Physics 120&121

Physics of Medical Imaging: Ultrasound and Radiography

FALL SEMESTER 2022

2-credit students: Register for PHY 120 only
3-credit students: Register for PHY 120 AND PHY 121

SYLLABUS (Please read carefully)

PHY 120&121 emphasizes ideas and concepts of modern physics that are used in medical imaging techniques like ultrasound imaging and radiography. The main audience of this course are pre-health, pre-dental, or premed students who traditionally do not major in physics or in engineering, but physics and engineering majors are also welcome to join the course, and learn about this application of physics.

We will start by looking at ultrasound imaging. This imaging technique is based on the classical physics that you have already learned in previous courses PHY 10&13, or PHY11&21, and will allow you to understand ultrasound images, their analysis, interpretation, and recognition of artifacts. After ultrasound imaging, we will move on to x-ray imaging. First we will concentrate on matter-radiation and matter-particle interactions that are at the core of the production of radiographic images, as well as on some basic dosimetry concepts. This will be followed by a discussion on how x-rays are generated. The goal of this section is to develop an understanding of which parameters can be manipulated in order to produce x-rays with the characteristics needed in a specific clinical setting. Finally, during the last part of the course, we will conclude by studying the principles of more advanced x-ray imaging applications (for example, CT-scans, Fluoroscopy, Angiography, Mammography, …).

By registering for both PHY 120 (2 credits) and the PHY 121 supplemental (1 credit) you can sign up for a 3-credit version of the course. The 3-credit version of this course will address additional topics via guided independent work, and will require a more extensive end-of-semester project and presentation. Possible topics are: Phased arrays and beam forming techniques in ultrasound imaging; More on ultrasound or radiography artifacts; A more in depth study of dosimetry that will also serve as a short introduction to concepts important in radiotherapy; Nuclear imaging: PET and SPECT; The formation of images from CT-scan data; Basic Image Optimization; …

Learning Outcomes
This course assumes that students already had introductory physics courses covering classical mechanics, electromagnetism, and some introductory quantum mechanics. Through this course students will acquire an understanding of several medical imaging technologies, and a deeper knowledge in sound propagation, light-matter interaction, particle-matter interaction, and atomic and nuclear physics, including such topics as piezoelectricity, the generation of high energy electromagnetic radiation by Bremsstrahlung, atomic structure, photon emission and absorption, and photon-electron collisions (Compton effect). Even though the coursework is appropriate for a 100 level course and will therefore not be a substitute for the more advanced 200 or 300 level physics courses, it will serve as a useful introduction into more advanced physics topics.

Instructor

Prof. Paola M. Cereghetti
pmc5@lehigh.edu
Office: LL 410
Office hours: I will be available before each class, please e-mail me.

Class Meetings

Monday and Wednesday: From 4:25pm to 5:40pm in room LL511.

While 3-credit students will take all classes, 2-credit students will take classes during week 1 through 8 of the semester and the last week of the semester for end of semester presentations.

Textbook and Class Notes

No textbook is required, I will be teaching from a variety of sources, and I will provide the material. Books on medical imaging: 1. *Physics of Medical Imaging (3rd. edition)* by Jerrold T. Bushberg *et al*., and 2. *Introduction to Physics in Modern Medicine (2nd. edition)* by Suzanne Amador Kane *et al*. The second book is more introductory, but excellent in its simplicity and clarity. Book on ultrasound: *The Physics and Technology of Diagnostic Ultrasound: A Practitioner's Guide* by Robert Gill. Book on Radiography: *Radiography in the Digital Age: Physics Exposure Radiation Biology* by Quinn B. Carroll. Book on nuclear imaging: *Essentials of Nuclear Medicine Physics, Instrumentation, and Radiation Biology* by Rachel A. Powsner et. al.

Homework

Homework will be assigned every week and will be due the following one. The homework will be in the form of reading assignments and/or problems pertinent to the imaging technique we are learning. Reading and problem solving are designed to help the students clarify the material.

Attendance

Attendance is mandatory and will count towards your course grade. Should you miss a class for a valid reason or other extenuating circumstances, please: 1. Let me know, possibly in advance, an e-mail is enough; 2. Talk with me to discuss your absence and to make sure you understand the material you missed.

Semester Project (NO Exams)

You will be assigned a topic of your choice, and you will have to complete a couple of assignments revolving around that topic. At the end of the semester, you will merge those assignments into your semester/final report and that will also be the topic of your presentation to the class during Week 14 of the semester (8 mins presentation for 2-credit students, 12 mins presentation for 3-credit students).

Grading:

Your grade in the course will be determined based on class participation, attendance, homework, the quality of your semester project and presentation. There are no exams in this course.

Accommodations for Students with Disabilities:

Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at https://studentaffairs.lehigh.edu/disabilities .

The Principles of Our Equitable Community:

Lehigh University endorses The Principles of Our Equitable Community [http://www.lehigh.edu/~inprv/initiatives/PrinciplesEquity_Sheet_v2_032212.pdf]. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Student Senate Statement on Academic Integrity

We, the Lehigh University Student Senate, as the standing representative body of all undergraduates, reaffirm the duty and obligation of students to meet and uphold the highest principles and values of personal, moral and ethical conduct. As partners in our educational community, both students and faculty share the responsibility for promoting and helping to ensure an environment of academic integrity. As such, each student is expected to complete all academic course work in accordance to the standards set forth by the faculty and in compliance with the University's Code of Conduct.

Mask's Policy:

There will be an announcement if mask wearing is required. Make sure to always have a mask with you.