WORCESTER STATE COLLEGE

AND

UNIVERSITY OF MASSACHUSETTS MEDICAL SCHOOL

(NUCLEAR MEDICINE TECHNOLOGY PROGRAM)

COURSE: NUCLEAR MEDICINE INSTRUMENTATION II

OFFERED: SPRING, 2016

TIME: TUESDAYS and THURSDAY, 3:00 TO 5:00 P.M.

LOCATION: S2-205 (same as last semester)

PROFESSOR: MICHAEL A. KING, PhD, H2-577
(Telephone number 774-442-4255)

TEXTBOOKS: CHERRY SR, SORENSON JA, and PHELPS ME: PHYSICS IN NUCLEAR MEDICINE. 4th Edition , ELSEVIER / SAUNDERS 2012

RADIOLOGICAL HEALTH HANDBOOK, USHEW, 1970

COURSE OBJECTIVES

After completion of the classroom lectures, doing the homework, and taking part in the classroom demonstrations, the student shall be able to:

1. Apply the principles of counting statistics to estimate the average and standard deviation of the counting rate with and without background, estimate the minimum detectable activity, determine the optimal division of counting times, apply the Chi-square test to determine if a counter is operating properly, and apply the t-test to determine if there is a statistically significant difference between two counting rates.

2. Understand the influence of source and detector geometry, attenuation, scatter, resolving time, background, and detector sensitivity on counting efficiency. Also know the difference between, ways of determining, and the way to correct for both paralyzing and non-paralyzing resolving time.

3. Understand the setup, clinical use, and limitations of the uptake probes.

4. Understand the setup, clinical uses, and limitations of rectilinear scanners. Know why a focus, multi-hole, collimator is typically employed with these systems.

5. Be able to draw a block diagram of the components of a gamma camera and understand the design trade-off associated with each component as a function of sensitivity, spatial resolution, and photon energy.

6. Know the various types of collimators used with a gamma camera and how spatial resolution, sensitivity, field of view, and spatial distortion vary for each as a function of distance and photon energy.

7. Know how to test cameras for uniformity, the causes of non-uniformity, and the operation of typical uniformity correction schemes employed by manufacturers.

8.. Know how to test for spatial distortion, spatial resolution, sensitivity, energy resolution, resolving time and the influence of counting rate, and multi-peak energy registration.

9. Understand the concepts of acceptance testing, quality assurance, and quality control. Know what the NEMA standards are and their role in selecting cameras, writing performance specifications, and acceptance testing.

10. Know the advantages and disadvantages of emission tomography over planar imaging. Know the difference between SPECT and PET.

11. Understand the methods of acquisition of emission profiles, and reconstruction of slices using filtered back-projection for both SPECT and PET. Know why low-pass filters, and attenuation correction are needed. Know the differences between 180 and 360 acquisitions.

12. Understand the need for and how to perform center-of-rotation, uniformity, pixel size, and spatial resolution performance tests.

13. Understand the formation of the latent image, and processing of film required to make the latent image apparent.

14. Understand the concepts of film contrast, film latitude, and speed.

15. Understand the factors which influence radiographic contrast, spatial resolution, and image noise.

16. Be able to convert numbers between different number systems and why binary is the natural number system for use with computers.

17. Understand the difference between hardware and software, and how the different hardware components function together to form a computer.

18. Know how information and software is stored on disks, tapes and in memory.

19. Understand the concepts of machine language, assembly language, higher level language, and Nuclear Medicine Command Language. Know the difference between Command Driven and Memory Driven Command languages.

20. Understand the different types of, and components of, operating systems.

21. Understand how an ADC functions to bring data from a gamma camera into a computer image. Know the different matrix sizes, and how memory, usage, noise, and spatial resolution dictate the selection between these. Know the different types of studies which can be acquired.

22. Understand the basic physics of x-ray production in an x-ray tube and the operation of a modern multi-slice CT system.

NUCLEAR MEDICINE PHYSICS II
COURSE OUTLINE

SPRING 2016

TUESDAY -THURSDAY, 3:00 to 5:00 PM

DATES	TOPICS	REFERENCES
Jan 19, 21	Liquid Scintillation and Solid State Detectors	1A: 96-97, 104-106, 151-153, 182-192 1B: 98-108, 149-164 2: 134-141 3: 223-230
Jan 26, 28 Feb 2	Counting Statistics	1A: 125-140 1B: 185-210 2: 237-249 3: 479-494 6: 337-343, 347-351
Feb 4, 9	Problems in Radiation Detection and Counting Systems	1A: 155-172 1B: 165-183 2: 250-261 3: 204-207 6: 325-331, 352-367
Feb 11	External Radiation Detection and Imaging: Overview, and Image Quality	1A: 233-252 1B: 253-272 3: 361-435 4: 171-177, 133-139
Feb 16	EXAM I	
Feb 18, 23, 25	Gamma Camera--Basic Principles	1A: 195-208 1B: 211-226 3: 231-255 4: 141-155 7: 495-514 12: 1-43 13: 11-19
March 1, 3, 8	Gamma Camera: Performance Characteristics, Quality Assurance, and Acceptance Testing	1A: 209-232 1B: 227-252 3: 255-270, 330-360 4: 157-170 6: 372-411 7: 514-550

DATES	TOPICS	REFERENCES
		11: 1-29 12: 46-126 13: 19-22
March 10, 15, 17, 29, 31	Emission Tomography, SPECT and PET	1A: 253-344 1B: 273-360 3: 286-318 4: 179-190 5: 130-138 6: 411-425 7: 527-541 8: 329-360 9: 163-176 10: 31-74 11: 30-52 13: 22-31
April 5	Image Recording, X-ray Film	3: 426-431 6: 343-347 8: 127-151
April 7	EXAM 2	
April 12,14, 19, 21	Computers in Nuclear Medicine	1A: 363-378 1B: 361-376 5: 1-95, 193-211 6: 288-324 9: 1-151 10: 1-30 13: 32-46
April 26, 28 May 3	X-ray, CT, SPECT/CT, and PET/CT Imaging	1A: 345-362 Handouts
May 5	FINAL EXAM	

REFERENCES
NUCLEAR MEDICINE PHYSICS II

1A. Cherry SR, Sorenson JA, and Phelps ME: Physics in Nuclear Medicine. Fourth Edition, Elsevier / Saunders, 2012.

1B. Cherry SR, Sorenson JA, and Phelps ME: Physics in Nuclear Medicine. Saunders, 2003.

2. Hendee WR: Radioactive Isotopes in Biological Research. John Wiley, 1973.

3. Rallo FD: Nuclear Medicine Physics, Instrumentation and Agents. C.V. Mosby Co., 1977

4. Chandra R: Introduction Physics of Nuclear Medicine. 4th Edition. Lea, and Febiger, 1992.

5. Lieberman DE: Computer Methods: The Fundamentals of Digital Nuclear Medicine. C.V. Mosby Co., 1977.

6. Early PJ, and Sodee DB: Principles and Practice of Nuclear Medicine. C.V. Mosby Co., 1985.

7. Hine GJ: Instrumentation in Nuclear Medicine. Vol. 1, Academic Press, 1967.

8. Christensen EE, et al; An Introduction to the Physics of Diagnostic Radiology. 2nd Ed. Lea, and Febiger, 1978.

9. Erickson JJ, and Rallo FD: Digital Nuclear Medicine. J.B. Lippincott Co., 1983.

10. Gelfand MJ, and Thomas SR: Effective Use of Computers in Nuclear Medicine. McGraw-Hill, 1988.

11. King MA, Zimmerman RE, and Links JM: Imaging Hardware and Software for Nuclear Medicine. American Institute of Physics, 1988.

12. Simmons GH: The Scintillation Camera. Society of Nuclear Medicine, 1988.

13. Graham LS, Benedetto AR, Muehllehner G, Pickens DR: Nuclear Medicine: Self-Study Program II: Instrumentation. Society of Nuclear Medicine, 1996.