Miami Dade College

Course Description

NMT2534C | Nuclear Medicine Instruction | 2.00 credits

This course will integrate and correlate the electrical and nuclear physics principles associated with the operation and calibration of radiation detection devices employed in nuclear medicine. The student will learn the various types of devices that are used to provide information from which the diagnostic images are obtained. Prerequisites: NMT1002L, NMT1312C, NMT2613 and PHY1020; Corequisites: NMT1713C, NMT2102, NMT2804C

Course Competencies:

Competency 1: The student will be able to demonstrate an understanding of various detectors used in the field of nuclear medicine by:

1. Describing the operation of the electrical components of various radiation detecting systems
2. Describing the function of amplifiers and preamplifiers
3. Describing pulse-size characteristics for an ion chamber when operated in the ion chamber region, the proportional region, and the G-M region, describing the gas-detector response as a function of voltage, and stating the basic principles of operation of gas detectors
4. Discussing the principles of operation of the pocket dosimeter, Cutie-pie, and dose calibrator

Competency 2: The student will be able to demonstrate an understanding of scintillation devices by:

1. Listing and describing the function of each component of a NaI (Tl) scintillation detector
2. Discussing scintillation measuring techniques
3. Describing the characteristics of the scintillation detection crystal
4. Describing the basic physical concepts involved with scintillation spectrometry, the practical operation of the scintillation detector, and the practical operation of the pulse-height analyzer portion of the spectrometer
5. Giving the necessary energy information and determine proper gain settings
6. Describing the primary use of scintillation spectrometers and the importance of proportional linearity between gamma energy and voltage pulse output
7. Operating a solid scintillation counter and demonstrating this ability by obtaining a gamma-ray spectrum using a single-channel analyzer
8. Discussing using sealers, timers, and RTE meters in a scintillation detector
9. Explaining the principles of liquid scintillation counting and list and describe the three counting methods
10. Stating the requirements for counting vials

Competency 3: The student will be able to demonstrate an understanding of counting statistics by:

1. Comparing and contrasting solid scintillation systems with liquid scintillation systems regarding the type of radiation detected, flours or scintillation used, energy transfer, energy resolution, and efficiency
2. Determining a statistically accurate counting rate for a radiation detector
3. Defining and differentiating between resolving time and dead time
4. Comparing and contrasting dead time of gas-filled detectors with scintillation detectors
5. Calculating, comparing, and contrasting the efficiency of gamma and beta emitters when using gas-filled detectors with scintillation detectors
6. Calculating mean, standard deviation, and reliability factor, given a set of nuclear counting events
7. Calculating what percentage of Gaussian distribution values fall within 1, 2, or 3 standard deviations
8. Calculating the mean and standard deviation of a single count value related to the Poisson distribution
9. Calculating a Chi-square test and obtaining a P value from a given set of data points

Competency 4: Students will be able to demonstrate an understanding of crystals and collimators by:

1. Discussing the development of the Anger scintillation camera, including the types and numbers of photomultiplier tubes, crystal diameter, and depth, collimators, light pipes, and changes in the electronics
2. Describing the physical parameters of collimators and crystals with particular attention to crystal diameter and thickness
3. Explaining the advantages and disadvantages inherent in using thin crystal parameters
4. Stating the characteristics of the parallel-hole, diverging, converging, and pinhole collimators as they relate to the Anger scintillation camera
5. Stating the physical parameters and uses of low-energy, medium-energy, and high-energy collimators

Competency 5: Students will be able to demonstrate an understanding of quality control as it relates to the use and care of nuclear medicine equipment by:

1. Explaining the function of the x, y, and z signals used in a gamma camera system, discussing the significance of the signals in producing an accurate image on the display screen
2. Describing the effects of astigmatism and focus on the final image
3. Discussing the purpose and use of multiple lenses on a multiformat imager
4. Discussing the dead time and framing time considerations with multiformat images
5. Describing methods for evaluating the spatial resolution of a collimator for an Anger scintillation camera
6. Explaining the relationship between detector size and the number of passes required in a whole-body camera system
7. Differentiating between intrinsic resolution and extrinsic resolution and extrinsic resolution as they relate to gamma camera resolution and describing procedures that can be used to measure each
8. Listing and discussing factors related to camera sensitivity
9. Defining the term "field uniformity"
10. Describing in detail the various factors that cause camera nonuniformity, stating the resulting potential effect on image quality
11. Defining the term "resolving time"
12. Describing the effect on an image when the wrong energy level collimator is used
13. Describing the effect on an image when the following situation occurs:
    a. cracked or fractured crystal
    b. improper PM tube calibration
    c. improper pulse-height analyzer calibration
    d. Improperly focused CRT
    e. unclean CRT

Competency 6: The student will be able to demonstrate an understanding of basic medical computing by:

1. Comparing and contrasting analog and digital computer systems and signals
2. Describing the organization and function of the central process unit of a computer
3. Describing how information is stored in a computer memory, including various memory systems in the discussion
4. Stating factors that determine actual computer memory capacity

Competency 7: The student will be able to demonstrate an understanding of image recording devices by:

1. Explaining what a cathode ray tube (CRT) is
2. Discussing the difference between a persistence- scope and a CRT
3. Naming the imaging devices available to NM
4. Discussing how matrix size impacts image display

Competency 8: The student will be able to demonstrate an understanding of SPECT and PET Imaging by:

1. Discussing the construction of tomographic related to the use of SPECT and/or PET imaging systems
2. Listing and describing factors that limit statistical accuracy in SPECT imaging
3. Listing conditions or pathologies for which SPECT imaging is advantageous over planar imaging
4. Stating radiopharmaceutical requirements that must be satisfied to do PET imaging

Competency 9: Students will be able to demonstrate an understanding of Image Processing by:

1. Comparing and contrasting the various display systems used on nuclear medicine computers
2. Describing the relationship between an ROI and a histogram generated from a dynamic study
3. Describing the acquisition and processing of nuclear medicine studies on the computer system, including but not limited to gated, first-pass, and quantitative ventilation/perfusion lung imaging and SPECT imaging procedures
4. Describing the use of the computer in development and administration of quality assurance testing of imaging equipment

Competency 10: Students will be able to demonstrate Quality Assurance (QA) by:

1. Defining and using the terminology associated with quality assurance/control in the proper text
2. Presenting a clear explanation of the sources of quality assurance/control regulations and procedures using appropriate terminology
3. Preparing a report about the effect of quality control on the quality of patient care in general and its application to nuclear medicine
4. Identifying the regulatory agencies that affect the practice of nuclear medicine, including specific regulations of the various agencies, the scope of their power, and enforcement considerations related to compliance versus noncompliance
5. Identifying methods and problems associated with standardization of quality assurance at the institutional level
6. Outlining a standardized medical informatic system and discussing the rationale for each type of record
7. Explaining which parameters of a quality control program are recorded daily, weekly, monthly, and at other periodic intervals and giving a rationale for the time factors
8. Discussing the function of the various types of calibrated sealed sources

Learning Outcomes:

- Communicate effectively using listening, speaking, reading, and writing skills
- Use quantitative analytical skills to evaluate and process numerical data
- Solve problems using critical and creative thinking and scientific reasoning
- Formulate strategies to locate, evaluate, and apply information
- Demonstrate knowledge of ethical thinking and its application to issues in society
- Use computer and emerging technologies effectively