APPLIED SCIENCE MINOR
(Two Tracks)

Six designated courses (see below), including independent research (at least 2 credits) and totaling at least 18 credits. Required Research Experience: APSC 402 *or* 404 *or* 495-496 (2 up to 4 credits), *or* pre-approved Senior Research projects from other departments. *Two tracks are available:*

TRACK ONE: COMPUTATIONAL BIOLOGY.

Take 2 of 3 required courses: APSC 451 Cellular Biophysics and Modeling; APSC 452 Networks in the Brain and Biology; APSC 453 Introduction to Bioinformatics. **Additional courses may be selected from the following:** APSC 312 Medical Imaging; BIOL 404 Topics in Biotechnology; BIO 406 Molecular Cell Biology; BIO 442 Molecular Genetics; MATH 302 Ordinary Differential Equations; MATH 351 Applied Statistics; MATH 410 Mathematical Biology; MATH 441/442 Introduction to Applied Mathematics; CHEM 341 Principles of Biophysical Chemistry. *Additional APSC Graduate courses that may be taken and counted with instructor permission:* APSC631 Applied Cellular Neuroscience; APSC632 Applied Systems Neuroscience; APSC751 Mathematical Physiology I; APSC752 Mathematical Physiology II.

TRACK TWO: MATERIALS SCIENCE.

Take 3 required courses: APSC 201 Materials Science; APSC 301 Mechanics of Materials; APSC 302 Applied Quantum Mechanics. **Additional courses may be selected from the following:** APSC 312 Medical Imaging; APSC *or* CHEM 411, Polymer Chemistry I; APSC *or* CHEM 412 & 416 Polymer Chemistry II; APSC 422 Intro Materials Characterization; APSC 474 Continuum Mechanics; CSCI 426 Simulation; MATH 441 *or* 442 Applied Mathematics I & II; PHYS 475 Mathematical Physics. *Additional APSC Graduate courses that may be taken and counted with instructor permission:* APSC 525 Intro. to solid Surfaces and Interfaces; APSC 607 Mathematical and Computational Methods; APSC 621 Principles of Materials Science; APSC 627 Lasers in Medicine, Science, and Technology; APSC 637 Intro. to Optoelectronics.

Description of the Minor

The Materials Science and the Computational Biology minor tracks both require 18 hours of course work, including at least 2 credits of independent research (which can be supervised by faculty who are not in or even affiliated with the Applied Science Department). Only 6 hours of the Computational Biology and 9 hours of the Materials Science tracks require specific courses in Applied Science, the rest of the courses may be selected from an approved list of courses in other departments, depending on the student's individual interest and background.

The Applied Science department provides courses and research opportunities for students who are interested in interdisciplinary science. Our two tracks entail both course work and hands-on laboratory-based research experiences in various applied science disciplines. Our courses, and especially the Minor, will provide both new and expanded opportunities for students to prepare for several interdisciplinary graduate programs or the job market.

Applied Science Introductory Courses

150W.01 Freshman Seminar: Applied Pseudoscience. Fall (4) This course offers a brief introduction to the scientific method, and then explores systematically a variety of paranormal phenomena (UFO's, ESP, Bermuda Triangle, etc.) It will help students to distinguish legitimate scientific discoveries from the bogus claims of tricksters and fools.

150W.02 Freshman Seminar: Recycling Technology. Fall (4) Everybody agrees that recycling is desirable, but implementation continues to face growing issues. Using a nearby city as a case study, we investigate technology, economics and policy issues, and work as a team with city staff to develop and present an improved recycling plan, each class member being responsible for specific areas.

New Undergraduate courses (Spring 2006)

APSC 201. Introduction to Materials Science. Spring (3) Holloway

This course introduces the field of materials science in a format suitable for undergraduate students. Materials and their properties are examined in the context of their use in everyday objects including sports equipment, automobiles, aircraft, display screens, compact disc players, hip-replacements, etc. The role materials have played and will continue to play in shaping society will be discussed. Examples and demonstrations will be the major component in this course. Course is intended as a 200-level introductory course for the materials science minor in Applied Science.

Specific topics covered in the course will include:

- Fundamental Concepts -- Electrons in Atoms
- Phase Diagrams
- Crystallography and Crystal Structure
- Metals, Ceramics, Polymers, and Composites
- Mechanical Properties of Solids
- Electronic Conductivity in Solids
- Optical Aspects of Solids

ASPC 327. Introduction to Lasers in Biomedicine. Spring (3) Luepke

The course will build a foundation for understanding the use of lasers in biology and medicine. There will be particular emphasis on laser beam interactions with human tissue for diagnosis, therapy, and surgery, with additional attention to optical coherence tomography, two-photon microscopy, fluorescent imaging, optical tweezers, and refractive surgery.

Specific topics covered in the course will include:

• Principles and properties of lasers and optics
• Electromagnetic waves, photons and light
• Basic Optics: reflection, refraction, diffraction, lenses and lens systems, interference
• Light propagation in tissue: absorption, scattering
• Thermal aspects of light-tissue interaction
• Therapeutic use of lasers: ablation, coagulation, cutting, welding, photodynamic therapy
• Diagnostic use of lasers (‘optical biopsies’): Optical spectroscopy and Optical Imaging
• Optical trapping / micromanipulation of cells
• Novel technologies and applications

APSC 452. Networks in the Brain and Biology. Spring (3) Del Negro

This course is a survey of networks in the brain and related physiological systems. Topics include mechanisms of cell-cell communication and collective emergent properties in natural systems, analyzed using graph theory and modeling approaches. Applications include simple neuronal networks in mammals and invertebrates, cardiac tissue, the pancreas, and small social networks of animals.

Specific topics covered in the course will include:

• Mechanisms and models of synaptic communication
• Modeling small networks of neurons
• Structural properties and connectivity patterns in neuronal networks
• Mechanisms of rhythm generation in brain networks
• Emergent properties in networks of interacting organisms (fireflies, termites, ants, etc.)
• Neuroendocrine networks at the intersection of brain and physiology

Continuing Undergraduate courses – 2006

301. Mechanics of Materials

Fall (3) Hinders (offered in Fall 2006)

Introduction to the concepts of stress and strain applied to analysis of structures. Development of problem solving ability for modeling and analysis of simple structures subject to axial, torsional, and bending loads, and physical intuition of realistic outcomes.

302. Applied Quantum Mechanics.

Spring (3) Vold (offered Spring 2006)

The applications of quantum mechanics to problems in materials science, with particular reference to quantum descriptions of solid state phenomena and the use of spectroscopy as a tool for materials characterization.

312. Medical Imaging.Spring

(3) Hinders. Prerequisites: PHYS101/102 or PHYS107/108. (not offered in 2005-06)

Introduction to the modern clinical non-invasive diagnostic imaging techniques. The course will cover the physical, mathematical and computational principles of x-ray, ultrasound, radionuclide and magnetic resonance imaging techniques.

401,402. Research in Applied Science.

Fall or Spring (1-3,1-3) Staff. Prerequisites: permission of the instructor.

Independent experimental or computational research under supervision of a faculty member. Hours to be arranged.

403,404. Independent Study in Applied Science.

Fall or Spring (1-3,1-3) Staff. Prerequisites: permission of the instructor.

Independent study under supervision of a faculty member. Hours to be arranged.

411. Polymer Science I.

Fall (3) Starnes. Prerequisites: CHEM209, CHEM301.

An introduction to the chemical aspects of polymer science at the molecular level. Topics include the preparation, modification, degradation and stabilization of polymers. Reaction mechanisms are stressed.

412. Polymer Science II.

Spring (3) Kranbuehl. Prerequisite: CHEM301.

An introduction to the physical aspects of polymer science at the molecular level. Topics include the properties of polymers in building and in solution, conformational analysis, viscoelasticity and rubber elasticity.

416. Polymer Laboratory.

Spring (1) Orwoll. Prerequisite or Corequisite: APSC 411 or APSC 412.

A series of experiments in polymer synthesis, solution characterization, and mechanical and thermal properties of polymers.

422. Introduction to Materials Characterization.

Spring (3) Kelley. Prerequisite: Background in physical sciences.

Science and technology of determining surface and bulk structure and composition of organic and inorganic materials under instrument and 'in-situ' conditions. Examples chosen appropriate to class interests.

431. Applied Cellular Neuroscience.

Fall (3). Del Negro. Prerequisit:e BIOL 345, BIOL 447. Corequisite: BIOL 447 (optional).

We examine cellular neurophysiology including membrane potentials, ion channels and membrane permeability, electrical signaling and cable properties, synaptic transmission, neuromodulation, and second messenger systems. We apply these concepts to motor control, homeostatic regulation, special senses.

432. Applied Systems Neuroscience.

*Spring (3). Del Negro. Prerequisites: BIOL 345**, BIOL 447, PSYC 313 . Corequisite: BIOL 447 (optional).***

We explore how behaviors arise due to multiple levels of organization in the nervous system. Topics include: reflexes, central pattern generator networks, neural control of breathing, the neural control of appetite, body weight, and obesity, and the neuropharmacology of nicotine addiction.

446. Introduction to Mathematical Physics.

Spring (3) Staff.

Vector analysis, complex variables, matrices, and series solutions of differential equations, orthogonal functions and partial differential equations. (Cross listed with PHYS475)

451. Cellular Biophysics and Modeling.

Spring (3) Del Negro Prerequisite: MATH111, MATH112 or 113.

An introduction to simulation and modeling of dynamic phenomena in cell biology and neuroscience. Topics covered will include the biophysics of excitable membranes, the gating of voltage- and ligand-gated ion channels, intracellular calcium signaling, and electrical bursting in neurons.

452 Networks in the Brain and Biology

Spring (3) Del Negro (offered Spring 2006)

A survey of networks in the brain and related physiological sytems. Topics include mechanisms of cell-cell communication and emergent properties in graph theory and applications in simple neuronal networks in mammals and invertebrates, the heart and the pancreas.

454. Introductory Bioinformatics.

Spring (3) Smith. (Not offered 2005-2006). *Prerequisite: MATH111, MATH112 or 113, BIO 203, CSCI 141 or permission of instructor.*

An introduction to the basic algorithms of computational molecular biology including nucleotide and amino acid sequence comparison, DNA fragment assembly, phylogenetic tree construction, and RNA and protein secondary structure prediction.

474. Continuum Mechanics.

Spring (3) Hinders. (not offered in 2005-06)

This course covers the basic concepts of mechanics and thermodynamics of continua, including conservation of mass, momentum and energy; stresses and strains; viscous fluids, elasticity and thermal stresses; viscoelasticity and creep; ultimate failure; introduction to plasticity; elastic waves and elastodynamics.

490. Studies in Applied Science.

Fall and Spring (1-5) Staff.

Advanced or specialized topics in Applied Science. Subjects, prerequisites, credits and instructors may vary from year to year. Course may be repeated for credit if the instructor determines that there will not be a duplication of material.

492. Global Changes.

Spring (3) Levine. Prerequisites: PHYS101 and 102, or CHEM103 and one 200-level course or higher, or GEO 101 and one 200-level course or higher. (not offered in 2005-06)

The impact of human activities on the global Earth system; i.e., the atmosphere, the oceans, the land, and the biosphere and the physics and chemistry of global atmospheric change will be considered.

494. Climate: Science and Policy.

Spring (3) Levine. Prerequisites: PHYS101 and 102, or CHEM103 and one 200-level course or higher, or GEO 101 and one 200-level course or higher. (not offered in 2005-06)

The scientific factors and processes that control climate will be examined. Climate change and its societal implications will be assessed. Ways to mitigate climate change via scientific and policy approaches will be discussed.

†495-496. Honors.

Fall, Spring (3). Staff. Prerequisite: Senior standing, an overall GPA of 3.0, and consent of the instructor.

Independent laboratory or computational research in applied science under the supervision of a faculty member. Students are required to write an Honors thesis based on a review of the literature and their research. For College provisions governing the Admission to Honors, see p. 54.

†498. Internship.

Fall, Spring and Summer (1-5) Bradley, Staff.

Research in accelerator science, atmospheric science, polymer science or quantitative materials characterization at the NASA-Langley Research Center in Hampton or the Thomas Jefferson National Accelerator Facility (TJNAF) in Newport News. Approval of the Chair of Applied Science is required prior to enrollment.