10.1. You identify various government regulations with the impact they have had on patient safety.
10.2. Your definition of quality assurance includes the scope and aim relating to the entire imaging process.
10.3. Your definition of quality control includes its scope and aim related to the imaging equipment.
10.4. You explain the various equipment tests specific to various X-ray imaging systems including: focal spot size estimation, half-value layer, geometric accuracies, kVp, timers, mAs, exposure reproducibility, resolution, contrast, displays, controls, indicators, mechanical movements, ion chamber operation, and IR-detectors.
10.5. Your explanation of ancillary equipment monitoring includes checking dose limiting systems, displays, cassettes, readers, and detectors.

Learning Objectives

10.a. Identify the role of various federal government regulations for the safety of patients related to imaging.
10.b. Define Quality Assurance.
10.c. Define Quality Control.
10.d. Explain external X-ray beam evaluation.
10.e. Explain monitoring of a variety of equipment in addition to the X-ray system.

11. Apply proper practices for imaging machine maintenance.

Assessment Strategies

11.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
11.2. Skill demonstration in simulated or actual situations.
11.3. Retention checks and quizzes.
11.4. Objective tests.

Criteria

Performance will meet expectations when:

11.1. You follow the TDS rules to limit X-Ray exposure in an actual or simulated lab situation.
11.2. You follow rules to avoid being injured by heavy moving mechanical systems in an actual or simulated lab situation.
11.3. You follow rules to avoid being shocked while working on energized equipment in an actual or simulated lab situation.
11.4. You use common sense in an actual or simulated lab situation.
11.5. You report on observation and assistance of maintenance of imaging systems consisting largely of verification of mechanical systems, cleaning, and lubricating.
11.6. You report on observation and assistance of equipment verification of imaging systems.

Learning Objectives

11.a. Implement required safety practices while working on imaging systems to limit exposure to radiation.
11.b. Apply precautions of working with heavy moving mechanical components.
11.c. Apply precautions of working on energized circuits.
11.d. Apply common sense practices.
11.e. Apply equipment verification procedures for imaging systems.
11.f. You observe equipment maintenance activities.
11.g. You observe equipment verification activities.

12. Explain Fluoroscopic X-Ray systems.

Assessment Strategies

12.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
12.2. Skill demonstration in simulated or actual situations.
12.3. Retention checks and quizzes.
12.4. Objective tests.

Criteria

Performance will meet expectations when:

12.1. You define fluorescence as a physical phenomenon.
12.2. You explain the following applications of fluoroscopy: dynamic studies of moving items, angiography, vascular studies, and positioning/placement applications.
12.3. You include the following components of a fluoroscopic/vascular imaging system: image intensifier or digital detector, tube location, tube support, system geometry, display system, and contrast injector.
12.4. You include the type of material in contrast media and its characteristics and applications in fluoroscopy and vascular imaging in general.
12.5. Your safety explanation includes limiting fluoroscopic power to reduce dose, shielding methods, and monitoring.

Learning Objectives

12.a. Define fluorescence.
12.b. Explain the application of fluoroscopy in an X-Ray system.

12.c. Explain the operation of the basic components of a fluoroscopic system.
12.d. Define contrast media.
12.e. Explain safety features related to fluoroscopic X-Ray systems.

13. Explain Mobile Radiography imaging.

Assessment Strategies

13.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
13.2. Skill demonstration in simulated or actual situations.
13.3. Retention checks and quizzes.
13.4. Objective tests.

Criteria

Performance will meet expectations when

13.1. Your definition includes a description of the equipment, its applications, and challenges for the radiographer.
13.2. You describe historical power systems with their limitations and modern power systems and its advantages.
13.3. You explain the SID commonly employed with mobile systems due to space considerations.
13.4. You describe SID, grid, and alignment errors which may cause radiographer to erroneously believe there is an equipment problem.
13.5. You include a description of types of drive controls and the need for safety in transporting heavy mobile systems.

Learning Objectives

13.a. Define mobile radiography.
13.b. Describe the power system used.
13.c. Explain the space limitations and SID.
13.d. Describe alignment problems.
13.e. Describe drive units.

14. Explain Mammography imaging.

Assessment Strategies

14.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
14.2. Skill demonstration in simulated or actual situations.
14.3. Retention checks and quizzes.
14.4. Objective tests.

Criteria

Performance will meet expectations when

14.1. Your definition describes the subject tissue type including the required values of kVp, mAs, focal spot size, and HVL for this tissue type.
14.2. Your imaging description includes the technique differences between conventional radiography and mammography.
14.3. Your description of the generator includes the requirements for constant kVp, low mA, and high s.
14.4. Your description of exposure control includes the increased demand for AEC in determining exposure along with the backup time requirements, and the need for manual exposure techniques with dense tissue or implants.
14.5. Your explanation of tube design includes the various target and window materials and construction variations, as required for producing the low kVp, high mAs, small focal spot, and limited HVL; while contrasting this design to conventional X-ray tubes.
14.6. Your explanation of the geometry includes the small SID, prominent heal effect, missed tissue, cathode placement, central ray placement, focal spot size, and tube tilt.
14.7. You describe the use of magnification for an imaging technique for increasing the visibility of detail of small structures and the subsequent advantages/disadvantages.
14.8. Your component explanation includes grid construction and compression devices.
14.9. You describe digital receivers and resolution.

Learning Objectives

14.a. Define mammography.
14.b. Describe the imaging requirements for mammography.
14.c. Describe generator requirements.
14.d. Describe the type of exposure control utilized.
14.e. Explain the design specifics of mammography X-ray tubes.
14.f. Explain the tube/subject geometry.
14.g. Describe variations in technique utilized.
14.h. Explain system components unique to mammography.
14.i. Describe the image receiver.

15. Describe miscellaneous imaging modalities.

Assessment Strategies

15.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
15.2. Skill demonstration in simulated or actual situations.
15.3. Retention checks and quizzes.
15.4. Objective tests.

Criteria

15.1. Your list includes modalities brought up in class.
15.2. You include physical phenomenon such as X-ray, temperature, light, Infrared, and sound.
15.3. Your definition of bone densitometry contains the application of testing bones along with bone science.
15.4. Your description of bone densitometry machines includes the single and dual X-ray energy system as well as the ultrasound system.
15.5. Your description includes the use of phantoms, scan locations, and safety.
15.6. You utilize a graph of the four combinations of accuracy/precision on a target.

Learning Objectives

15.a. List many minor imaging modalities.
15.b. List different physical phenomenon utilized for different imaging modalities.
15.c. Define bone densitometry.
15.d. Describe different types of bone densitometry machines.
15.e. Describe the use of bone densitometry machines.
15.f. Explain precision vs accuracy.

16. Explain Computed Tomography (CT) imaging modality.

Assessment Strategies

16.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
16.2. Skill demonstration in simulated or actual situations.
16.3. Retention checks and quizzes.
16.4. Objective tests.

Criteria

Performance will meet expectations when:

16.1. Your comparison includes description of machines, theory of operation and typical applications.
16.2. You include the tube, gantry, patient transport, detector, processor, display, and collimators on a sketch relating that to the component functions.
16.3. You explain the theory of operation of CT imaging focusing on the construction of the image from absorption data.
16.4. Your list of 1st thru 5th generation CT imaging system includes the general physical structure and operation and image capabilities.
16.5. You focus on total dose of CT images for safety issues including discussion of recent limit requirements and excess dose examples.
16.6. You include the following maintenance issues: SW upgrades, cleaning system, tube life, and moving parts.
16.7. You relate Windowing and Leveling to the range and center value of the CT #'s used to create an image to display the required density of the subject of interest.

Learning Objectives

16.a. Compare CT imaging to other types of imaging.

16.b. List the typical applications of CT imaging.
16.c. Identify the major components of a CT system.
16.d. Explain the function of the major components of a CT system.
16.e. Explain the theory of operation of CT imaging.
16.f. List the features of 1st thru 5th generation CT imaging system.
16.g. Describe safety issues related to CT imaging.
16.h. Explain common maintenance issues.
16.i. Explain Windowing and Leveling.

17. Explain Ultrasound imaging modality.

Assessment Strategies

17.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
17.2. Skill demonstration in simulated or actual situations.
17.3. Retention checks and quizzes.
17.4. Objective tests.

Criteria

Performance will meet expectations when:

17.1. Your comparison of therapeutic to imaging ultrasound includes power levels and applications.
17.2. You include the following therapeutic ultrasound applications: shock wave lithotripsy, sonophoresis, acoustic hemostasis, and physical therapy.
17.3. You relate imaging ultrasound applications to the safety feature and image quality limitations.
17.4. You include the following major components: crystal, oscillator, coupling media, acoustic lenses, transducer types, signal processor, display, and contrast media.
17.5. You include piezoelectric crystal function, constant speed of sound, and echoes to theory of operation of ultrasound imaging.
17.6. You include the physical effects of sound on the human body in relation to the power output.
17.7. You focus on probe care and cost and SW upgrades as common maintenance issues.

Learning Objectives

17.a. Compare therapeutic ultrasound systems to imaging ultrasound systems.
17.b. Explain common therapeutic ultrasound applications.
17.c. Explain common imaging ultrasound applications.
17.d. Identify the major components of an ultrasound imaging system.
17.e. Explain the function of the major components of an ultrasound imaging system.
17.f. Explain the theory of operation of ultrasound imaging.
17.g. Describe safety issues related to ultrasound imaging.
17.h. Explain common maintenance issues.

18. Explain Nuclear Medicine imaging modalities.

Assessment Strategies

18.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.
18.2. Skill demonstration in simulated or actual situations.
18.3. Retention checks and quizzes.
18.4. Objective tests.

Criteria

Performance will meet expectations when:

18.1. Your comparison of Nuclear Medicine imaging to other types of imaging focuses on the functional images obtained and the administration of radiopharmaceuticals.
18.2. You include the type of radioactive decay of materials used for radiopharmaceuticals and their half-lives, and administration routes.
18.3. You include the following applications: cancer studies, cardiac studies, thyroid studies, and brain studies.
18.4. You include the following major components: gamma camera, collimators, detectors, and detector distribution; and their use in each type of system.
18.5. You include the chain of events: radiopharmaceutical administration and uptake, duration of study,

detection of decay particles, processing of image, display of image for the theory of operation of Nuclear Medicine imaging.

18.6. Your list of the features of different types of Nuclear Medicine imaging systems including SPECT and PET includes the difference of the construction of the machines and the types of images obtained, and the difference between radiopharmaceuticals used.

18.7. You focus on the safety issues related the administration of radioactive substances.

18.8. You include the following common maintenance issues: SW upgrades, pharmaceutical delivery systems, patient transport.

Learning Objectives

18.a. Compare Nuclear Medicine imaging to other types of imaging.

18.b. Explain radiopharmaceuticals.

18.c. List the typical applications of Nuclear Medicine imaging.

18.d. Identify the major components of a Nuclear Medicine system.

18.e. Explain the function of the major components of a Nuclear Medicine system.

18.f. Explain the theory of operation of Nuclear Medicine imaging.

18.g. List the features of different types of Nuclear Medicine imaging systems including SPECT and PET.

18.h. Describe safety issues related to Nuclear Medicine imaging.

18.i. Explain common maintenance issues.

19. Explain Magnetic Resonance Imaging (MRI) modalities.

Assessment Strategies

19.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.

19.2. Skill demonstration in simulated or actual situations.

19.3. Retention checks and quizzes.

19.4. Objective tests.

Criteria

Performance will meet expectations when:

19.1. Your comparison of MRI imaging to other types of imaging focuses on the safety issues, and soft study applications.

19.2. You include the following applications: soft tissue, functional MRI, and spine/brain studies.

19.3. You include the following major components: magnet, RF Transmitter, gradient system, detection system, and imager system.

19.4. You include spin physics, resonance, and the Larmor equation in the theory of operation of MRI imaging.

19.5. You focus on the safety issues related to the danger to people in the MRI environment related to metal objects as projectiles or metal implant concerns and the required safety precautions.

19.6. You include the following common maintenance issues: SW upgrades, patient transport, and cryogen maintenance.

Learning Objectives

19.a. Compare MRI imaging to other types of imaging.

19.b. List the typical applications of MRI imaging.

19.c. Identify the major components of a MRI system.

19.d. Explain the function of the major components of a MRI system.

19.e. Explain the theory of operation of MRI imaging.

19.f. Describe safety issues related to MRI imaging.

19.g. Explain common maintenance issues.

20. Explain Radiation Oncology systems.

Assessment Strategies

20.1. Participation in assigned activities including classroom discussions, observation of and responses to in and out of class training, reading materials, and practice questions.

20.2. Skill demonstration in simulated or actual situations.

20.3. Retention checks and quizzes.

20.4. Objective tests.

Criteria

Performance will meet expectations when:

20.1. You explain Radiation Oncology as a treatment system rather than an imaging system but compare the similarity of the equipment to different types of imaging system equipment.
20.2. You include cancer treatment as the major application of Radiation Oncology systems.
20.3. You include the following types of Radiation Oncology systems: Cobalt-60 machine, linear accelerator, and Gamma Knife.
20.4. You include the following for each type of system: Cobalt-60 machine (pellet source, rotation of source to opening in shielding), linear accelerator (modulator, electron gun, RF power source, accelerator wave guide, target), and gamma knife (radioactive source, multiple openings in shielding).
20.5. You explain the theory of operation of Radiation Oncology systems related to the different types of systems.
20.6. You include the importance of collimation, treatment plans, simulations, and room shielding as safety issues related to Radiation Oncology systems.
20.7. You include the following common maintenance issues: SW upgrades, and motorized parts.

Learning Objectives

20.a. Compare Radiation Oncology treatment systems to different types of imaging systems.
20.b. List the typical applications of Radiation Oncology systems.
20.c. Identify the major components of a Radiation Oncology system.
20.d. Explain the function of the major components of a Radiation Oncology system.
20.e. Explain the theory of operation of Radiation Oncology systems.
20.f. Describe safety issues related to Radiation Oncology systems.
20.g. Explain common maintenance issues.