Virginia Western Community College
RAD 242
Computed Tomography Procedures and Instrumentation
(Physics and Instrumentation)

Prerequisites
ARRT Registered or Registry Eligible

Course Description

This course is designed to facilitate technologists in the optimization of imaging parameters and patient care for the demonstration of anatomy and pathology using Computed Tomography. The focus of this course will be an introduction to the physics and instrumentation of Computed Tomography.

Semester Credits: 2 **Lecture Hours: 2**

Required Materials

Textbook:
Computed Tomography, Physical Principles, Clinical Applications, and Quality Control. Seeram, Euclid. 4TH Edition. Saunders. ISBN: 9780323312882

Other Required Materials:
Internet Access

Course Outcomes
At the completion of this course, the student should be able to:

- Receive an introduction exposure to the physical principles of CT including the advantages and limitations of CT
- Gain an understanding of CT data acquisition concepts
- Understand the image reconstruction process related to CT
- Recognize the components for optimal image quality and artifact reduction
- Discover concepts related to all types of CT imaging

- Study the fundamentals of manipulating imaging parameters to achieve optimal images for the visualization of anatomical structures for related examinations
- Recognize common artifacts specific to the modality
- Gain knowledge of the indications, patient preparation, scanning protocols, imaging techniques, and contrast requirements for Head, Cerebral Vessels, Neck and Spine; Chest, Abdomen, Pelvis and Musculoskeletal system

Topical Description

Chapter 1: Computed Tomography Overview

- Describe data acquisition and image reconstruction
- Describe how CT scanners work
- List the historical highlights of Computed Tomography
- List processes in digital image processing

Chapter 2: Digital Imaging Processing

- Describe the limitations of film-based imaging
- Define digital image processing
- List and discuss the characteristics of the digital image
- Describe the components of image digitization
- Identify image-processing techniques
- Define image compression
- Explain the advantages of digital image processing

Chapter 3: Physical Principles of Computed Tomography

- Describe the limitations of radiography and tomography
- Give the advantages of CT
- Discuss the following:
    - Data Acquisition
    - Radiation attenuation
    - Data acquisition geometries
    - Data Processing
    - CT numbers
    - CT and energy dependence
    - Linear attenuation coefficients
    - Hounsfield units
    - Image display, storage and communication
    - Windowing
- Describe CT image Format
- Describe the technical considerations for CT
- Discuss the advantages and limitations of CT

Chapter 4: Data Acquisition Concepts

- Describe and discuss the various data acquisition geometries utilized for CT
- Describe slip-ring technology
- Explain the importance of slip-ring technology
- List the components of the x-ray system as related to CT
- Describe the characteristics various types of CT detectors
- Relay the function of the CT detectors
- List the components of CT detectors
- Describe z-sharp technology

Chapter 5: Image Reconstruction

- List the basic principles of image reconstruction
- Define the following and relay the importance:
  - Algorithms
  - Fourier Transform
  - Convolution
  - Interpolation
- Describe the problem for CT image reconstruction
- Discuss reconstruction algorithms relative to CT image reconstruction
- Discuss the types of measurement data necessary for CT image reconstruction
- Describe image reconstruction for spiral or helical CT
- Describe the cone-beam geometry and algorithms for new generation multislice CT scanners

Chapter 6: Iterative Reconstruction Basics

- Learn the Assumptions Made to Derive the FBP Algorithm
- Describe Noise Reduction Techniques
- Learn IR Algorithms without Modeling: Fundamental Concept:
  Input
  IR Loop
  Output
- See examples of IR Algorithms

Chapter 7: Basic Instrumentation

- List the basic equipment configuration of the CT imaging system
- Describe the CT computer and image processing system
- Discuss the image display, storage, recording and communications necessary for CT
- Explain the components of the CT control console

Chapter 8: Image Post-processing and Visualization Tools

- Define image post-processing
- List applicable techniques for image post processing
- Discuss windowing and the purpose of windowing in CT
- Define multiplanar reconstruction (MPR)
- List the various visualization tools available in CT
- Discuss benefits of advanced visualization tools such as SSD, MIP, 4D Angio and Curved MPR

Chapter 9: Image Quality

- Define image quality in CT
- Explain high contrast spatial resolution
- Explain low contrast resolution
- Define temporal resolution
- List the factors that affect temporal resolution
- Discuss techniques utilized to reduce the impact of motion
- Discuss the importance of CT accuracy and linearity
- Identify the importance of CT uniformity
- Define noise in CT
- List sources of noise in CT
- Discuss how to control noise in CT
- List the various types and causes of image artifacts
- Identify image artifacts on CT images
- List techniques used to control image artifacts

Chapter 10: Radiation Dose in Computed Tomography

- Discuss radiation quantities and their units
- Discuss radiation bioeffects
- Explain CT scanner x-ray beam geometry
- Discuss CT dosimetry concepts
- List and discuss factors affecting dose in CT
- Discuss the fundamentals of automatic tube current modulation
- Summarize the image quality paradigms
- Describe CT dose optimization
- Relay radiation protection considerations for CT

Chapter 11: Single-slice Spiral/Helical CT (SSCT): Physical Principles and Instrumentation

- Discuss conventional slice-by-slice CT scanning
- Explain principles of SSCT
- Describe the differences in instrumentation for spiral/helical scanners compared to conventional CT scanners.
- Discuss the basic scan parameter and terms for spiral/helical CT
- Compare SSCT/Conventional CT image quality and dosing
- Explain the evolution of MSCT scanners
- Discuss the physical principles of MSCT
- Explain the instrumentation for MSCT
- Describe isotropic imaging
- Discuss image quality consideration for MSCT
- Discuss advances in future technology for CT

Chapter 12: Other Technical Applications of CT

- Discuss advanced applications of CT Imaging

Chapter 13:Three-Dimensional Computed Tomography: Basic Concepts

- Learn the Rationale and History of Three –dimensional Concepts
- Describe the Classifications of Three-Dimensional Imaging Approaches
  - Slice Imaging
  - Projective Imaging
  - Volume Imaging
- Rendering Techniques
  - Surface Rendering
  - Volume Rendering
  - Intensity Projection Renderings
- Learn the Equipment and Clinical Applications
- The Future of 3D Imaging and the role the Technologist plays

Chapter 18: Quality Control for CT Scanners

- Define quality control
- Discuss importance of quality control
- List the principles of quality control
- Describe the various quality control tests for CT scanners

Note to Instructors