MEDICAL PHYSICS (MED PHYS)

MED PHYS/PHYSICS 265 — INTRODUCTION TO MEDICAL PHYSICS
2 credits.

Primarily for premeds and other students in the medical and biological sciences. Applications of physics to medicine and medical instrumentation. Topics: biomechanics, sound and hearing, pressure and motion of fluids, heat and temperature, electricity and magnetism in the body, optics and the eye, biological effects of light, use of ionizing radiation in diagnosis and therapy, radiation safety, medical instrumentation. Two lectures with demonstrations per week.
Requisites: A yr crse of college level intro physics
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No

MED PHYS/H ONCOL 410 — RADIOBIOLOGY
2-3 credits.

Effects of ionizing radiations of living cells and organisms, including physical, chemical, and physiological bases of radiation cytotoxicity, mutagenicity, and carcinogenesis; lecture and lab.
Requisites: None
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/B M E/H ONCOL/PHYSICS 501 — RADIOLOGICAL PHYSICS AND DOSIMETRY
3 credits.

Interactions and energy deposition by ionizing radiation in matter; concepts, quantities and units in radiological physics; principles and methods of radiation dosimetry.
Requisites: Calculus and modern physics
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS/N E 506 — MONTE CARLO RADIATION TRANSPORT
3 credits.

Use of Monte Carlo technique for applications in nuclear engineering and medical physics. Major theory of Monte Carlo neutral particle transport is discussed. Standard Monte Carlo transport software is used for exercises and projects. Major emphasis is on analysis of real-world problems.
Requisites: NEEP 305 or equiv and one of NEEP 405, 408, Med Phys 501 or 569, or consent of instructor
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/B M E 530 — MEDICAL IMAGING SYSTEMS
3 credits.

2D Fourier image representation, sampling, and image filtering with applications in medical imaging. Principles of operation, impulse responses, signal-to-noise, resolution and design tradeoffs in projection radiography, tomography, nuclear medicine, ultrasound, and magnetic resonance imaging. Knowledge of linear signals systems, convolution, basic probability, ID Fourier Transforms
Requisites: ECE 330 or Med Phys 473 or equiv or cons inst.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/B M E 535 — INTRODUCTION TO ENERGY-TISSUE INTERACTIONS
3 credits.

Explore physical interactions between thermal, electromagnetic and acoustic energies and biological tissues with emphasis on therapeutic medical applications.
Requisites: Graduate student or senior level in Engineering or Medical Physics or consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS/I SY E 559 — PATIENT SAFETY AND ERROR REDUCTION IN HEALTHCARE
2 credits.

Techniques for evaluating and reducing risks in medical procedures, including probabilistic risk assessment methods, failure mode and effects analysis, human factors analysis, and quality management. Discussions of patient safety standards, recommendations from agencies, and continual quality improvement.
Requisites: Jr st or cons inst
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/PHYSICS 563 — RADIONUCLIDES IN MEDICINE AND BIOLOGY
2-3 credits.

Physical principles of radioisotopes used in medicine and biology and operation of related equipment; lecture and lab.
Requisites: PHYSICS 205, PHYSICS 241, or PHYSICS 249, or Graduate Standing
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017
MED PHYS/B ME 566 — PHYSICS OF RADIOTHERAPY

4 credits.

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications; lecture and lab.

Requisites: B M E/H ONCOL/MED PHYS PHYSICS/B M E/H ONCOL/ MED PHYS 501

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

MED PHYS/B ME 567 — THE PHYSICS OF DIAGNOSTIC RADIOLOGY

4 credits.

Physics of x-ray diagnostic procedures and equipment, radiation safety, general imaging considerations; lecture and lab.

Requisites: Modern physics, calculus, and Fourier analysis, or consent of instructor

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

MED PHYS/B ME 568 — MAGNETIC RESONANCE IMAGING (MRI)

2 credits.

Core course covering the physics associated with magnetic resonance imaging emphasizing techniques employed in medical diagnostic imaging. Major MRI topics include: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and clinical applications. At the completion of this course, students should have an understanding of the technical and scientific details of modern magnetic resonance imaging and its use in diagnosing disease. Graduate students who have not taken MATH 222 and PHYSICS 202 at UW-Madison must have the equivalent coursework in order to be successful in this course.

Requisites: (MATH 222 and PHYSICS 202, 208, 241, 244, 248 or 249) or graduate or professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

MED PHYS/N E 569 — HEALTH PHYSICS AND BIOLOGICAL EFFECTS

3-4 credits.

Physical and biological aspects of the use of ionizing radiation in industrial and academic institutions; physical principles underlying shielding instrumentation, waste disposal; biological effects of low levels of ionizing radiation; lecture and lab.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

MED PHYS 570 — ADVANCED BRACHYTHERAPY PHYSICS

3 credits.

The use of radioactive sources for radiotherapy including: materials used, source construction dosimetry theory and practical application, dosimetric systems, localization and reconstruction. The course covers low dose rate, high dose rate and permanently placed applications.

Requisites: B M E/H ONCOL/MED PHYS PHYSICS/B M E/H ONCOL/ MED PHYS 501 and B M E/MED PHYS/B M E 566

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

MED PHYS 571 — ADVANCED EXTERNAL RADIATION ONCOLOGY PHYSICS

3 credits.

Physics of ionizing radiation therapy with emphasis on external beam dosimetry and treatment planning.

Requisites: B M E/H ONCOL/MED PHYS PHYSICS/B M E/H ONCOL/ MED PHYS 501 and B M E/MED PHYS/B M E 566

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

MED PHYS 572 — ADVANCED RADIATION TREATMENT PLANNING

3 credits.

Physics of clinical, computer-based radiotherapy planning is taught. Topics include dose algorithms, measurement data, commissioning, contouring and volume definition, beam placement, modifiers and apertures and plan evaluation. Forward based and inverse planning (including IMRT optimization) are taught.

Requisites: Med Phys 501 and Med Phys 566

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

MED PHYS/B ME 573 — MEDICAL IMAGE SCIENCE: MATHEMATICAL AND CONCEPTUAL FOUNDATIONS

3 credits.

The conceptual and mathematical foundations of medical imaging, including both deterministic and stochastic aspects.

Requisites: 1 yr each of undergrad physics calc or cons inst

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2017

MED PHYS/B ME 574 — IMAGINE IN MEDICINE: APPLICATIONS

3 credits.

Continuation of 573, with application of concepts to practical medical imaging problems and emerging quantitative imaging techniques.

Requisites: B M E/MED PHYS/B M E 573

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
MED PHYS/B ME 575 — DIAGNOSTIC ULTRASOUND IMAGING
2 credits.

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound.

Requisites: Graduate or professional standing or (MATH 234, 319, or 320 and PHYSICS 202 or 208)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS 577 — PRINCIPLES OF X-RAY COMPUTED TOMOGRAPHY
3 credits.

Provides a basic foundation of x-ray computed tomography (CT) for those who are interested in the principles and applications of CT in Medical Physics. Focuses on the physics of CT, system design, image artifacts, and recent advances in CT techniques.

Requisites: Grad st; Modern physics, calculus, and Fourier analysis, or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/B ME 578 — NON-IONIZING DIAGNOSTIC IMAGING
3 credits.

This is a graduate level core course covering the physics associated with magnetic resonance imaging and diagnostic ultrasound emphasizing techniques employed in medical diagnostic imaging. Major MRI topics include: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization. Ultrasound based topics covered include: propagation of ultrasonic waves in biological tissues, principles of ultrasonic measuring and imaging instrumentation, design and use of currently available tools for performance evaluation of diagnostic instrumentation, and biological effects of ultrasound. At the completion of this course, students should have an understanding of the technical and scientific details of modern non-ionizing medical magnetic resonance and ultrasound devices and their use in diagnosing disease. Medical Physics 573 ("Imaging in Medicine") is useful but not a specific prerequisite.

Requisites: MATH 222, PHYSICS 202
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

MED PHYS/B ME/PHMCOL-M/PHYSICS/RADIOL 619 — MICROSCOPY OF LIFE
3 credits.

Survey of state of the art microscopic, cellular and molecular imaging techniques, beginning with subcellular microscopy and finishing with whole animal imaging.

Requisites: PHYSICS 104, 202, 208, or 248 or MED PHYS/PHYSICS/MED PHYS 265
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS/B ME/PHMCOL-M/PHYSICS/RADIOL 619 — MICROSCOPY OF LIFE
3 credits.

Survey of state of the art microscopic, cellular and molecular imaging techniques, beginning with subcellular microscopy and finishing with whole animal imaging.

Requisites: PHYSICS 104, 202, 208, or 248 or MED PHYS/PHYSICS/MED PHYS 265
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS/B ME/PHMCOL-M/PHYSICS/RADIOL 619 — MICROSCOPY OF LIFE
3 credits.

Survey of state of the art microscopic, cellular and molecular imaging techniques, beginning with subcellular microscopy and finishing with whole animal imaging.

Requisites: PHYSICS 104, 202, 208, or 248 or MED PHYS/PHYSICS/MED PHYS 265
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS/B ME 650 — BIOLOGICAL OPTICAL MICROSCOPY
3 credits.

This course for graduate students will cover several aspects of state of the art biological and biophysical imaging. We will begin with an overview of geometrical optics and optical and fluorescence microscopy, with an emphasis on instrumentation. The bulk of the course will focus on advanced imaging techniques including nonlinear optical processes (multi-photon excitation, second harmonic generation, and stimulated Raman processes) and emerging super-resolution methods. Special emphasis will be given to current imaging literature and experimental design.

Requisites: Senior or Graduate standing, and CHEM 104 or 109 or 116 and, PHYSICS 104 or 202 or 208
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS/NTP 651 — METHODS FOR NEUROIMAGING RESEARCH
3 credits.

Provides a practical foundation for neuroimaging research studies with statistical image analysis. Specific imaging methods include functional BOLD MRI, structural MRI morphometry, and diffusion tensor imaging. Lectures and associated in-class computer exercises will cover the physics and methods of image acquisition, steps and tools for image analyses, the basis for statistical image analyses and interpretation of the results.

Requisites: Junior standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MED PHYS 661 — RAD LAB - RADIOTHERAPY PHYSICS
2 credits.

Requisites: B M E/MED PHYS/B ME 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS 662 — RAD LAB - DIAGNOSTIC RADIOLOGICAL PHYSICS
1 credit.

Requisites: B M E/MED PHYS/B ME 567
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS 663 — RAD LAB - NUCLEAR MEDICINE PHYSICS
1 credit.

Requisites: MED PHYS/PHYSICS 463
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
**MED PHYS 664 — RAD LAB - HEALTH PHYSICS**  
1 credit.  
**Requisites:** Graduate or professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  

**MED PHYS 665 — RAD LAB: CT, MRI, AND DSA PHYSICS**  
1 credit.  
**Requisites:** B M E/MED PHYS/B M E 567  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  

**MED PHYS 666 — RAD LAB - MEDICAL ULTRASOUND PHYSICS**  
1 credit.  
**Requisites:** Graduate or professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  

**MED PHYS 671 — SELECTED TOPICS IN MEDICAL PHYSICS**  
1-3 credits.  
Various subjects of interest to medical physics faculty and students.  
**Requisites:** None  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** Yes, unlimited number of completions  
**Last Taught:** Spring 2018  

**MED PHYS 679 — RADIATION PHYSICS METROLOGY**  
3 credits.  
Metrology, the science of measurement, is a critical component of medical physics. Topics covered: measurement statistics, determination of uncertainty, characteristics of ionization chambers, electrometers and other ionizing radiation measurement devices. Effects of instrumentation on clinical measurements.  
**Requisites:** Med Phys 501; Med Phys 566 567 recommended  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Fall 2017  

**MED PHYS 699 — INDEPENDENT READING OR RESEARCH**  
1-3 credits.  
**Requisites:** Consent of instructor  
**Course Designation:** Level - Advanced  
L&S Credit - Counts as Liberal Arts and Science credit in L&S  
Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** Yes, unlimited number of completions  

**MED PHYS 701 — ETHICS AND THE RESPONSIBLE CONDUCT OF RESEARCH AND PRACTICE OF MEDICAL PHYSICS**  
1 credit.  
This course will introduce the concepts of ethics in the daily practice of medical physics and other scientific disciplines and provide tools for identifying resources. Special emphasis will be placed in how these principles have to be applied to ensure the confidentiality of the patients, the safety of the research subjects (human and animals), differentiation between ethical and legal issues, as well as the understanding of the principles that deal with authorships, intellectual property in the academic- and industry- based environment. This will be a 1 credit course (16hs). It will consist of 8 weekly meetings (2 hs each session).  
**Requisites:** Graduate or professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  

**MED PHYS/B M E 710 — ADVANCES IN MEDICAL MAGNETIC RESONANCE**  
3 credits.  
This course studies in some depth the theory and applications of magnetic resonance (MR) in medicine. It provides the necessary theoretical background to understand advanced MR techniques including magnetic resonance imaging (MRI).  
**Requisites:** B M E/MED PHYS/B M E 568  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Fall 2017  

**MED PHYS 719 — MULTI-MODALITY MOLECULAR IMAGING IN LIVING SUBJECTS**  
3 credits.  
Gives and overview of all major areas in molecular imaging, based on each imaging modality. Additional topics include, but are not limited to, role of molecular imaging in stem cell research, molecular imaging with nanoparticles, theranostics, molecular imaging in drug development, optical imaging and its clinical applications, reporter gene imaging, imaging of apoptosis, PET imaging of cancer, imaging protein-protein interactions.  
**Requisites:** Graduate or professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  

**MED PHYS/B M E/PHYSICS 775 — ADVANCED ULTRASOUND PHYSICS**  
3 credits.  
Foundations of acoustic wave equations, diffraction phenomena and acoustic beam formation, models for acoustic scattering from discrete structures and inhomogeneous continua, speckle statistics including speckle correlation, applications of these topics in medical imaging.  
**Requisites:** Med Phys 575, PHYSICS 311, 322, 325, MATH 234, or cons inst  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No
MED PHYS/H ONCOL 812 — RADIATION MEDICINE PHYSICS
CLERKSHIP
2 credits.

Allows students to observe and participate in the application of medical physics principles in the clinical setting. Under supervision, students will perform the functions of a clinical medical physicist in radiation medicine.

Requisites: B M E/H ONCOL/MED PHYS/PHYSICS/B M E/H ONCOL/
MED PHYS 501 and B M E/MED PHYS/B M E 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MED PHYS 900 — JOURNAL CLUB AND SEMINAR
1 credit.

Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions

MED PHYS 990 — RESEARCH
1-12 credits.

Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions