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. Enroll Info: None
Requisites: PHYSICS 104, 202, or 208
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
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: Graduate/professional standing or (PHYSICS 202 or 208 and ZOOLOGY/BIOLOGY/BOTANY 152 or 153)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

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. Enroll Info: None
Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/ professional 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 2018

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. Enroll Info: None
Requisites: N E 305 and (N E 405, N E 408, PHYSICS/B M E/H ONCOL/ MED PHYS 501 or N E/MED PHYS 569) or graduate/professional standing
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
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: Graduate/professional standing or (E C E 330 or MED PHYS/ B M E 573)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: PHYSICS 202, 208, 248, or PHYSICS/MED PHYS 265, or graduate/professional standing
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. Enroll Info: None
Requisites: Consent of instructor
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: Spring 2019
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. Enroll Info: None
Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional 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 2018

MED PHYS/B M E 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. Enroll Info: None
Requisites: PHYSICS/B M E/H ONCOL/MED PHYS 501
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MED PHYS/B M E 567 — THE PHYSICS OF DIAGNOSTIC RADIOLOGY
4 credits.

Physics of x-ray diagnostic procedures and equipment, radiation safety, general imaging considerations; lecture and lab. Enroll Info: None
Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional standing
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 2018

MED PHYS/B M E 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. Enroll Info: None
Requisites: Graduate/professional standing or (MATH 222 and PHYSICS 202, 208, 241, 244, 248 or 249)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: MATH 234 and (PHYSICS 241 or 249) or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: MED PHYS/B M E 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2011

MED PHYS 571 — ADVANCED EXTERNAL RADIATION ONCOLOGY PHYSICS
3 credits.

Physics of ionizing radiation therapy with emphasis on external beam dosimetry and treatment planning. Enroll Info: None
Requisites: MED PHYS/B M E 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2011

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. Enroll Info: None
Requisites: MED PHYS/B M E 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018
MED PHYS/B M E 573 — MEDICAL IMAGE SCIENCE: MATHEMATICAL AND CONCEPTUAL FOUNDATIONS

3 credits.

The conceptual and mathematical foundations of medical imaging, including both deterministic and stochastic aspects. Enroll Info: None
Requisites: MATH 234, 319 and (PHYSICS 202 or 208) or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MED PHYS/B M E 574 — IMAGING IN MEDICINE: APPLICATIONS

3 credits.

Builds on the fundamental conceptual and mathematical foundations addressed in MED PHYS/B M E 573, with application of concepts to practical medical imaging problems and emerging quantitative imaging techniques. Enroll Info: None
Requisites: MED PHYS/B M E 573
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MED PHYS/B M E 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. Enroll Info: None
Requisites: Graduate/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
Last Taught: Spring 2019

MED PHYS/B M E 578 — NON-IONIZING DIAGNOSTIC IMAGING

3 credits.

Covers 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. Enroll Info: None
Requisites: MATH 234, 319, (PHYSICS 202 or 208) and (PHYSICS 241 or 248) or graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

MED PHYS/ANATOMY/B M E/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. Enroll Info: None
Requisites: PHYSICS 104, 202, 208, or 248 or 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 2018

MED PHYS/B M E/CHEM 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. Enroll Info: None
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
Last Taught: Spring 2018

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. Enroll Info: None
Requisites: Graduate/professional standing or (PHYSICS 104, 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
Last Taught: Fall 2018
### MED PHYS 662 — RAD LAB - DIAGNOSTIC RADIOLOGICAL PHYSICS

1 credit.

Provides hands on experience using and testing radiographic, fluoroscopic and mammographic x-ray systems. Imaging requirements, image quality, and radiation dose aspects of each modality are covered, along with practical methods for evaluating the performance of clinical units. Enroll Info: None

**Requisites:** MED PHYS/B M E 567  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Spring 2018

### MED PHYS 663 — RAD LAB - NUCLEAR MEDICINE PHYSICS

1 credit.

Provides an introduction to the technical skills required in nuclear medicine physics. This will include laboratory rotations in basic radiopharmaceutical production and quality control, basic operation and quality control testing on PET and SPECT scanners, time series image analysis of radotracer studies and nuclear medicine dosimetry and radiation safety training. The student will gain a firsthand understanding of the professional duties performed by a nuclear medicine medical physicist. Enroll Info: None

**Requisites:** PHYSICS/MED PHYS 563  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Spring 2015

### MED PHYS 664 — RAD LAB - HEALTH PHYSICS

1 credit.

Uses project-based learning (PBL) as a powerful teaching method to address common challenges and solutions addressed by medical health physicists. Each semester, students work on a different project that addresses concepts that are important in the current health physics environment. Enroll Info: None

**Requisites:** Consent of instructor  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Spring 2017

### MED PHYS 665 — RAD LAB - CT, MRI, AND DSA PHYSICS

1 credit.

Provides hands on experience using and testing computerized tomography (CT), magnetic resonance imaging (MRI), and digital subtraction angiography (DSA) systems. Image quality, MRI and radiation safety, accreditation, and regulatory compliance issues with these modalities are also covered. Enroll Info: None

**Requisites:** MED PHYS/B M E 567 and 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 666 — RAD LAB - MEDICAL ULTRASOUND PHYSICS

1 credit.

Introduces concepts and methodology for measuring acoustic properties of materials and for operating and performing physics tests of state of the art clinical ultrasound scanners. Students set up and operate a laboratory apparatus employing single element ultrasound transducers. This is followed by hands on experiments that challenge students to explain physical and engineering characteristics of clinical scanners, details of operator controls, features of Doppler and color flow modes, and resolution limitations. Practical scanning exercises provide familiarity with selected applications of clinical ultrasound equipment, both for diagnosis and for guiding interventions. Routine quality assurance tests done by medical physicists are also performed. Enroll Info: None

**Requisites:** MED PHYS/B M E 575  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Fall 2018

### MED PHYS 671 — SELECTED TOPICS IN MEDICAL PHYSICS

1-3 credits.

Various subjects of interest to medical physics faculty and students. Enroll Info: None

**Requisites:** Consent of instructor  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** Yes, unlimited number of completions  
**Last Taught:** Spring 2019

### 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. Enroll Info: None

**Requisites:** PHYSICS/B M E/H ONCOL/MED PHYS 501  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Fall 2018

### MED PHYS 699 — INDEPENDENT READING OR RESEARCH

1-3 credits.

Provides opportunities for graduate students to gain experience using the scientific method to address specific scientific problems. This includes selection of a research topic, performing literature reviews to evaluate peer-reviewed and other publications, developing a research design, identifying possible pitfalls, and performing and reporting on experiments performed. Communication of the research findings within and outside the university is encouraged. Enroll Info: None

**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  
**Last Taught:** Spring 2019
MED PHYS 701 — ETHICS AND THE RESPONSIBLE CONDUCT OF RESEARCH AND PRACTICE OF MEDICAL PHYSICS
1 credit.
Addresses 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. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MED PHYS/B M E 710 — ADVANCES IN MEDICAL MAGNETIC RESONANCE
3 credits.
Addresses the theory and applications of magnetic resonance (MR) in medicine, by providing the necessary theoretical background to understand advanced MR techniques including magnetic resonance imaging (MRI). Enroll Info: None
Requisites: MED PHYS/B M E 568
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MED PHYS 719 — MULTI-MODALITY MOLECULAR IMAGING IN LIVING SUBJECTS
3 credits.
Provides an 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. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2013

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. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2013

MED PHYS 777 — PRINCIPLES OF X-RAY COMPUTED TOMOGRAPHY
3 credits.
Understand the basic principles of x-ray computed tomography (CT), and how to think when a technical problem arises in CT. Accomplished through a review of the history of CT developments and key components of CT systems, lectures on various CT reconstruction algorithms, image quality, and radiation dose, origin and correction methods of various CT artifacts. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

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. Enroll Info: None
Requisites: PHYSICS/B M E/H ONCOL/MED PHYS 501 and MED PHYS/B M E 566
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2008

MED PHYS 900 — JOURNAL CLUB AND SEMINAR
1 credit.
Provides medical physics graduate students with the opportunity to critically evaluate and report on published research and/or research seminar presentations by speakers, from both within the university and from the larger scientific community. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MED PHYS 990 — RESEARCH
1-12 credits.
Provides graduate students with mentorship to support their development of independent research goals and methods needed to address specific scientific problems that will result in a comprehensive dissertation. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019