Oakland University *College of Arts & Sciences* *Department of Physics*

PHY 3260, Medical Physics
4 Credit Hours
Winter 2021

Instructor: Eugene Surdutovich **E-mail:** surdutov@oakland.edu
Class meets: MWF 2:40 – 3:47pm on Zoom **Office hours:** upon request

Text: *Intermediate Physics for Medicine and Biology, 5th Edition*, by Hobbie & Roth.
An electronic version of the textbook is available through the OU library.
Book Website: https://sites.google.com/view/hobbieroth/home (get the errata!).
Book Blog: http://hobbieroth.blogspot.com

Grading: I will give you the better of the following two scores in the table on the left below:

Exam 1		**25%**	**15%**
Exam 2		**25%**	**25%**
Final Exam		**30%**	**40%**
Discussions		**5%**	**5%**
Homework		**15%**	**15%**
Total		**100%**	**100%**

Grading Scale:

A	**96-100**
A-	**90-95**
B+	**85-89**
B	**80-84**
B-	**75-79**
C+	**70-74**
C	**65-69**
C-	**60-64**
D+	**55-59**
D	**50-54**
F	**< 50**

Discussion articles:

1/15: Ultrasonography is soon likely to become a viable alternative to x-ray mammography for breast cancer screening. *Med Phys*, **37**:4526-4529, 2010.
1/22: High intensity focused ultrasound may be superior to radiation therapy for the treatment of early stage prostate cancer. *Med Phys*, **38**:3909-3912, 2011.
2/5: The eventual rejection of the linear no-threshold theory will lead to a drastic reduction in the demand for diagnostic medical physics services. *Med Phys*, **46**: 3325, 2019.
2/12: The more important heavy charged particle radiotherapy of the future is more likely to be with heavy ions rather than protons. *Med Phys*, **40**:090601, 2013.
2/19: Advocating for use of the ALARA principle in the context of medical imaging fails to recognize that the risk is hypothetical and so serves to reinforce patients' fears of radiation. *Med Phys*, **44**:3-6, 2017
2/17: We do not need randomized clinical trials to demonstrate the superiority of proton therapy. *Med Phys*, **39**: 1685, 2012.
3/5: In the future, emission-guided radiation therapy will play a critical role in clinical radiation oncology. *Med Phys*, **46**: 1519, 2019.
3/12: Medical use of all high activity sources should be eliminated for security concerns. *Med Phys*, **42**:6773, 2015.
3/19: In the era of IGRT and small- and focal-field external beam radiotherapy, brachytherapy is a dying modality. *Med Phys*, **44**:351-354, 2017.
3/26: CT is still not a low-dose imaging modality, *Med Phys*, **47**: 293, 2020.
4/9: Low-dose radiation as a treatment for COVID-19 pneumonia: A threat or real opportunity? Med Phys, **47**, 2020
April 16: Biomedical image analysis challenges should be considered as an academic exercise, not an instrument that will move the field forward in a real, practical way, Med. Phys., **47:** 2325, 2020.

PHY-3260 **Tentative Course Schedule** **Winter 2021**

Week	Day	Date	Lecture Topics	Chapters
1	W	1/6	Introduction, Sound and ultrasound	13
	F	1/8	Sound and ultrasound	13
2	M	1/11	Sound and ultrasound	13
	W	1/13	Atoms and Light	14
	F	1/15	Atoms and Light	14
3	M	1/18	Martin Luther King's Day – no class	
	W	1/20	Interaction of Photons and Matter	15
	F	1/22	Interaction of Photons and Matter	15
4	M	1/25	Interaction of Photons and Matter	15
	W	1/27	Interaction of Photons and Matter	15
	F	1/29	Exam 1	
5	M	2/1	Medical Uses of X rays	16
	W	2/3	Medical Uses of X rays	16
	F	2/5	Medical Uses of X rays	16
6	M	2/8	Least Squares and Signal Analysis	11
	W	2/10	Least Squares and Signal Analysis	11
	F	2/12	Least Squares and Signal Analysis	11
7	M	2/15	Least Squares and Signal Analysis	11
	W	2/17	Least Squares and Signal Analysis	11
	F	2/19	Least Squares and Signal Analysis	11
8		2/20-2/28	Winter recess – no classes	
9	M	3/1	Images	12
	W	3/3	Images	12
	F	3/5	Images	12
10	M	3/8	Images	12
	W	3/10	Images	12
	F	3/12	Images	12
11	M	3/15	Images	12
	W	3/17	Images	12
	F	3/19	Exam 2	
12	M	3/22	Nuclear Medicine	17
	W	3/24	Nuclear Medicine	17
	F	3/26	Nuclear Medicine	17
13	M	3/29	Nuclear Medicine	17
	W	3/31	Nuclear Medicine	17
	F	4/2	Nuclear Medicine	17
14	M	4/5	MRI	18
	W	4/7	MRI	18
	F	4/9	MRI	18
15	M	4/12	MRI	18
	W	4/14	MRI	18
	F	4/16	MRI	18
16	M	4/19	Review	
17	T	4/27	3:30 – 6:30 p.m. Final Exam, cumulative	

Goals

An ability to apply knowledge of mathematics, science, and engineering to medicine.

This class can be thought of as a workshop in applying mathematical modeling to problems in medicine. We will apply the wave equation to model ultrasound imaging, and use Fourier transforms to understand tomography.

An ability to identify, formulate, and solve engineering problems.

We discuss many examples of solving engineering problems, including how to image the body using ultrasound, and how to use x-rays to treat cancer.

A recognition of the need for, and an ability to engage in, life-long learning.

We will read and discuss "point/counterpoint" articles from the journal *Medical Physics*, which address critical current controversies.

A knowledge of contemporary issues

We examine many contemporary issues in biology and medicine, such as shortages of the radioisotope technetium, and the use of functional magnetic resonance imaging to monitor brain activity.

An ability to use engineering tools necessary for engineering practice

We will apply the tools of mathematical modeling to study engineering problems, such as using Doppler ultrasound to measure blood flow, and using infrared light to design a pulse oximeter.

Apply the principles of physics and physiology, mathematics and medicine.

We will apply physics and mathematics to problems in biology and medicine. For example, we will use the physics of light interference to design a device for optical coherence tomography, and use optics to understand color vision.

Solving biomedical engineering problems

We will examine several case studies about how to solve biomedical engineering problems, such as how to use filtered back-projection to do tomography, and how to use magnetic resonance imaging to measure diffusion.

Analyzing, modeling, designing engineering devices

We will analyze several engineering devices, from tungsten x-ray sources to semiconductor x-ray detectors.