

GS02-1104: INTRODUCTION TO MEDICAL PHYSICS II: MEDICAL IMAGING

SPRING 2018 SCHEDULES

Day: MWF, January 08 – April 27, 2018; Final exam on May 02, 2018

Time: 11:00 am – 12:00 Noon

Room: FCT14.5059, Imaging Physics Classroom
3SCR2.3932 (Ultrasound only)

Contact: **John Rong, PhD**, course coordinator
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Admin Assistant: **Kathleen Prentice**
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Instructors: Richard Bouchard, Ph.D.
Dianna Cody, Ph.D.
William Geiser, M.S.
Xinming Liu, Ph.D.
John Rong, Ph.D. (Coordinator)

Grading (including homework, projects, labs, quizzes and exams):

X-ray A:	25%
X-ray B:	25%
CT:	25%
Ultrasound:	25%

Textbooks and other materials:

Required:

1. *The Essential Physics of Medical Imaging*, 3rd edition, Bushberg, et al, Lippincott Williams & Wilkins, 2011. ISBN-10: 0781780578, ISBN-13: 9780781780575. ~\$170-220.

Recommended:

1. *Physics of Radiology*, 2nd edition, Anthony Wolbarst, Medical Physics Publishing Corp., 2005. ISBN: 1930524226.
2. *Medical Imaging Physics*, 4th edition, William R. Hendee and E. Russell Ritenour, John Wiley & Sons, 2002. ISBN: 0471382264.
3. *Imaging Systems for Medical Diagnostics: Fundamentals, Technical Solutions and Applications for Systems Applying Ionizing Radiation, Nuclear Magnetic Resonance and Ultrasound*, Arnulf Oppelt (Editor), Wiley-VCH, 2006. ISBN: 3895782262.
4. *Computed Tomography: Principles, Design, Artifacts, and Recent Advances*, Jiang Hsieh, SPIE Press, 2003. ISBN: 0819444251.
5. *Computed Tomography: Fundamentals, System Technology, Image Quality, Applications*, 2nd edition, Willi A. Kalender, Wiley-VCH, 2006. ISBN: 3895782165.
6. *Medical CT and Ultrasound: Current technology and Applications*, Lee W. Goldman and J.Brian Fowlkes, Proceedings of the 1995 AAPM Summer School, Advanced Medical Publishing, Inc. 1995. ISBN: 1883526035.

7. *The Expanding Role of medical Physics in Diagnostic Imaging*, G. Donald Frey and Perry Sprawls, Proceedings of the 1997 AAPM Summer School, Advanced Medical Publishing, Inc. 1997. ISBN: 1888340096.
8. *Practical Digital imaging and PACS*, J. Anthony Seibert, et al, AAPM Medical Physics Monograph No. 25, Medical Physics Publishing Corp, 1999. ISBN: 0944838200.
9. *Intravascular Brachytherapy and Fluoroscopically Guided Interventions*, Stephen Balter, et al, AAPM Medical Physics Monograph No. 28, Medical Physics Publishing Corp, 2002. ISBN: 1930524102.
10. *Specifications, Performance Evaluations, and Quality Assurance of radiographic and Fluoroscopic Systems in the Digital Era*, Lee W. Goldman and Michael V. Yester, AAPM Medical Physics Monograph No. 30, Medical Physics Publishing Corp, 2004. ISBN: 1930524218.
11. *Review of Radiologic Physics*, 3rd edition, Walter Huda, Lippincott Williams & Wilkins, 2009. ISBN: 0781785693. ISBN-13: 978-0781785693.
12. RAPHEX Examinations on Diagnostic Radiologic Physics, published for RAMPS by Medical Physics Publishing Corp.

Web based teaching modules:

1. RSNA/AAPM Online Physics Modules at <http://www.aapm.org/education/webbasedmodules.asp>
2. IAEA RPOP training materials at http://rpop.iaea.org/RPOP/RPoP/Content/AdditionalResources/Training/1_TrainingMaterial/Radiology.htm
3. Dr. Perry Sprawls' Physical Principles of Medical Imaging Online at <http://www.sprawls.org/resources/>
4. ImPACT: Imaging Performance Assessment of CT Scanners at <http://www.impactscan.org/>

Lecture schedule (updated on 04/10/2018):

Date	Lecture	Title	Instructor
		INTRODUCTION	
1/8	1	Course overview, introduction to diagnostic imaging modalities and image physics practices	Rong
		X-RAY A	
1/10	2	X-ray Production: x-ray tube construction, anode, cathode, focal spot, x-ray filtration	Liu
1/12	3	X-ray Production: x-ray generator, major components, AEC	Liu
1/15		Martin Luther King, Jr. Day (no class)	
1/17	4	X-ray Interactions, attenuation coefficients, beam quality	Liu
1/19	5	Radiography: image formation, film/screen, H&D, focal spot blurring	Liu
1/22	6	Radiography: latitude, contrast, dose, scatter, image noise	Liu
1/24	7	Historical development and physics principles of mammography systems, modes of operations	Geiser
1/26	8	Screen-film mammography, mean glandular dose, ACR QC tests	Geiser
1/29	9	Digital Radiography/Mammography: digital detectors, CCD, CR, FP	Liu
1/31	10	Digital Radiography/Mammography: digital image correction, image processing and enhancement	Liu
2/2	11	Advances in Radiography: Dual Energy, Digital Tomosynthesis	Liu

X-RAY B			
2/5	12	Fluoroscopic imaging chain components and systems, image intensifier, system functionality	Rong
2/7	13	Flat-panel based fluoroscopy, modes of operation, automatic exposure control, image quality and radiation dose in fluoroscopic procedures	Rong
2/9		Exam 1: X-ray A (11:00am – 12:30pm)	Rong
2/12	14	Digital Images, PACS, Network	Liu
2/14	15	Image Quality I: Signal, Contrast, Effects of Scatter/Glare	Liu
2/16	16	Image Quality II: Spatial Resolution, PSF, MTF	Liu
2/19	17	Image Quality III: Noise Properties, SNR, CNR, Figure of merit	Liu
2/21	18	Image Quality IV: NPS, NEQ, DQE	Liu
2/23	19	Observer Performance – Perceptual Study, contrast-detail, ROC	Liu
2/26	20	Review radiation terms and units, dose indices, patient dose estimate in x-ray imaging, role of medical physicist in handling patient dose	Rong
2/28	21	Overview of radiation protection and shielding in diagnostic imaging	Rong
COMPUTED TOMOGRAPHY			
3/2	22	CT fundamentals and historical development, CT practices at MDA	Rong
3/5	23	CT Image Acquisition: scanner generations, CT tube, detector, slip-ring, helical scan and pitch factor, CT number	Rong
3/7	24	CT Image Acquisition: MSCT detectors and configuration, data interpolation, over-beaming, over-ranging and adaptive beam collimation, tube current modulation	Rong
3/9		Exam 2: X-ray B (11:00am – 12:30pm)	Rong
3/12-16		Spring Break	
3/19	25	CT Image Reconstruction: projection and sonogram, filtered backprojection, reconstruction algorithms	Rong
3/21	26	CT Image Reconstruction: concepts of iterative reconstruction, available clinical options	Rong
3/23	27	CT Image Quality: spatial resolution, low-contrast detectability, noise/CNR, factors affecting CT image quality, tools/phantoms for image quality evaluation	Rong
3/26	28	CT Image Quality: causes of image artifacts and possible solutions for artifact reduction	Rong
3/28	29	Dual Energy CT: how does it work and what are the options? available clinical systems, and established and potential applications	Cody
3/30	30	CT Radiation Dosimetry: MSAD, CTDI, DLP, dose report, SSDE	Rong
4/2	31	Overview of CT accreditation programs, ACR requirements, physicist responsibility, phantom testing and dosimetry	Rong
ULTRASOUND			
4/4	32	Ultrasound introduction: history of ultrasound, modern uses and fundamentals of ultrasound physics	Bouchard
4/6	33	Interactions with tissue I: derivation of the acoustic wave equation	Bouchard
4/9		Exam 3: CT (11:00am – 12:30pm)	Rong
4/11	34	Interactions with tissue II: introduction to acoustic scattering and absorption	Bouchard
4/13	35	Beamforming I: design and performance features of a modern ultrasound array transducer	Bouchard
4/16	36	Beamforming II: derivation of an array-based ultrasound diffraction pattern and description of factors ultrasound resolution	Bouchard

4/18	37	Ultrasound imaging I: technical workflow to generate a B-mode image on a modern ultrasound system	Bouchard
4/20	38	Ultrasound imaging II: ultrasound imaging features and modalities (e.g., Doppler imaging)	Bouchard
4/23	39	Ultrasound imaging artifacts: explanation regarding the source and appearance of common ultrasound imaging artifacts	Bouchard
4/25	40	Ultrasound quality assurance & safety: methodology used to conduct QA plan on a modern ultrasound system	Bouchard
4/27	41	Advanced ultrasound: an in-depth introduction to two new ultrasound imaging modalities, elasticity and photoacoustic imaging, with an emphasis on the modality-specific physics and hardware	Bouchard
5/2		Exam 4: Ultrasound (9:00am – 11:00am)	Bouchard

Lab schedule (updated on 04/10/2018):

Date	Location	Lab	Title	Instructor
2/6 & 2/7 3:00- 5:00pm	ACB7.1007 Chest Room M1	1	Image formation, image quality and dosimetry in radiographic imaging	Liu
2/6 & 2/7 3:00- 5:00pm	ACB5.1617 Mammo Room #4	2	Image formation, image quality and annual performance testing in mammographic imaging	Geiser
3/27 3:00- 5:00pm	B3.4583	3	CT daily QC, spatial resolution, low-contrast detectability	Liu
3/28 3:00- 5:00pm	B3.4583	4	CT Number accuracy and linearity and CT image artifacts	Liu
3/30 1:00- 3:00pm	B3.4583	5	CTDI measurements and patient dose estimate	Rong
TBD	3SCR2	6	US image acquisition, data filtering/processing and reconstruction for a B-mode image of an ultrasound phantom target	Bouchard