

DEPARTMENT OF PHYSICS
LEHIGH UNIVERSITY

Physics 195: Physics of Medical Imaging

Fall Semester 2016

SYLLABUS (Please read carefully)

Physics 195 is the next class in the sequence of PHY 10 and PHY 13. PHY 195 emphasizes ideas and concepts of modern physics that are used in several medical imaging techniques. In addition to a description of the physical principles behind some imaging techniques, which will serve as a continuation of the quantum physics and electromagnetism that was introduced in PHY 13, we will learn how experimental data are collected and analyzed to create the image that a physician will eventually interpret for clinical purposes.

During a good part of the semester, we will learn about Magnetic Resonance Imaging (MRI), and, because this is a new class and I would like to take into consideration your specific interests, we will together decide what other techniques (CT scans, PET scans, ...) you are most interested in discussing. This is a two credit class, so we are limited in the amount of information we can learn.

The main physical effect behind MRI is Nuclear Magnetic Resonance (NMR). The physical principles of NMR may be a little bit more complex to study than for other imaging techniques, but NMR is so widely used in medicine and research, for imaging but also for spectroscopy, that it will be worth the effort. In fact, although the physical principles at the heart of different imaging techniques may not be the same, data collection and analysis have often a lot in common, and part of what we will learn in the example of MRI will also make the next technique easier to grasp. We will get some simple hands on experience by gathering and analyzing data using a very simple NMR machine (which is also able to produce a magnetic field gradient, necessary for MRI).

One final note: Medicine is not the only field where imaging techniques are used. In fact, exciting a system and detecting its reaction at different locations in space is a technique applied in a variety of disciplines, from physics itself, to protein structure studies, to engineering, just to mention a few examples. While we will use medical imaging as the main field of application of the physics that we will discuss, the physical concepts learned in this course will serve as a general enrichment in physics that goes beyond PHY 13.

Instructor

Prof. Paola M. Cereghetti

cereghetti@lehigh.edu

Office: LL 410

Office hours: I will be available each Tuesday before and after class, and you are always welcome to e-mail me and schedule an appointment at a different time!

Class Meetings

The lecture meets once a week on Tuesdays from 4:10pm to 6:00pm, in LL310, with a 10 minutes break in the middle.

Textbook and Class Notes

No textbook is required, I will be teaching from a variety of sources, and I will provide the material. Two interesting books are: 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. Note that this is a two credit class, and that it will be literally impossible to cover all the topics you can find in these books!

Homework

The amount of work will be geared towards a 2 credit class. Homework will be assigned weekly, in the form of problems to clarify the material as well as reading assignments to prepare for the following class. Ideally, I envision the class as being $\frac{1}{3}$ lecture, $\frac{1}{3}$ discussion, $\frac{1}{3}$ practice with problems. Homework solutions will be provided.

Lab: NMR Experiment

You will gather and analyze data using a very simple NMR machine. We will learn how to operate the machine in class, and you will be able to choose a time when you will perform the experiment individually or in groups of two.

Attendance

Since this class meets only once a week, attendance is indispensable.

Exams

There will be 2, mainly multiple choice, exams to make sure the information you learn is organized and retained. To simplify your studying, I will provide a summary of concepts to know. There will be no final exam, instead you will do research about about a special topic related to a particular imaging technique, and prepare a paper and a presentation (minimum 10 minutes, maximum 20 minutes). The technique does not need to have been studied in class, and the topic can be of your choice or I can help you find one.

Grading:

Your numerical grade in the course will be determined as follows:

Attendance	10
Homework	10
2 Hour Tests	20
Lab	10
Special Topic	10

Total	60

Accommodations for Students with Disabilities:

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, Williams Hall, Suite 301 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

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.