SCHOOL OF PLANT AND ENVIRONMENTAL SCIENCES

Our Website (http://www.spes.vt.edu)

Overview

The School of Plant and Environmental Sciences increases the University's capacity to tackle challenges in agriculture and food security, the green industry, plant biology, and the environment. Currently, the School offers two undergraduate degrees and seven majors: 1) Crop and Soil Sciences, 2) Ecological Restoration, 3) Environmental Horticulture, 4) Environmental Science, 5) Integrated Agriculture Technologies, 6) Landscape Design and Turfgrass Science, and 7) Plant Science.

Degree Programs

Environmental Science

The Environmental Science degree program brings the basic sciences to bear on many crucial concerns about the environment. The environments of particular interest are terrestrial and wetland ecosystems and associated land and water resources. Specific concerns include environmental protection, pollution prevention and remediation, land-use planning, waste management, ground- and surface-water quality, reclamation and remediation of disturbed or contaminated sites, and minimizing human impacts on the environment.

Plant Science

The Plant Science degree program trains students to improve the productivity, utilization, and sustainability of plants grown for human use. Students obtain a thorough education in the applied plant sciences related to the major disciplinary areas in our School - Crop and Soil Sciences, Environmental Horticulture, Landscape Design and Turfgrass Science, and Plant Science.

Majors

Crop and Soil Sciences

Crop and Soil Sciences major prepares students for graduate school and crop-related management careers in the private and public sectors. Students in this major learn the principles of crop production, soil science, nutrient management, and pest management to improve the productivity of large-scale field crops while protecting the environment.

Ecological Restoration

Ecological Restoration is the process of guiding the recovery of degraded or destroyed ecosystems in agricultural, urban, and mined landscapes and associated waters. Students in the Ecological Restoration major engage in a structured program of learning that moves from introductory courses in the biological and physical sciences to courses in soil science, ecology, geology, plant science, and ecological restoration. The curriculum accommodates both in-class and field-based learning and was designed in conjunction with the Society for Ecological Restoration's Certified Ecological Restoration Practitioner In-Training program (CERPIT).

Environmental Horticulture

Horticulture is an applied plant science that covers the study of ornamental plants, floriculture, and intensively managed crops like fruits and vegetables. In addition to plant science, students also learn about principles of greenhouse management and other controlled environmental agriculture systems (e.g., vertical farming). The program covers a range of applied and basic environmental plant science topics, from plant-soil interactions, biotechnology, landscape design, sustainable urban landscaping, urban forestry, crop production, and plant breeding.

Environmental Science

The Environmental Science curriculum is multidisciplinary and strongly science and technology oriented. Students learn about preserving, protecting, and remediating resources and the ecosystems that provide them. Our rigorous program has established an excellent reputation among employers and our graduates are in great demand primarily working in environmental engineering fields, environmental consulting, and various governmental agencies.

Integrated Agriculture Technologies

The Integrated Agriculture Technologies major seeks to prepare a new generation of students that will work in the applied plant sciences using advanced technologies to improve plant productivity and protecting the environment. Students learn to work with drones, robots, environmental sensors, satellite imaging, and data analytics to improve the sustainability field crops and horticultural systems. Students in the major gain a unique combination of technological know-how and extensive practical knowledge in the plant and soil sciences.

Landscape Design and Turfgrass Science

Landscape Design and Turfgrass Science major learn to design, build, and manage beautiful and functional landscapes using science-based practices that improve the living environment and contribute to environmental sustainability. Students choose a concentration area that best meets their chosen career path- Landscape Design or Turfgrass Management. Students in the Landscape Design concentration learn principles related to the design, installation, and maintenance of different types of landscapes in the public and private sectors. Students working in Turfgrass Management concentration learn principles related to the care and management of lawns, landscapes, golf courses, and athletic fields.

Plant Science

The Plant Science major prepares students for graduate school and careers in the private and public sectors working in the fields of plant breeding, biotechnology, plant pathology, and weed science. Students learn principles of plant biology, molecular biology, biochemistry, plant genetics, and crop breeding and apply these to better understand how to improve plant productivity and sustainability.

Minors

The School offers minors in Crop and Soil Environmental Sciences, Environmental Science, Horticulture, Plant Health Sciences, Turfgrass Management, Viticulture, and Wetland Science. The course requirements for each vary and include a required course (s) plus 15 or 16 more credit hours selected from courses from within and outside the department. Consult the department office (330 Smyth) or the "Minors" section in the Academic Catalog navigation.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (https://

catalog.vt.edu/undergraduate/undergraduate-policies/)") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the applicable program curriculum page.

Opportunities to Excel

Students with outstanding records can qualify for the Honors Program and graduate "in honors" in crop and soil environmental sciences. Other opportunities for personal and professional growth and for recognition include Agronomy Club, Environmental Student Organization, Horticulture Club, and Turf Club. Membership in Alpha Zeta, Gamma Sigma Delta, Pi Alpha Xi or other honoraries, and several scholarships are also available. Many students participate in internships that are commonly available in the respective disciplines.

Graduate courses and research opportunities lead to M.S. and Ph.D. specializations in the Crop, Soil, and Environmental Sciences, Horticulture, and Plant Pathology and Weed Science. (See the Graduate Catalog (https://catalog.vt.edu/graduate/) for more information.)

- Crop and Soil Sciences Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/crop-soil-sciences/)
- Ecological Restoration Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/ecological-restoration-bs/)
- Environmental Horticulture Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/environmental-horticulture-bs/)
- Environmental Science Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/environmental-science-bs/)
- Integrated Agriculture Technologies Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/integrated-agriculture-technologies/)
- Landscape Design and Turfgrass Science Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/landscape-design-turfgrass-science/)
- Plant Science Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/school-plant-environmental-sciences/plant-science/)

Head: Michael Evans
Associate Director for Undergraduate Programs: Benjamin Tracy (231.8259, bftracy@vt.edu)
Professors: A. O. Abaye, E. Beers, J. F. Derr, M. J. Eick, J. D. Eisenback, G. K. Evanylo, J. H. Fike, J. M. Goatley Jr., C. Hong, C. S. Johnson, D.B. Langston Jr, R. O. Maguire, J. M. McDowell, A. Niemiera, M. A. Saghai Maroof, D. G. Schmale III, T. Thompson, B. F. Tracy, B. A. Vinatzer, G. Welbaum, J. H. Westwood, M. Williams, K. Xia
Associate Professors: S. D. Askew, B. D. Badgley, M. Balota, J. N. Barney, A. B. Baudoin, E. Colláková, M. L. Flessner, W. H. Frame, J. M. Galbraith, D. Holshouser, J. G. Jelesko, S. Li, G. Pilot, M.S. Reiter, S. L. Rideout, R. Stewart, X. Wang, C. A. Wilkinson, and B. Zhao
Assistant Professors: B. Bargmann, P. Brown, D. C. Haak, D. S. McCall, M. Nita, B.B. Posadas, A. Possinger, J. L. Reid, J. Samtani, D. Sandor, N. Santantonio, H. Seyyedhasani, S. Shafian, S. Sherif, V. Singh, K. South, M. Steele, and B. Zhang
Affiliate Professor: A. Pereira
Adjunct Professors: J. Atland, M. Chaungsheng, K. Da, Y. Dan, B. Flinn, R. F. Follett, Z. Liu, S. Lowman J. E. Perry III, P. J. Thomas, R. W. Tiner, M. J. Vepraskas, and S. Zhang
AP Faculty Professional: S. Douglas, J. Freeborn, S. Gugercin, L. Fox, A. Straw, and A. Vallotton
Instructors: J. Kardos, B. Leshyn, and L.R. Salamanca
Special Research Faculty: E. A. Bush, S. Y. Park, and E. Unglesbee

Undergraduate Course Descriptions (CSES)

CSES 2224 - Foundations of Precision Agriculture (3 credits)
Integrated technologies in the plant and environmental sciences including: global positioning systems (GPS), geographic information systems (GIS), remote and proximal sensing, variable rate technology (VRT) and decision support systems (DSS). Application to site-specific nutrient, water, weed and disease management.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2244 - Agriculture, Global Food Security and Health (3 credits)
Agriculture and food security within the larger context of applied agronomy, gender role, cultural and political aspects of food production, food policy, production contraints, and global population growth. Emphasis on gender iniquity and globalized food systems will be made. Service learning experience both local and global to promote career opportunity in international development.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2434 - Crop Evaluation (2 credits)
Identification of more than 200 crops, weeds, seeds and crop diseases. Seed testing for purity according to the rules of the Association of Official Seed Analysts. Crops graded according to the official USDA grain grading standards.
Instructional Contact Hours: (6 Lab, 2 Crd)

CSES 2444 - Agronomic Crops (3 credits)
An introduction to crop production in Virginia, presenting basic climatic, crop, and soil characteristics and their relation to cropping systems. Introduces basic mechanical, chemical, and managerial tools of crop production and examines feed quality and seed and forage storage.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2564 - Turfgrass Management (3 credits)
Growth, development, adaptation, and selection of the major turfgrass species. Principles of establishment, mowing, nutrition, irrigation, cultivation, and pest control of lawns and utility turfs.
Corequisite(s): BIOL 1105
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3114 - Soils (3 credits)
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant-and earth-science majors. Partially duplicates 3134.
Prerequisite(s): CHEM 1036
Corequisite(s): CSES 3124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOS 3614

CSES 3124 - Soils Laboratory (1 credit)
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134.
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: GEOS 3624

CSES 3144 - Soil Description and Interpretation (3 credits)
Describing, classifying, evaluating, and interpreting soil and site properties in the class and field. Local field trips supplement lecture and laboratory studies. Required for students interested in attending soil judging contests.
Corequisite(s): CSES 3114, CSES 3124
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

CSES 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3304, GEOS 3304

CSES 3564 - Golf and Sports Turf Management (3 credits)
Principles of turfgrass science and culture required for successful establishment and management of intensely utilized fine golf and sports turf surfaces. Pre: CSES 3564 or equivalent turfgrass science fundamentals course from transfer institution.
Prerequisite(s): CSES 2564
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3614 - Soil Physical and Hydrological Properties (3 credits)
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance.
Prerequisite(s): (CSES 3114 and CSES 3124) or (GEOS 3614 and GEOS 3624)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4064 - Soil Microbiology (3 credits)
Soil microbes as determinants of plant growth, sustainable agricultural systems, and global nutrient cycles. Environmental controls of soil microbes and relationship to soil decomposition. Soil as a micro-habitat. Application to soil management and plant growth, plant-microbe mutualisms, probiotics, biocontrol, composting, ecosystem restoration, and disease suppression.
Prerequisite(s): BIOL 1105 and (CSES 3114 or ENSC 3114 or GEOS 3614) or (CSES 3134 or ENSC 3134)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4134 - Soil Genesis and Classification (3 credits)
Formation of soils across landscapes, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4144 - Plant Breeding and Genetics (3 credits)
Genetic variation in plants and its importance in plant breeding, and comparisons of theories and procedures in breeding of self-pollinated versus cross-pollinated plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4174 - Soil Evaluation and Sampling (3 credits)
Naming, describing, classifying, sampling, and interpreting soil and site properties in the field to assess environmental impacts and suitability under specific land use scenarios. Selecting and evaluating sites of representative soil resources across the landscape using accepted professional protocols, simulating workplace responsibilities and performance. Local and regional field trips and sampling projects provide professional skill development evaluated by practitioners and potential employers.
Prerequisite(s): CSES 3114 or CSES 3144
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4214 - Soil Fertility and Management (3 credits)
Soil productivity and nutrients required for crop growth; fertilizer sources and nutrient reactions in soil; methods of fertilizer nutrient placement in major tillage systems; and interpretation of soil tests and plant analyses for determining crop nutrient requirements.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4224 - Applied Concepts in Precision Agriculture (3 credits)
Advanced applications of core components and technologies used for integrated plant and environmental studies. Global Navigation Satellite Systems (GNSS), remote sensing technologies, Geographic Information Systems (GIS), soil sampling, yield monitoring, and analysis and decision-making systems applied for site specific management of production agriculture resources.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4234 - Agro Data Integration (3 credits)
Data science applications in the agricultural sciences. Data pipelines and modern Linux, cluster and cloud-based computing environments. Command line interface and shell scripting. Programming and data processing in Python programming language. Data analysis and visualization in R programming language. Agronomic data analysis and data mining.
Prerequisite(s): CSES 2224 and CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4334 - Principles and Practice of Agroforestry (3 credits)
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4334

CSES 4344 - Crop Physiology and Ecology (3 credits)
Developmental and ecological processes important in cropping situations: seed physiology, root and canopy development, flowering, water stress, energy flow, competition; emphasis on physiological adaptations, limitations to yield, and yield-optimizing strategies.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4354 - Advanced Agronomic Crops (3 credits)
Survey of major agronomic crops grown in the Eastern US and their production including: corn, soybean, wheat, barley, cotton, peanut, tobacco and alfalfa. Covers impact of environmental conditions and management on crops, resource requirements for productivity, and effects on soil resources.
Prerequisite(s): CSES 2444
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4524 - Drone Applications in Ag Systems (3 credits)
Unmanned Aerial Systems (UAS) or drones as an advanced remote sensing technology to collect ultra-high spatial resolution images. Exploration of components of drones and sensors in laboratory setting. UAS operational concepts, and legal requirements, principles of drone data collection and drone platforms. Overview of data processing software and generation of land maps from drone photogrammetry. Image analysis to make recommendations for water, nutrient and pesticide applications.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4534 - Internet of Things (IoT) for Smart Farming (3 credits)
Internet of Things (IoT) technology in the plant and environmental sciences and applications to smart-farming ecosystems and agricultural industry. IoT platforms and systems used in smart farming programs related to field equipment management, IoT components, data management, and cybersecurity. Applying wireless sensors, controllers, computers, actuators, and software via wireless network devices.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4544 - Forage Crop Ecology (3 credits)
Species adaptation interrelated with soil, climatic, and biotic factors as associated with establishment, production, utilization, and nutritional value of forages.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4854 - Wetland Soils and Mitigation (3 credits)
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4864 - Capstone: Crop & Soil Sciences (3 credits)
Experiential and discussion-based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan that is defended orally. Review available careers in the crop and soil sciences. Compose and critique resumes and cover letters. CSS majors only. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (ENSC)

ENSC 1015 - Foundations of Environmental Science (3 credits)
Interrelationships between human activities and the environment; emphasis on biological, chemical, and physical principles that govern the flow of energy, materials, and information among physical, ecological and human systems.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 1016 - Foundations of Environmental Science (3 credits)
National and global perspective on societal concerns about the environment and human sustenance, including agriculture. Emphasizes the relationship between human systems and natural systems; ecosystem services and land, water and atmospheric resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 3134 - Soils in the Landscape (3 credits)
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ENSC 3604 - Fundamentals of Environmental Science (3 credits)
Interrelationships between human activities and the environment; provides national and global perspective; emphasis is on the physical, chemical, and biological principles and processes that are essential to an understanding of human-environment interactions; the role of energy in human and natural systems; environmental legislation and human behavior.
Prerequisite(s): BIOL 1105 or CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3634 - Physics of Pollution (3 credits)
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3644 - Plant Materials for Environmental Restoration (3 credits)
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils.
Prerequisite(s): BIOL 1106
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: BIOL 4164

ENSC 4244 - Ecological Restoration (3 credits)
Process of assisting the recovery of degraded ecosystems by linking ecological concepts to restoration interventions. Invasive species management, revegetation methods, soil and water quality, faunal restorations. Restoration project design, planning, monitoring and implementation.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4314 - Water Quality (3 credits)
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies.
Prerequisite(s): MATH 1026 or MATH 1226 and (BIOL 1105 or BIOL 1106) and (CHEM 1035 or CHEM 1036)
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4344 - Ecological Restoration Field Practicum (2 credits)
Hands-on experience in planning ecological restoration projects, designing ecological restoration strategies, preparing degraded sites for restoration, managing invasive species in ecological restoration projects, implementing ecological restoration techniques, and monitoring restoration outcomes in degraded sites. Additional topics include adaptive management, stakeholder relationships, effective communication in ecological restoration projects, and challenges and barriers to restoration success.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (2 Lec, 2 Crd)

ENSC 4414 - Monitoring and Analysis of the Environment (2 credits)
Provides comprehensive hands-on-laboratory-and field-based experience and information on the principles and methods for field monitoring and sampling, as well the physical, chemical, and biological analysis of soil, surface water, groundwater, and solid wastes within the context of regulatory compliance. Optional 40-hour Hazards Materials (HAZMAT) training will be available. Senior standing required.
Prerequisite(s): (ENSC 3604 or ENSC 4314 or CSES 4314 or BIOL 4004) and (MATH 1026 or MATH 2015 and CHEM 1036 and BIOL 1105)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ENSC 4734 - Environmental Soil Chemistry (3 credits)
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 and CSES 3124 or ENSC 3124 or GEOS 3624 and CHEM 2514 or CHEM 2535 and CHEM 2114 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 4734

ENSC 4764 - Bioremediation (3 credits)
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4774 - Reclamation of Drastically Disturbed Lands (3 credits)
Remediation, rehabilitation, revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and materials analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134 or CSES 3304 or GEOG 3304 or GEOS 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (HORT)

HORT 1264 - Landscape Skills Practicum (1 credit)
Relevant skills important for the success in the landscape industry. Safe equipment operation, landscape, irrigation and hardscape installation, management and estimating techniques, marketing and sales strategies, and arboriculture methods.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 2134 - Plants and Greenspaces in Urban Communities (3 credits)
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2134

HORT 2144 - Indoor Plants (3 credits)
Basic horticultural principles, identification and cultural criteria applicable to foliage and flowering plants grown indoors. Specific plant groups discussed include ferns, cacti and succulents, and carnivorous plants, among many others.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2164 - Floral Design (3 credits)
Fundamental art theory, historical and cultural influences, tools and techniques as applied to current floral art. Emphasis on applied experiential learning through designing, building and producing acceptable floral displays for home and public environments. Sustainable and ethical practices in growing and purchasing flowers. Fee $128.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 2184 - Plants, Places, and Cultures in a Global Context (3 credits)
Impact of worldwide production and trade in fruits, vegetables, and cut flowers (horticultural commodities) on societies, cultures, economies, politics, and environment. Case studies covering history, economics, social/cultural impacts of producing fruit, vegetables, tea, coffee, and other horticultural crops in producing and consuming countries. Case studies illustrate inextricable interactions and interconnectedness between horticultural crops and cultures.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2224 - Horticulture Science and Industry (2 credits)
Survey course of horticultural crops (fruits, vegetables, ornamentals) and enterprises. Includes plant science and business aspects of horticultural production and service industries, and introduces related issues and emerging technologies such as work force characteristics, organic production, and biotechnology. I.
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 2234 - Environmental Factors in Horticulture (3 credits)
Principles and practices in managing environmental factors - temperature, water, light, atmospheric gases and pollutants, and soil and minerals - that influence growth and production of horticultural plants.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2244 - Plant Propagation (3 credits)
Principles and practices of plant propagation by sexual and asexual methods.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

HORT 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 2304

HORT 2834 - Sustainable Agriculture Practicum (3 credits)
Hands-on training in sustainable agricultural production at a student-operated vegetable and fruit farm. Participation in tasks required in managing a diversified sustainable horticulture operation, including planting, pest management, irrigation, and post-harvest handling. Discussion of soil fertility, planning, efficiency, food safety and community food systems. May be repeated with different content, for a maximum of 6 credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

HORT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 3114 - Wines and Vines (3 credits)
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 3114

HORT 3324 - Herbaceous Landscape Plants (3 credits)
Identification, growing requirements, culture, landscape use, physiology, and propagation of native and non-native herbaceous landscape plants for temperate environments. Ornamental annuals and perennials; cultivated wildflowers, plants for wetland and aquatic systems.
Prerequisite(s): HORT 2244
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3325 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3326 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3354 - Trees in the Built Environment (3 credits)
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment.
Prerequisite(s): (FREC 2314 or BIOL 2304 or HORT 2304) and (FREC 2324 or HORT 3325 or HORT 3326)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3354

HORT 3664 - Hardscape Materials and Installation (2 credits)
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction methods, and business aspects required for hardscape construction.
Prerequisite(s): HORT 2224
Instructional Contact Hours: (6 Lab, 2 Crd)

HORT 4205 - Public Gardens Maintenance and Management (1 credit)
4205: Principles and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Pre: Junior standing required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4206 - Public Gardens Maintenance and Management (1 credit)
4205: Principals and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Junior status required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4324 - Greenhouse Management (3 credits)
For persons who intend to manage or advise those managing commercial or institutional greenhouses. Includes greenhouse construction, environmenal controls, disease/insect identification and management, control of plant growth, root-zone management, and marketing and management principles specific to greenhouse operations. Pre: Coursework or experience in plant growth and environmental management required.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4334 - Greenhouse and Controlled Environment Agriculture Management (3 credits)
Managing commercial or institutional greenhouses and/or controlled environment operations. Construction, environmental controls, disease/insect identification and management, control of plant growth, root-zone management. Marketing, accounting, and management principles specific to greenhouse and controlled environment operations.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4344 - Production of Food Crops in Controlled Environment Agriculture (3 credits)
Controlled environment agriculture. Study of major hydroponic systems used in the production of horticultural food crops. Crop life cycles, nutrient requirements. Cost analysis and troubleshooting common problems that arise in controlled environment systems.
Prerequisite(s): HORT 4334
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4504 - Landscape Contracting (2 credits)
Capstone course for students entering the landscape contracting industry. Includes contracts, site plan interpretation, cost estimation and bidding, project sequencing, business marketing, irrigation design, and current issues. Emphasis on real-world skills and problem solving. Pre: Senior Standing Required.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HORT 4545 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4546 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction. 4545, I; 4546, II.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to address complex ecological city design and planning problems at a variety of scales. Pre: Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, LAR 4554, SPIA 4554

HORT 4614 - Ornamental Plant Production and Marketing (3 credits)
In-depth production and marketing of woody and herbaceous plants in wholesale nursery and floriculture/greenhouse and related retail outlets. Includes production laboratory.
Prerequisite(s): HORT 2234 and HORT 2244 and HORT 4324 and AAEC 2434
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 4654 - Viticulture (3 credits)
Overview of grapevine growth and development, factors affecting yield and grape quality, and regional industry. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4764 - Vegetable Crops (3 credits)
A comprehensive study of major and minor vegetable crops of Virginia, the U.S., and world in relation to production practices, crop development, nutritional value, and quality characteristics.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4784 - Vegetable Seed Production (2 credits)
The study of production agriculture or reproductive biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology. Pre: 4764 or 2244 or equivalent experience in vegetable crops, plant propagation, or plant growth and development.
Prerequisite(s): HORT 4764 or HORT 2244
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4794 - Medicinal Plants and Herbs (3 credits)
Comprehensive study of medicinal plants/herbs history, production, processing, lore and documented scientific benefits. Traditional plant medicinal practices of Native Americans, Chinese, Indians, European and African cultures will be contrasted with use of contemporary herbal products.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (PPWS)

PPWS 2004 - Mysterious Mushrooms, Malicious Molds (3 credits)
Study of the fungi and their close relatives, with special attention to their roles in the natural world and in shaping the course of human history. Historical and practical significance of fungi as sources of medicine, pathogens of plants and animals, rotters and decayers of organic matter, makers of food and drink, manufacturers of dangerous toxins, and producers of mind-altering chemicals. A student must have a basic understanding of biology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2104 - Plants, Genes, and People (3 credits)
Explores how and why humans have manipulated plant genomes from prehistory through the current genomic era by examining the scientific, cultural, historical, and legal aspects of plant gene management in both conventional and transgenic crops.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2754 - Weeds That Shape Our World (3 credits)
How weeds shape our world, and why society will never get rid of them. Introduction to weed identification, weeds in their socio-cultural, environmental, and economic context. Consideration of the tension among their beneficial aspects, control, human attitudes, and the ethical dilemmas they post to society.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4104 - Plant Pathology (4 credits)
Introduction to plant pathology as a science and a crop protection discipline. Plant disease diagnosis, biology, and identification of plant disease-causing agents, factors leading to disease build-up, and management of plant diseases. Diseases of specific crops are studied as examples to illustrate general principles.
Prerequisite(s): (BIOL 1005 or BIOL 1105) and (BIOL 1006 or BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PPWS 4114 - Microbial Forensics and Biosecurity (3 credits)
Concepts of comparative and evolutionary genomics for pathogen characterization and identification taught through case studies of bioterrorism, involuntary and voluntary disease transmission, infectious disease epidemics, and genetically modified organisms; emphasis placed on unambiguous source attribution of a disease outbreak to a particular microbe, risk assessment, response as individual, community, and nation to a bioterrorism attack or disease outbreak, federal biosecurity regulations, and career opportunities.
Prerequisite(s): BIOL 2604 or PPWS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 4154 - Plant Problem Diagnosis (3 credits)
Plant problem diagnosis in the laboratory and field, including recognition of disease, insect and abiotic (nonliving) problems, as well as the major groups of plant pathogens of a variety of regionally important horticultural and agronomic crops. General management options for pests and pathogens.
Corequisite(s): PPWS 4104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4264 - Pesticide Usage (3 credits)
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENT 4264

PPWS 4604 - Biological Invasions (3 credits)
Broad overview of the causes, consequences, and epidemiology of invasive plants, animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day, covering the invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment will be covered via case studies, within a policy context.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (SPES)

SPES 1004 - First Year Seminar (1 credit)
Exploration of topics related to the School of Plant and Environmental Sciences from a multidisciplinary perspective focusing on communication and teamwork, problem-solving, inquiry, and digital literacy.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPES 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2004 - Cannabis - Science, Industry, and Culture (3 credits)
Major crops in the genus Cannabis (hemp and marijuana). Historical development, botanical aspects, and current research. Medicinal, recreational and industrial products and their use. Legal, cultural, political and socioeconomic issues surrounding cannabis crops.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 2014 - Professional Development Skills (1 credit)
Professional development skills and planning for undergraduates in the School of Plant and Environmental Sciences (SPES). Explore career opportunities and resources available at Virginia Tech. Improve professional communication skills, resume and cover letter writing, and learning plans for experiential learning opportunities.
Prerequisite(s): SPES 1004
Instructional Contact Hours: (1 Lec, 1 Crd)

SPES 2244 - World Crops: Food and Culture (3 credits)
How to feed the world in 2050, world crops, primary regions of production, factors that determine where they are grown, economic importance, and use in the human diet. Linkage between food and culture, recipe preparation, and their role in defining who we are, where we come from, and what we have experienced along the way. Tracing of food migration and the African, Caribbean, Asian, Latin American, and European influence on the American cuisine. The universality of food and how every single culture and religion uses food as part of the celebration of life, death, and many cultural events.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SPES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

SPES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4014 - Career Development and Planning (1 credit)
Professional development and skills gained during School of Plant and Environmental Sciences (SPES) experiential learning program. Linking experiential learning to future career planning and selection. Reflection on SPES curriculum and experiential learning as a path to fulfilling career goals. Explore role of mentoring and leadership in career development.
Prerequisite(s): SPES 2014
Instructional Contact Hours: (1 Lec, 1 Crd)

SPES 4114 - Topics: StudyAway: Production, Culture and Social Aspects US Agriculture (3 credits)
Experiential learning, hands-on and face-to-face experience with agricultural industries involved in food production, marketing and consumption. Comparative analysis of agriculture production history, practices and constraints in different regions of the US. The course has two components. One; the in-class (onsite) discussion, analysis, and comparison of the diverse agricultural production systems between Virginia and, two; the studying “away” part (Example, California, Arizona, the Mississippi Delta). Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 4864 - Plant Sciences Capstone (2 credits)
Writing and discussion-based learning synthesizing prior knowledge gained in Plant Science degree program. Practice in science-based expository writing and speaking applied to undergraduate coursework, undergraduate research, or work-related experience in the Plant Sciences. Restricted to students in Plant Science degree program. Pre: Junior or Senior standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

SPES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course