

Course Title: Fundamentals of Medical Imaging
Course Number: MPHY 516
Course Credits: 3 credits

Instructor: Daniel Sandoval **Email:** Djsandoval@salud.unm.edu
Office Location: Fitz Hall B05 **Office Phone:** 505-272-9298
Office Hours: M, W, F, 1400 - 1600 pm, or by appointment.

Class Meeting Day(s): T,R **Class Time:** 09:30 – 10:45
Class Location: TBD **Term:** Spring 2021

Course Description:

Course provides review of x-ray interactions, x-ray production, mammography, fluoroscopy, image quality, digital radiography, physics of computed tomography, magnetic resonance imaging, and nuclear medicine imaging, PACS and digital systems, and diagnostic radiation shielding

Course Goals:

This course will cover material required by the Commission of Medical Physics Education Programs (CAMPEP) for medical physics graduate program accreditation and will focus on topics related to diagnostic imaging physics. This course will prepare students for their initial certification in medical physics and the American Board of Radiology (ABR) Part 1 exam.

Student Learning Objectives:

Students will demonstrate an understanding of the following topics, which are required by CAMPEP for program accreditation:

1. History of medical imaging
2. Mathematical Models
3. Reconstruction Mathematics, medical image analysis
4. Radiation Protection and Safety
 - a. Personnel monitoring
 - b. Radiation dose limits
 - c. Protection regulations
 - d. Shielding Principles: beams and sources
 - e. External Exposure
5. Radiography
 - a. X-ray tube construction and X-Ray beam production; kV, mA, pulse width
 - b. X-ray beam properties and interactions in matter
 - c. Sources of image contrast and noise; detector efficiency and dose, noise power spectrum analysis
 - d. Spatial and temporal resolution
 - e. Detector technologies, anti-scatter grid
 - f. Digital and computed radiography
 - g. Mammography
6. Fluoroscopy
 - a. Detector technologies; flat panel imager, image intensifier/TV
 - b. Radiographic contrast agents
 - c. Automatic exposure control, basic imaging modes
 - d. Digital angiography, digital subtraction angiography

- e. Operating technique and dose to patient and staff
- 7. Computed Tomography
 - a. Basic data acquisition principles and scanning modes
 - b. Basic reconstruction modes
 - c. In-plane spatial resolution, slice thickness, image noise, dose
 - d. Artifacts
 - e. CT scanning technique & patient dose
- 8. Nuclear Medicine
 - a. Modes and processes of radioactive decay
 - b. Basics of nuclear reactions and radioactivity
 - c. Image quality and reconstruction
 - d. Physics of SPECT and PET systems
- 9. Magnetic Resonance Imaging
 - a. Magnetization, precession, Larmor equation, rotating frame of reference, spin tipping
 - b. T1 and T2 relaxation
 - c. Pulse sequences and image formation
 - d. Spin echo image formation
 - e. Image contrast
 - f. Definition of common acquisition parameters and signal-to-noise ratio
 - g. Artifacts
 - h. MR contrast agents
 - i. Safety and biological effects
- 10. Ultrasound
 - a. Propagation of ultrasound through tissue; sources of contrast
 - b. Diagnostic transducers
 - c. 2-D, 3-D ultrasound imaging
 - d. Spatial and temporal resolution
 - e. Doppler and color flow imaging
 - f. Artifacts
 - g. US Contrast agents
 - h. Safety and biological effects

Textbook(s):

Essential Physics of Medical Imaging, Third Edition, Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt, John M. Boone, Lippincott Williams & Wilkins 2012

Recommended References:

NCRP 147. Council, N., & Radiation, O. N. (2005).

Course Requirements:

	Percentage of Grade
Quizzes	20
Homework	20
Midterm	30
Final Exam	30

Grading:

Final grades will be based on the sum of all possible course points as noted above.

% of available points	Grade
90-100	A
80-89	B
70-79	C
60-69	D
<60	F

Course Schedule:

Days	Lecture	Instructor	Bushberg Chapter
1/19/2021 1/21/2021	Introduction <ul style="list-style-type: none"> • History of medical imaging • Mathematics relevant to medical physics • Reconstruction Mathematics, medical image analysis and processing • Informatics 	Sandoval	1,4,5
1/26/2021 1/28/2021	Radiography I <ul style="list-style-type: none"> • X-ray tube construction and X-Ray beam production; kV, mA, pulse width • X-ray beam properties and interactions in matter 	Sandoval	3,6
2/2/2021 2/4/2021	Radiography II <ul style="list-style-type: none"> • Sources of image contrast and noise; detector efficiency and dose, noise power spectrum analysis • Spatial and temporal resolution 	Sandoval	4
2/9/2021 2/11/2021	Radiography III <ul style="list-style-type: none"> • Detector technologies, anti-scatter grid • Digital and computed radiography 	Sandoval	7
2/16/2021 2/18/2021	Mammography <ul style="list-style-type: none"> • Mammographic system • Digital breast tomosynthesis • Stereotactic biopsy • Performance Testing and QA of mammographic systems 	Sandoval	8
2/23/2021 2/25/2021	Fluoroscopy I <ul style="list-style-type: none"> • Detector technologies; flat panel imager, image intensifier/TV • Radiographic contrast agents 	Sandoval	9

3/2/2021 3/4/2021	<p>Fluoroscopy II</p> <ul style="list-style-type: none"> • Automatic exposure control, basic imaging modes • Digital angiography, digital subtraction angiography • Operating technique and dose to patient and staff • Performance testing and QA of fluoroscopic systems 	Sandoval	9
3/9/2021 3/11/2021	<p>Radiation Protection and Safety</p> <ul style="list-style-type: none"> • Protection Principles • Shielding Principles • Dose limits • External exposure • Personnel monitoring 	Sandoval	21
3/11/2021	Midterm		
3/15/2021 - 3/19/2021	Spring Break		
3/23/2021 3/25/2021	<p>Computed Tomography I</p> <ul style="list-style-type: none"> • Basic data acquisition principles and scanning modes • Basic reconstruction modes 	Lamoureux	10
3/30/2021 4/1/2021	<p>Computed Tomography II</p> <ul style="list-style-type: none"> • In-plane spatial resolution, slice thickness, image noise, dose • Artifacts 	Lamoureux	10
4/6/2021 4/8/2021	<p>Computed Tomography III</p> <ul style="list-style-type: none"> • CT scanning technique & patient dose 	Lamoureux	10
4/13/2021 4/15/2021	<p>Nuclear Medicine</p> <ul style="list-style-type: none"> • Modes and processes of radioactive decay • Basics of nuclear reactions and radioactivity • Radiopharmaceuticals • Internal Dosimetry • Image quality and reconstruction • Physics of SPECT and PET systems 	Chambers	15,16
4/20/2021 4/22/2021	<p>Magnetic Resonance Imaging I</p> <ul style="list-style-type: none"> • Magnetization, precession, Larmor equation, rotating frame of reference, spin tipping • T1 and T2 relaxation • Pulse sequences and image formation • Spin echo image formation 	Selwyn	12

4/27/2021 4/29/2021	Magnetic Resonance Imaging II <ul style="list-style-type: none"> • Image contrast • Definition of common acquisition parameters and signal-to-noise ratio • Artifacts • MR contrast agents • Safety and biological effects 	Selwyn	12,13
5/4/2021 5/6/2021	Ultrasound <ul style="list-style-type: none"> • Propagation of ultrasound through tissue; sources of contrast • Diagnostic transducers • 2-D, 3-D ultrasound imaging • Spatial and temporal resolution • Doppler and color flow imaging • Artifacts • US Contrast agents • Safety and biological effects 	Lamoureux	14
5/11/2021	Review and Final	Sandoval	

The Schedule of Activities is subject to change. Minor changes will be announced in class, major ones provided in writing.

Accommodation Statement

Accessibility Services (Mesa Vista Hall 2021, 277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to assure your needs are met in a timely manner. If you need local assistance in contacting Accessibility Services, see the Bachelor and Graduate Programs office.

Title IX Statement

A Note About Sexual Violence and Sexual Misconduct: As a UNM faculty member, I am required to inform the Title IX Coordinator at the Office of Equal Opportunity (oeo.unm.edu) of any report I receive of gender discrimination which includes sexual harassment, sexual misconduct, and/or sexual violence. You can read the full campus policy regarding sexual misconduct at <https://policy.unm.edu/university-policies/2000/2740.html>. If you have experienced sexual violence or sexual misconduct, please ask a faculty or staff member for help or contact the LoboRESPECT Advocacy Center.

Academic Integrity

The University of New Mexico believes that academic honesty is a foundational principle for personal and academic development. All University policies regarding academic honesty apply to this course. Academic dishonesty includes, but is not limited to, cheating or copying, plagiarism (claiming credit for the words or works of another from any type of source such as print, Internet or electronic database, or failing to cite the source), fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other

students. The University's full statement on academic honesty and the consequences for failure to comply is available in the University Catalog and in the Pathfinder.

Cell Phones and Technology

As a matter of courtesy, please turn off cell phones, pagers, and other communication and entertainment devices prior to the beginning of class. Notify me in advance if you are monitoring an emergency, for which cell phone ringers should be switched to vibrate.

Respect the UNM Community by Preserving Health

You have the ability to prevent the spread of COVID-19 and to preserve the health of fellow students, your instructor, staff and the community by following UNM health protocols. The UNM Provost Administrative Directive on Mandatory Student Face Covering and Symptom Reporting of July 9, 2020 requires that all students on UNM-Main and UNM branch campuses wear face masks in the face-to-face classroom and on campus unless they have a specific mask accommodation (confidentially documented with the Accessibility Resource Center). UNM Provost Administrative Directive is consistent with Governor Lujan Grisham's **Public Health Emergency Order, as amended**, and the **Public Health Order of the New Mexico Health Secretary**. It also requires daily participation in symptom screening through covidscreen, which will be sent via UNM e-mail.

Acceptable masks and mask wearing in class: A two-layer mask that covers the nose and mouth and that is cleaned regularly is acceptable. A face shield is not sufficient protection. It is vital that you wear your mask correctly, covering your nose and mouth. Removing your mask for an extended period to eat or drink in class violates the Provost Administrative Directive and endangers others.

Mask Wearing Accommodation: Individuals with a documented disability or diagnosis may seek accommodation with the UNM Accessibility Resource Center (ARC) (arc.unm.edu). Individuals do not need to reveal private information to an instructor. ARC will require documentation of health requirements, which will be kept confidential. The instructor will be informed only of any need for accommodation.

Consequences of not wearing a mask properly: Unless you have an ARC-approved accommodation, if you don't wear a mask, or if you do not wear a mask properly by covering your nose and mouth, you will be asked to leave class. If you fail to wear a mask properly on more than one occasions, you can expect to be dropped from the class. If you insist on remaining in the classroom while not wearing a mask (without an ARC-determined accommodation), class will be dismissed for the day to protect others and you will be dropped from the class immediately.

This class may move to remote delivery at any time to preserve the health and safety of the students, instructor and community. Please check [fill in your communication system] regularly for updates about our class and please check <https://bringbackthepack.unm.edu> regularly for general UNM updates.