

Professor: Scott M. LaBrake, Ph.D.

Email: labrakes@union.edu

Office Hours: M: 11:00^{am} – 3:00^{pm}
WF: 10:30^{am} – 11:30^{am}
Sun: 9:00^{am} – 11:00^{am}

By Appointment

Web: <http://minerva.union.edu/labrakes>

Required Text: *Physics in Modern Medicine*, 3rd Ed. by Suzanne Amador Kane

Other References:

Hendee's Physics of Medical Imaging, 5th Ed. by E. Samei & d. Peck

Physics of Radiology, 2nd Ed. by A. Wolbarst

Life Science Applications for Physics, by J. Faughn

Physics of the Body, 2nd Ed., by J Cameron, J. Skofronick, & R. Grant

Biomedical Applications of Intro. Physics, by J. Tuszynski & J. Dixon

Physics in Biology and Medicine, by P. Davidovits

Human Physiology, 5th Ed., By L. Sherwood

Clinically Oriented Anatomy, 5th Ed., by K. Moore & A. Dalley

Physics of Radiology, 2nd Ed. By Anthony Wolbarst

Course Description:

This course introduces the technologies used in modern medicine and the basic physical principles that underlie them. Topics will include laser surgery, ultrasound imaging, laparoscopic surgery, diagnostic x-ray imaging, nuclear medicine, computed tomography (CAT) scans, magnetic resonance imaging (MRI) scans, and radiation therapy. Safety issues involved in the use of each technique will be considered in depth, and discussions will include societal implications of the growing use of technology in medicine.

Specific medical applications discussed will include (but are not limited to): arthroscopic shoulder surgery, laser eye surgery, dermatological laser surgery, obstetrical ultrasound, cardiovascular ultrasound, renal ultrasound, mammography, osteoporosis screening, lung cancer, bone cancers, radiation therapy, and applications of PET and MRI brain scans in neuroscience.

Attendance:

While attendance is not mandatory, it is expected that you will attend class on a regular basis. Material will be covered in a rapid fashion over the winter term, covering about one chapter per week. Past experience dictates that your success in this class is directly proportional to your attending. There will be several guest lectures by experts from different areas of medicine and medical physics. The dates listed for the speakers are tentative and subject to change, but I will keep you updated. These lecturers give up a substantial amount of time to be with us so courtesy dictates that you will not be absent on these days.

Honor Code:

Union College recognizes the need to create an environment of mutual trust as part of its educational mission. Responsible participation in an academic community requires respect for and acknowledgement of the thoughts and work of others, whether expressed in the present or in some distant time and place. Matriculation at the College is taken to signify implicit agreement with the Academic Honor Code, available at honorcode.union.edu. It is each student's responsibility to ensure that submitted work is his or her own and does not involve any form of academic misconduct.

Students are encouraged to work on the assignments together with others in the course. It is expected, however, that the work you hand in to be graded needs to be written up independently by you after discussions with other students. Please indicate on the homework who you worked with in preparing the assignment. You may consult, if needed, your textbook, other textbooks, peer-reviewed journals, the physics help center, the internet, the writing center, your instructor, or other physics instructors in completion of your assignments. Anything that is not directly your own work must be cited. You do not need to cite help that you get from the physics help center or the writing center. In addition, anything that you take from the internet, other textbooks, journals, and the like must be cited. If you are unsure of anything, you are expected to ask your course instructor for clarification regarding, but not limited to, collaboration, citations, and plagiarism. Ignorance is not an excuse for breaching academic integrity. Students are also required to affix the full Honor Code Affirmation, or the following shortened version, on each item of coursework submitted for grading: *"I affirm that I have carried out my academic endeavors with full academic honesty."* [Signed, Jane Doe]

Course Grade:

Your course grade will be determined based on a professional judgment of your work on the following scale:

- Exams 40% (Mid-term Exam 20% and Final Exam 20%)
- Research Paper 40%
- Critiques on Guest Lectures 10%
- Homework 10%
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Homework:

The homework assigned is representative of the topics that will be highlighted throughout the term. It is strongly advised that you do the suggested homework as noted in class as well as other relevant problems, of your choosing, on the covered topics from the text.

- The homework will consist of problem solving as well as short answer written responses (remember you're getting WAC-R credit.)
 - In general, several homework problems will be assigned each night and the problems will be collected during class the following Monday. The solutions to the problems will be posted on my website after class on Monday.
 - All quantitative problem solutions need to have a short narrative about how you arrived at the solution (a quick summary of the main steps you used and why) and a

“reasonableness check.” For the reasonableness check you should provide a brief explanation as to why the solution you got was reasonable or not. If the solution is not reasonable, why not. If it’s a calculation error, please go back and find the error.

- Once the homework solutions have been posted, late homework will be accepted and will be assigned a value of 50% of the points for the assignment.
- I would advise you talk to me, your classmates, or just ponder the question for a day or so. *Too often students confuse reading the solution to the problem with their actual understanding of the problem.*
- The mathematical complexity of this course is limited to your ability to do algebra as well as basic mathematical operations.

Research Paper:

The research paper gives you an opportunity to investigate a topic that interests you from the intersection of the fields of medicine, physics, technology, and/or medical physics and should contain some significant physics content. A partial list of topics will be provided for you to peruse and choose from if you like. However, you are of course free to choose your own topic in consultation with me. I’m going to limit the topics to one per person, unless there is significant difference between topics. You will be getting WAC-R credit for the course, and this paper should be a significant writing project. Your paper will be produced and graded in stages.

State 1: The first stage is a written thesis statement of the topic to be investigated with some supporting references and the references need to be from peer-reviewed journals, books, or other scholarly sources. I will give you feedback on the thesis idea(s) and we will meet individually to discuss the research project idea feedback in preparation for the rough draft. This will be due at the end of week 2 (Friday, January 17).

Stage 2: At the end of week 7 (Friday, February 21), you will submit a rough draft of your research paper with references. I will read and provide written feedback on the scientific and technical aspects of the paper (this is the medicine, physics, technology, and/or medical physics content) and written feedback on the writing. I will return the draft of the research paper to you by the middle of week 8 with my comments and suggestions for revision/improvement. During week 7, I will meet individually with you to discuss the rough draft and help you refine the paper in preparation for the draft and final versions.

Stage 3: At the end of week 10 (Friday, March 10), you will submit a final draft of your research paper. I will comment and grade the research paper and return it to you by the middle of week 11 (finals week.)

Your paper should contain a minimum of 8 references and the number of references from the non-primary sources is limited to 10% of your total number of references (rounded up to the nearest whole number.) Thesis topic statements, rough drafts, and final drafts will be submitted electronically to the instructor on or before the due date a time of the instructors choosing.

Exams:

- There will be one in-class midterm exam and a two-hour final exam. The in-class hour exam is scheduled for Friday, February 14 (week #6) and this is the only date that the exam will be given and will not be changed for any reason. Please plan accordingly in your other classes.
- ***Emphasis will be placed on demonstration of the ability to apply the concepts and techniques learned in class to new situations.***
- ***All problem types and/or examples tested on exams may not be done explicitly in class.***
- If you cannot make a scheduled exam, then it is your responsibility to contact the instructor ***in person a minimum of at least 24 hours in advance of the exam. Make-up exams may be granted only in exceptional circumstances, as determined solely by the instructor, and may be oral and will be given at the discretion and convenience of the instructor. You should discuss you intended absence with the instructor well in advance of the exam and provide appropriate documentation to support your absence.***
- The final exam will be not be cumulative and no make-up exam will be given for any reason. The date and time of the final is TBD. ***This is the only time that the final exam will be given.***

Critiques of Guest Lectures:

There will be three to four guest lectures this term from medical, dental, health care professionals, and/or medical physicists. These are professionals from the fields of medicine, technology, and medical physics who will show you where they use the medical imaging techniques studied in class for the diagnosis/treatment of disease in the body in everyday practice. This is your opportunity to critique the guest lectures. You should take some notes during their lectures and in your critique write a summary of their lecture giving the main ideas that the lecturer was trying to convey and how those ideas relate to class. Some guest lecturers may make their lecture slides available to you so that you can refer to them. This is not necessarily a given as some material may be copyright, in the process of manuscript production, classified, or if in the author's opinion may jeopardize their research or scholarly interests or activities. You should comment on the applicability of the lecture to the class, difficulty level of the lecture, areas that were particularly good or that were a source of confusion. Your critiques should be a minimum of 2 double spaced pages, and these are due the next class meeting following the lecture. Critiques will be submitted electronically to the instructor on the due date on or before a time of the instructors choosing. If you do miss a guest lecture you earn a zero on that critique. Critiques will be graded for the summary of the main ideas and how they connect to the class as well as for the writing of the critique.

Proposed Course Schedule:

Week #1

- Introduction and Optics – Applications to endoscopic and arthroscopic surgery.
- Presentation by Jenna Pitera from the Schaffer Library on how to do research at the library.

Week #2

- Laser surgery – Applications in ophthalmology, dermatology, general surgery and photodynamic therapy.
- Research paper topics should be chosen with references provided and is due on Friday, January 17, 2025.

Week #3

- Ultrasound – Applications in obstetrics and cardiology.

Week #4

- X-ray imaging – Applications in mammography and osteoporosis screening
- Guest Lecture *Dr. Matthew Kaye, MD, Union Class of 2016, Virginia Commonwealth University, Cardiology.*

Week #5

- X- ray imaging – CT scans.

Week #6

- X- ray imaging – CT scans.
- Mid-term exam on Friday, February 14, 2025

Week #7

- Nuclear Medicine – Applications in radionuclide imaging, bone scans, PET scans and imaging of the brain.
- Rough draft of research paper due Friday, February 21, 2025.

Week #8

- Nuclear Medicine – Applications in radionuclide imaging, bone scans, PET scans and imaging of the brain.
- Radiation medicine and safety – Applications in cancer therapy.

- Guest Lecture by *Dr. Tom Mazur, PhD, Union College class of 2007, Washington University School of Medicine, St. Louis MO, Medical Physics.*

Week #9

- Radiation medicine and safety – Applications in cancer therapy.
- Possible afternoon/evening field trip to the Stratton VA cancer treatment center in Albany.

Week #10

- Magnetic resonance Imaging – Applications to sports medicine, breast and brain imaging.
- Guest Lecture by *Dr. Rich Simmons, MD, Union College Class of 1999, The Child Neurology Group of Community Care Physicians, Clifton Park, NY, Neurology/Child Neurology.*
- Final Research Papers Due Monday, March 10, 2025.