PHYSICS

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Chair
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Faculty with Research Interests
For more information regarding faculty visit the Department of Physics website.

The Department of Physics offers B.S., M.S., and Ph.D. degrees in physics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have ready access to the expertise that the full faculty brings. In addition, the department offers a professional master's degree and a related certificate program for part-time students, both on campus, and through distance learning.

Research Centers

Center for Accelerator and Particle Physics
Center for the Molecular Study of Soft and Condensed Matter
Center for Synchrotron Radiation Research and Instrumentation

Research Facilities

The Department of Physics has state-of-the-art computer and laboratory equipment, and conducts research in the areas of elementary particle physics, accelerator physics, condensed matter physics, biological physics, computational physics, and synchrotron radiation research including x-ray optics and x-ray imaging. Department faculty and staff have constructed and operate user facilities for x-ray scattering, XAFS spectroscopy, and imaging at the Advanced Photon Source at Argonne National Laboratory. Additional research facilities include on-campus x-ray diffraction facilities; thin-film growth facilities; STM, AFM, and scanning electron microscope; a high-field nuclear magnetic resonance; Raman; UV-Vis; and Fourier transform infrared spectrometers. Laboratories for experimental research in biophysics, low-temperature, condensed matter physics, and particle and accelerator physics are active. Collaborative programs are carried on with Fermi National Accelerator Laboratory, Argonne National Laboratory, and the Advanced Photon Source. The department hosts or co-hosts the Center for Accelerator and Particle Physics (CAPP), the Center for the Molecular Study of Soft and Condensed Matter, and the Center for Synchrotron Radiation Research and Instrumentation (CSRRI).

Departmental Graduate Examinations

All full-time students in the M.S. and Ph.D. programs are required to pass the written M.S. comprehensive/Ph.D. qualifying fundamentals examination by the end of their fourth semester of study. This requirement can be met with a GPA of at least 3.3 based on core curriculum classes after the completion of at least four of the six core classes. Part-time students must pass this examination by a comparable stage of their programs. The written examination is offered twice each academic year. A student may attempt the written examination a maximum of two times. Ph.D. students are additionally required to pass an oral Topical exam to pass the qualifier and continue in the Ph.D. program. Students passing the written exam may obtain their master's degree after completing the requirements described in the following sections. All students in the Ph.D. program who have passed the written qualifying examination must take and pass a comprehensive examination at least one year prior to the final oral defense. Part-time students must pass this examination by a comparable stage of their programs. The comprehensive examination consists of a written proposal, an oral presentation, and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation, and final oral thesis defense.

All students in the professional master's degree program are required to take and pass a comprehensive exam unless specifically exempted based on academic achievement. Students may sit for the exam a limited number of times.

Admission Requirements

Minimum Cumulative Undergraduate GPA

3.0/4.0

Minimum GRE Scores

The Graduate Record Examination (GRE) is required for all applicants.

- Master's/Master of Science: 295 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 310 (quantitative + verbal), 3.0 (analytical writing)

Minimum TOEFL Scores

80/550 (internet-based/paper-based test scores)

Applicants to the doctoral program in physics are strongly encouraged, but not required, to take the subject-area GRE exam in physics.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to the department's program are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the master's or M.S. comprehensive/Ph.D. qualifying examination.

The department offers programs leading to M.S. and Ph.D. degrees in physics, along with a M.S. degree in applied physics. The M.S. degree is not a prerequisite for the Ph.D. The department also offers a professional master's program in health physics designed for both the part-time and full-time student and available through distance learning. Research is organized into small groups of faculty members, post-doctoral associates, graduate students, and undergraduate students working on closely related projects. The principal active areas include experimental and theoretical condensed matter physics, experimental and theoretical elementary particle physics, synchrotron radiation physics, accelerator physics, structural and computational biophysics, magnetism, and electrodynamics. Classes are generally small and informal, and thesis research is carried out in close collaboration with the faculty adviser.

In recognition of the value of teaching experience in strengthening an individual's understanding of his or her field of study and as an aid in making career decisions, the department requires full-time students to participate in instructional activities. Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any graduate classes.

Degrees Offered

- Master of Health Physics
- Master of Science in Applied Physics
- Master of Science in Physics
- Doctor of Philosophy in Physics

Co-Terminal Options

Bachelor of Science in Physics/Master of Health Physics

Undergraduate students may register for the co-terminal Bachelor of Science in Physics/Master of Health Physics after the fourth semester of study. Students must fulfill the requirements of both the Bachelor of Science in Physics and the Master of Health Physics. A full course of study is approximately ten semesters of study, and graduate coursework typically begins in the fourth year. For further details, refer to Synopsis of Co-Terminal Studies section in this catalog.

Certificate Program

- Radiological Physics

Course Descriptions

PHYS 501
Methods of Theoretical Physics I
Vector analysis including curvilinear coordinates. Tensor algebra. Ordinary differential equations. Method of infinite series. Regular singularities, Frobenius method. First look at special functions. Gamma-, beta-, error functions. Airy function. Fourier series. Hilbert space, its basic properties. Sturm-Liouville theory. Orthogonal polynomials. Legendre, associated Legendre, Hermite, Laguerre etc. polynomials. Bessel functions, their properties, basic applications. Partial differential equations, their classification. Boundary conditions. Physical models with PDE. Separation of variables method, Cartesian system of coordinates. Separation of variables in cylindrical and spherical system of coordinates. Spherical functions. Fourier transform method.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 502
Methods of Theoretical Physics II
Group theory. Discrete groups, elementary examples and properties. Lie groups, Lie algebras, generators. Their fundamental properties. Group representations. O(3), SU(2), SU(3), Lorentz groups and their applications. Complex variables: algebra, Cauchy-Riemann conditions, harmonic functions. Complex variables integrals: Cauchy theorem, Cauchy formula. Laurent series. Residues calculus: isolated singular points, poles, calculation of integrals using residues, other applications. Branches, singularities on the path of integration. Conformal mapping and its applications. Green functions. Their connection to complex variables calculus. Advanced, retarded, causal GF, application in physics. Integral equations.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 505
Electromagnetic Theory
Special relativity, its kinematics and dynamics. Lorentz transformations. 4D tensors and their algebra. Covariant formulation of electrodynamics. Electromagnetic field strength tensor, Maxwell equations. Gauge transformations and gauge invariance. Electrostatics, boundary value problems. Multipole expansion. Magnetostatics. Electric charge motion in an external electromagnetic field. Macroscopic electrodynamics. Electromagnetic waves..Dipole, quadruple and magnetodipole radiation. Light scattering, radiation damping. Optics. Electromagnetic field of a relativistic charge. Synchrotron radiation. Vavilov-Cherenkov radiation.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 508
Analytical Dynamics
Hamilton's Principle, Lagrange's formalism, function, and equations. Invariance properties and conservation laws. One dimensional motion. Central force problem. Small harmonic oscillations. Nonlinear oscillations. Scattering theory. Rigid body motion. Non-inertial reference frames. Hamilton's formalism, function, and equations. Canonical transformations. Hamilton-Jacobi theory. Integrable systems and canonical perturbation theory.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 509
Quantum Theory I
Survey of solutions to the Schrodinger Equation in one, two, and three dimensions. Hydrogen, helium, and other atoms. Spin 1/2 particles. Entangled states. EPR Paradox. Bell's Theorem. Formalism of quantum mechanics. Magnetic fields in quantum mechanics. Aharonov-Bohm Effect. Berry's Phase. Time Independent Perturbation Theory. Spin-orbit coupling. Variational method. WKB Method. Many electron wavefunction. Pauli Principle. More detailed look at excited states of helium atom. Time Dependent Perturbation Theory. Fermi's Golden Rule. Lifetime of excited atomic states.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 510
Quantum Theory II
Second quantization. Multiparticle systems. Applications of second quantization. Rotations and angular momentum. Angular momenta algebra. Group theory applications in quantum mechanics. Spin and spinors. Scattering theory. Particle in a magnetic field. Landau levels. Path integral formulation of classical and quantum mechanics. Relativistic quantum mechanics. Klein-Gordon equation. Multiparticle interpretation. Dirac equation. Gamma-matrices and their algebra. Bispinors. Gauge invariance in QM. Spontaneous symmetry breaking.
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 515
Statistical Mechanics
Ensembles and distribution functions. Classical gases and magnetic systems. Ideal Quantum Gases. Interacting systems. Real Space Renormalization group and critical phenomena. Quantum Statistical Mechanics: Superfluidity and superconductivity. Fluctuations and dissipation.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 518
General Relativity
Lorentz transformations, Minkowski space, 4D vectors and tensors, kinematics and dynamics of special relativity. Riemann geometry, Christoffel symbols, covariant derivatives, geodesics, curvature tensor, Einstein equations. Classical experiments of general relativity, Schwarzschild solution, physics of black holes. Cosmology, Big Bang theory, gravitational waves. Instructor permission required.
Lecture: 3 **Lab:** 0 **Credits:** 3

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 patterrning 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 and engineering principles governing challenging real-world problems or needs. Each student selects a topic based on her or his background and interest such as the development of novel or new scientific instruments, medical devices, consumer products, energy (conservation, transport, and storage) system, thermal management devices and systems, sustainability, etc.). Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, in the development of new or improved designs, methodologies, systems, and solutions. No specific background is required other than curiosity, interest, and dedication.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 526
Applied Physics Case Studies for Scientists and Engineers
This is the second of a two-part course designed to provide science and engineering students with the opportunity to investigate the underlying physics and engineering principles governing challenging real-world problems or needs. Each student selects a topic based on her or his background and interest such as the development of novel or new scientific instruments, medical devices, consumer products, energy (conservation, transport, and storage) system, thermal management devices and systems, sustainability, etc.). Experimental, theoretical, numerical techniques or a combination thereof are used, as needed, in the development of new or improved designs, methodologies, systems, and solutions.
Prerequisite(s): PHYS 525 with min. grade of B
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 537
Solid State Physics I
Crystal structure and crystal binding. Free electron model of metals and semiconductors. Energy band theory. Elastic Properties. Lattice Waves, Dielectric properties.
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
Higher order susceptibility, spin-orbit coupling, optical absorption, superconductivity. Properties of metals, semiconductors, and insulators. Device physics. Magnetic properties of materials.
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 540
Computational Accelerator Physics
Single-particle dynamics and numerical integration; transverse and longitudinal motion; phase space distributions and ellipses; transfer map methods; periodic systems; advanced beam optics modules; magnetic fields and FEM; RF cavities; errors and resonances; symplectic integration; other topics (final presentations).
Corequisite(s): PHYS 505
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
Radiation Instrumentation Laboratory
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.
Prerequisite(s): PHYS 571 with min. grade of C
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
Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation effects in biomolecules. Radiation inactivation of enzymes, nucleic acids, and viruses. Biological effects of ultraviolet radiation. Photosensitization. Radiation protection and sensitization. Radiation effects in vivo, radiation therapy, and phototherapy.
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.
Lecture: 2 **Lab:** 0 **Credits:** 2

PHYS 567
Radiological Emergency Preparedness and Response
This course is designed to provide students an introduction of the nature of the nuclear and radiological emergencies arising from either accidents or malicious acts, and the management actions in the preparedness and response. The lecture content is to familiarize students with emergency management guidance documents. It will focus on several aspects of emergency preparedness and response. In the process it will also include the recovery from the incident.
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 568
Radiation Source Security and Management
This course is designed to introduce radioactive sources that are currently used in all applications including defense, industry and medical areas. It will address the necessity to control and manage the licensed sources, particularly those designated by the International Atomic Energy Agency (IAEA) as Category I or II sources. The discussion will cover the potential consequences and impact of the lost sources either by lack of management or by theft. The course will also address the potential use of radioactive sources for malicious intents, such as for the radiological dispersal device (RDD, or "dirty bomb") or for the improvised nuclear device (IND).
Lecture: 3 **Lab:** 0 **Credits:** 3

PHYS 569
Seminars on Radiological Emergency Field Experience
This course will provide a series of discussions on the practical aspects in radiological emergency management by acquiring experiences from speakers representing various organizations in the emergency management community across the federal, state and local level. It is intended to provide students with valuable experiences in radiological emergency preparedness and response.
Lecture: 3 **Lab:** 0 **Credits:** 3

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.
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. This course should be taken in a student's final semester.
Prerequisite(s): PHYS 571 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 572 with min. grade of C
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; radioisotopes in nuclear medicine; 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
Intro 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.
Prerequisite(s): PHYS 550 with min. grade of C
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 Forensicsi 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
Continuation of Residence.
Lecture: 0 **Lab:** 0 **Credits:** 0

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

SCI 511
Project Management
Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 522
Public Engagement for Scientists
This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.
Lecture: 3 **Lab:** 0 **Credits:** 3

SCI 595
Ethics for the Health Professions
Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.
Lecture: 1 **Lab:** 0 **Credits:** 1