PHYS 520
Bio-Nanotechnology
In this multidisciplinary course, we will examine the basic science behind nanotechnology and how it has infused itself into areas of nanofabrication, biomaterials, and molecular medicine. This course will cover materials considered basic building blocks of nanodevices such as organic molecules, carbon nanotubes, and quantum dots. Top-down and bottom-up assembly processes such as thin film patterning through advanced lithography methods, self-assembly of molecular structures, and biological systems will be discussed. Students will also learn how bionanotechnology applies to modern medicine, including diagnostics and imaging and nanoscale, as well as targeted, nanotherapy and finally nanosurgery.
Lecture: 3 Lab: 0 Credits: 3

PHYS 525
Applied Physics Methods for Scientists and Engineers
This is the first of a two-part course designed to provide science and engineering students with the opportunity to investigate the underlying physics principles governing a challenging real-world problem. Problems are selected by each student based on her or his background and interest from a set of topics provided by the faculty. Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, to develop new or improved designs, methodologies, devices, systems, or solutions. Prerequisite: Instructor permission required.
Lecture: 3 Lab: 0 Credits: 3

PHYS 526
Applied Physics Case Studies for Scientists and Engineers
This is the second part of a two-part course designed to provide science and engineering students with the opportunity to investigate the underlying physics principles governing a challenging real-world problem. Problems are selected by each student, based on her or his background and interest, from a set of topics provided by the faculty. Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, to develop new or improved designs, methodologies, devices, systems, or solutions. Prerequisite: Instructor permission required.
Prerequisite(s): PHYS 525 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 537
Solid State Physics I
Prerequisite(s): PHYS 405 with min. grade of C and PHYS 406 with min. grade of C or PHYS 509 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 538
Solid State Physics II
Prerequisite(s): PHYS 510* with min. grade of C, An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 Lab: 0 Credits: 3

PHYS 539
Physical Methods of Characterization
A survey of physical methods of characterization including x-ray diffraction and fluorescence surface techniques including SEM, TEM, AES and ESCA, thermal methods and synchrotron radiation methods. Same as CHEM 509.
Lecture: 3 Lab: 0 Credits: 3

PHYS 545
Particle Physics I
The course is an introduction to and overview of the field of elementary particle physics. No previous exposure is assumed. The first third of the course is devoted to the symmetries of the strong interaction. The second third is a modern introduction to the gauge theories of the electromagnetic, strong, and weak interactions, and their leading evaluation via Feynman diagrams. The final third introduces topics of current and speculative research.
Prerequisite(s): PHYS 510 with min. grade of C and PHYS 509 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 546
Particle Physics II
The course is a continuation of PHYS 545, but it is self-contained. The goal is to provide a functional understanding of particle physics phenomenology of QED, QCD, and electroweak physics. Topics include QED: Spin-dependent cross sections, crossing symmetries, C/P/CP; QCD: Gluons, parton model, jets; Electroweak interactions: W, Z, and Higgs. Weak decays and production of weak bosons; Loop calculations: Running couplings, renormalization.
Prerequisite(s): PHYS 510 with min. grade of C and PHYS 509 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 550
Instrumentation for Health Physics
Detecting and measuring radioactive material and radiation levels depends upon many types of detectors and instrumentation. Theory of detectors ranging from chambers operating in pulse and current producing modes to solid state detectors is applied to measuring and monitoring systems. Electronics ranging from simple rate meters and scalers to high speed multi-channel analyzers are used. Computer-linked instrumentation and computer-based applications are applied to practical problems.
Lecture: 1 Lab: 4 Credits: 3

PHYS 553
Quantum Field Theory
Quantum field theory is a language to understand large numbers of degrees of freedom in most areas of physics such as high energy, statistical, and condensed matter physics. Topics covered include: canonical quantization of fields; path integral quantizations of scalar, Dirac, and gauge theories; symmetries and conservation laws; perturbation theory and generating functionals; regularization and renormalization.
Prerequisite(s): PHYS 510 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3
PHYS 561
Radiation Biophysics
Prerequisite(s): PHYS 410 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 563
Project Management: Business Principles
The course will cover a wide range of business principles highlighting project management and the components of business that employees may encounter. The goal of the course is to help the student understand basic business principles and project management skills, help the student understand the application of organizational behavior in today's workplace and equip the student to function more effectively both independently and as a team in today's organizations.
Lecture: 2 Lab: 0 Credits: 2

PHYS 566
Environmental Health Physics
Impact of ionizing radiation and radionuclides on the environment. Identifying environmental effects of specific natural and artificial nuclides. Models for deposition and transport of nuclides, including air and water disbursement. Environmental dosimetry and remediation. Facility decommissioning and decontamination.
Prerequisite(s): PHYS 572 with min. grade of C
Lecture: 2 Lab: 0 Credits: 2

PHYS 570
Introduction to Synchrotron Radiation
Production and characterization of synchrotron radiation, dynamical and kinematical diffraction, absorption and scattering processes, x-ray optics for synchrotron radiation and x-ray detectors. Overview of experimental techniques including XAFS, XPS, SAXS, WAXS, diffraction, inelastic x-ray scattering, fluorescence spectroscopy, microprobe, tomography and optical spectroscopy.
Lecture: 3 Lab: 0 Credits: 3

PHYS 571
Radiation Physics
Fundamentals of Radiation Physics will be presented with an emphasis on problem-solving. Topics covered are review of atomic and nuclear physics; radioactivity and radioactive decay law; and interaction of radiation with matter, including interactions of heavy and light charged particles with matter, interactions of photons with matter, and interactions of neutrons with matter.
Lecture: 3 Lab: 0 Credits: 3

PHYS 572
Introduction to Health Physics
Health Physics profession; Units in radiation protection; Radiation sources; Interaction of ionizing radiation with matter; Detectors for radiation protection; Biological effects of ionizing radiation; Introduction to microdosimetry; Medical health physics; Fuel cycle health physics; Power reactor health physics; University health physics; Accelerator health physics; Environmental health physics; Radiation accidents.
Prerequisite(s): PHYS 571 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3

PHYS 573
Standards, Statutes and Regulations
This course studies the requirements of agencies that regulate radiation hazards, their basis in law and the underlying US and international standards. An array of overlapping requirements will be examined. The effect regulatory agencies have upon the future of organizations and the consequences of noncompliance are explored.
Lecture: 3 Lab: 0 Credits: 3

PHYS 574
Introduction to the Nuclear Fuel Cycle
This course introduces the concept and components of the nuclear fuel cycle that originated from the mining of uranium through the production and utilization of nuclear fuel to the nuclear/radioactive waste generation and disposal. The mechanisms of normal operations through the fuel cycle process will be discussed, as well as the accidental situations, with expanded coverage on nuclear reactor issues. Emphasis will be placed on the radiological health and safety aspects of the operations. The study will also include key regulatory compliance issues.
Lecture: 2 Lab: 0 Credits: 2

PHYS 575
Case Studies in Health Physics
This is a non-instructional course designed to promote the understanding of radiation safety through lessons learned from the past incidents. The focus will be on the means for improving the future operations of the facilities/devices. The course is recommended to be among the last courses taken by students who have gained at least one year of academic exposure in health physics and with some level of capability to address the underlying technical aspects.
Prerequisite(s): PHYS 571 with min. grade of C and PHYS 573 with min. grade of C and PHYS 572 with min. grade of C
Lecture: 3 Lab: 0 Credits: 3
PHYS 576
Radiation Dosimetry
This course is designed to study the science and technique of determining radiation dose and is fundamental to evaluating radiation hazards and risks to humans. This course covers both external dosimetry for radiation sources that are outside the human body and internal dosimetry for intake of radioactive materials into the human body. Topics will include: dosimetry recommendations of ICRP for occupational exposure; US NRC and DOE requirements for particular work environments; and MIRD methodology for medical use of radionuclides.
Prerequisite(s): PHYS 571* with min. grade of C and PHYS 572* with min. grade of C. An asterisk (*) designates a course which may be taken concurrently.
Lecture: 3 Lab: 0 Credits: 3

PHYS 577
Operational Health Physics
Covers the basic principles for establishing and maintaining an effective institutional radiation safety program including the following: facility design criteria; organizational management issues; training; internal and external radiation control; radioactive waste disposal; environmental monitoring; radiation safety instrumentation; ALARA program; and emergency response planning. The course will also cover facility licensing/registration with state and federal agencies and legal issues such as institutional and individual liability, fines, violations, and worker rights and responsibilities.
Lecture: 2 Lab: 0 Credits: 2

PHYS 578
Medical Health Physics
Medical Health Physics (MHP) profession; sources of radiation in the medical environment; diagnostic use of X-rays (radiography, mammography, CT, fluoroscopy); therapeutic use of X-ray and gamma radiation (Co-60 and Linac based radiation therapy); radiotherapy using sealed radioisotopes (brachytherapy); radiation protection in diagnostic and interventional radiology; radiation protection in nuclear medicine; radiation protection in external beam radiotherapy; radiation protection in brachytherapy; radiation accidents in medicine.
Lecture: 2 Lab: 0 Credits: 2

PHYS 580
Introduction to Radiochemistry
This course is designed to introduce the fundamental principle of radiation science for students majoring in radiochemistry.
Lecture: 3 Lab: 0 Credits: 3

PHYS 581
Radiochemistry Laboratory
This laboratory-related course will offer opportunities for students to have hands-on experience in sample preparation, source preparation, and counting measurements.
Lecture: 1 Lab: 2 Credits: 3

PHYS 582
Applications of Radiochemistry
This course will provide discussion and overview of practical applications of radiochemistry. Various special topics in the following five general series of practical radiochemistry will be offered. Each series covers different topics related to that particular discipline. 1. Actinide Chemistry Series 2. Environmental Radiochemistry/Bioassay 3. Nuclear Fuel Cycle Series 4. Nuclear Forensics 5. Radioelement Compounds.
Lecture: 3 Lab: 0 Credits: 3

PHYS 585
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. May be taken twice by M. S. students to fulfill course credit requirements.
Lecture: 1 Lab: 0 Credits: 1

PHYS 591
Research and Thesis M.S.
(Credit: variable) Prerequisite: Instructor permission required.
Credit: Variable

PHYS 594
Research Project
Research project.
Credit: Variable

PHYS 597
Reading and Special Problems
Independent study to meet the special needs of graduate students in department-approved graduate degree programs. Requires the written consent of the instructor. May be taken more than once. Receives a letter grade. (Credit: variable) Prerequisite: Instructor permission required.
Credit: Variable

PHYS 600
Continuation of Residence
Lecture: 0 Lab: 1 Credits: 1

PHYS 685
Physics Colloquium
Lectures by invited scientists in areas of physics generally not covered in the department. Must be taken twice by M. S. students and four times by Ph. D. students. May be substituted by PHYS 585 for M. S. students.
Lecture: 1 Lab: 0 Credits: 0

PHYS 691
Research and Thesis Ph.D.
(Credit: Variable)
Credit: Variable