COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

GRADUATE PROGRAMS

- **Agricultural and Resource Economics (MS)**
- **Agricultural Education (MA)**
- **Animal and Food Sciences (MS, PhD)**
- **Bioresources Engineering (MS)**
- **Entomology and Wildlife Ecology (MS, PhD)**
- **Operations Research (MS, PhD)**
- **Plant and Soil Sciences (MS, PhD)**
- **Public Horticulture (Longwood Graduate Program) (MS)**
- **Statistics (MS)**

The College of Agriculture and Natural Resources offers graduate education through all of its academic departments: Animal and Food Sciences, Bioresources Engineering, Entomology and Wildlife Ecology, Food and Resource Economics, and Plant and Soil Sciences. Each department offers programs leading to the Master of Science degree; additionally, programs leading to the Doctor of Philosophy degree are offered in Animal Science, in Entomology and Wildlife Ecology, Operations Research, and in Plant and Soil Sciences. The College manages an MS degree program cooperatively with Longwood Gardens in the area of Public Horticulture. Additionally, the MA degree is offered in Agricultural Education through the Department of Food & Resource Economics.

The College is interested in attracting highly qualified students with a desire to enter into research and teaching. Professors are formally responsible for research projects in the Delaware Agricultural Experiment Station, and students often move into a facet of an established research project. Close association with the departmental research program affords opportunities to broaden a student's perspective of the research process. Each department has several areas of focus within the discipline.

The Department of Animal and Food Sciences has three graduate degree offerings: the PhD in Animal Science, the MS in Animal Science and the MS in Food Science. In Animal Science, a student may specialize in animal physiology and nutrition; avian microbiology, immunology and pathology; avian molecular biology, genomics, and bioinformatics; and ruminant nutrition, microbiology, and physiology. The MS program in Food Science emphasizes food safety with a focus on food processing and packaging.

The Department of Bioresources Engineering offers a MS degree in Bioresources Engineering and research opportunities through the Operations Research program (see Food & Resource Economics) with studies involving soil and water resources, or environmental issues.

The Department of Entomology and Wildlife Ecology offers graduate opportunities in both applied and basic research dealing with insects, birds, mammals, and other wildlife. Areas of emphasis include ecology, plant-insect interactions, biological control, and conservation biology.

The Department of Food and Resource Economics offers areas of study in quantitative economics, international agricultural trade, economic development, resource economics, marketing and policy. Also housed in the department is the Statistics program, which offers an MS in Statistics, and the interdisciplinary Operations Research program, which offers the MS and the PhD.

In Plant and Soil Sciences, areas of study include plant breeding, tissue culture, molecular biology, pathology, plant improvement, physiology and horticulture. In Soil Science the areas are soil chemistry, biochemistry, microbiology and management. A specialized MS program, the University of Delaware/Longwood program in Public Horticulture is a 2-year Master's degree program requiring a thesis.

The College of Agriculture and Natural Resources houses modern research laboratories and equipment in Worrilow Hall, Townsend Hall, the Charles C. Allen, Jr. Laboratory, the Fischer Greenhouse Laboratory, the Delaware Biotechnology Institute, and other buildings located on the Delaware Experiment Station. Field plots, a 35-acre woodlot, and animal research facilities are available for graduate research. An excellent library and computing site are located in the college. For more information, please see http://ag.udel.edu.

AGRICULTURAL EDUCATION

Telephone: (302) 831-1357
http://ag.udel.edu/

PROGRAM OVERVIEW

The Agricultural Education Program offers a Master of Arts (MA) degree that qualifies the individual for initial teacher certification in the areas of agricultural and natural resources education. Recent undergraduate students or career changers in the areas of agriculture and natural resources or in various technology fields are likely candidates for this degree program.

The pragmatic, hands-on program provides pedagogical skills and uses an investigative, scientific, design-and-construct, and problem solving approach to teaching. The curriculum is designed to allow students to teach in both the classroom and laboratory setting.

REQUIREMENTS FOR ADMISSION

In addition to the general graduate admission requirements of the University, all applicants are required to have satisfactorily

completed an approved undergraduate baccalaureate program of study and may not be certified or employed as a teacher. For students lacking appropriate preparatory course work, additional courses applicable to certain areas of study may be required prior to admission, or students may be admitted with the provision that certain content courses be completed concurrent with the courses in the degree program. On a 4.0 system, applicants must have a general undergraduate academic index of 2.5 and a minimum 2.75 index in their major field of study. Applicants must have a combined score of at least 1050 on the verbal and quantitative portions of the GRE. Students for whom English is not their first language must attain a minimum score of 600/250/100 on the paper based/computer based/IBET TOEFL examination. All students must provide three letters of recommendation from individuals able to assess the applicant's academic potential. The deadline for application is April 2 of each year. Admission to graduate programs at the University of Delaware is selective and competitive based on the number of well-qualified applicants and the limits of available faculty and facilities. Those who meet stated minimum academic requirements are not guaranteed admission, nor are those who fail to meet those requirements necessarily precluded from admission if they offer other appropriate strengths.

Requirements For The MA Degree

Students are required to complete a minimum of 33 credit hours, including 21 credit hours of professional education courses, 9 credit hours of an Internship in Teaching, and a three credit Student Teaching Seminar, which is the final requirement for the degree. The Internship in Teaching is a placement in a middle and/or secondary school and, with the degree, prepares a student for initial certification in Agricultural and Natural Resources Education. To be awarded the degree, students must achieve a cumulative GPA of 3.0 on a 4.0 scale for all graduate course work taken and a minimum grade of B in AGED 600 (Internship in Teaching).

Animal And Food Sciences

Telephone: (302) 831-2524
http://ag.udel.edu/
Faculty Listing: http://ag.udel.edu/anfs/faculty/facultyStaff.htm

Program Overview

The Department of Animal and Food Sciences offers three graduate degree programs: The Master of Science (MS) degree in Animal Science, the MS degree in Food Science and the Doctor of Philosophy (PhD) degree in Animal Science.

In Animal Science, research programs are offered in physiology; ruminant and poultry nutrition; microbiology, immunology and pathology; molecular biology, genomics, and bioinformatics.

In Food Science, research programs are offered in food bacteriology; virology and parasitology; food biochemistry; and food processing.

Research Facilities

Well-equipped laboratories for conducting research are located in Worrilow and Townsend Halls, the Allen Biotechnology Laboratory, the Delaware Biotechnology Institute (DBI), and the Delaware Agricultural Experiment Station Farm. The Allen Biotechnology Laboratory is a state of the art, biosafety level 2 and 3 facility for the study of conventional and highly pathogenic avian disease agents and recombinant poultry microorganisms. The department maintains dairy cattle, sheep, and poultry for graduate instruction and research on the Delaware Agricultural Experiment Station Farm. Students have access to supercomputers, servers and desk top computers for data collection, analysis and presentation and an excellent library in the College of Agriculture and Natural Resources.

Requirements For Admission

An applicant for graduate study in Animal and Food Sciences should have an appropriate background from the Baccalaureate degree, with a minimum cumulative grade point average of 2.75, and a 3.00 average in his/her major. Undergraduate preparation for most areas of study should include general and organic chemistry, biology/microbiology, biochemistry, physics, and calculus. For students lacking appropriate preparatory course work, additional courses applicable to certain areas of study may be required prior to admission. A Graduate Record Examination combined score (quantitative + verbal sections) of 1075 on the general exam is desirable. Exceptions may be made for students with special backgrounds, abilities, and interests. All students must provide three letters of recommendation from former professors, a completed Graduate Studies Application form, and a completed assistantship form if applying for financial aid. Foreign students must demonstrate competence in the use of the English language by a minimum score of 575/233/85 on the paper based/computer based/IBET TOEFL and provide evidence of sufficient financial support for the course of the degree program. Foreign students applying for a teaching assistantship must have a minimum score of 600/250/100 on the paper based/computer based/IBET TOEFL examination. Applicants may be requested to visit the department for a personal interview before a final decision concerning admission is made. Admission to the graduate program is dependent upon availability of an appropriate faculty advisor in the student's area of study.

Financial Aid

Please refer to the chapter "Graduate Fellowships and Assistantships" in this catalog.

Requirements For The Degrees In Animal And Food Sciences

The MS degree program in Animal Science and the MS degree program in Food Science require a minimum of 30 graduate credit hours of which six credits must be a master's thesis. The programs are usually expected to be completed in two years of full-time study. Students, with the assistance of their advisor, are required to prepare and present a research proposal to their graduate committee for review and approval of the proposed research project. Course selections are made with the approval of the student's graduate committee. Candidates for the MS degree are required to pass an oral examination on the thesis and allied areas of study. All students pursuing the MS degree will complete the following core courses; ANSC 865 Seminar and CHEM 527 Introductory Biochemistry or CHEM 641 Biochemistry, and a statistics course [FREC 608 Research Methods, FREC 806 Research Techniques and Procedures, or equivalent]. Attendance in Graduate Seminar (ANSC 865) is required each semester for all graduate students. Following completion of the research outlined in the proposal, the MS degree candidate will prepare a written thesis according to the guidelines set forth by the Office of Graduate Studies. A thesis defense, preceded by a seminar, will be held. The student's advisor and graduate committee will administer and evaluate the thesis defense.

The PhD degree program provides the necessary flexibility to design an appropriate plan of study and has only minimal course requirements. A doctoral committee will be appointed within six months following matriculation. The committee shall consist of between four and six faculty or professional members nominated by the graduate advisor and approved by the Department Chairperson. Participation from industry, government or other academic departments on the doctoral committee may be required depending

on the student's area of research. At least one member of the committee shall be from outside the Department of Animal and Food Sciences; however, not more than half of the committee members shall be from outside the Department. Departmental Adjunct Faculty shall be considered as "outside" members in their participation on doctoral committees. The committee is responsible for approving the student's course work and research program. The committee will prepare, administer, and evaluate the student's comprehensive and final examinations and will supervise and approve the dissertation. The student's faculty advisor serves as chair of the doctoral committee.

Core Courses and General Requirements. All students pursuing the PhD will complete the following core courses; ANSC 865 Seminar, ANSC 969 Doctoral Dissertation, CHEM 641 Biochemistry, CHEM 642 Biochemistry, and a statistics course [FREC 608 Research Methods, FREC 806 Research Techniques and Procedures, or equivalent]. Attendance in Graduate Seminar (ANSC 865) is required each semester for all graduate students. Beyond the core courses, no specific number of courses completed or credits earned are uniformly required. The student and advisor in concert with the doctoral committee will select appropriate course work based on the student's background and major and minor (if applicable) area(s) of specialization for the PhD Consideration will be given to the student's prior training and experience at the undergraduate (B.A. or B.S.) and MS and/or D.V.M. (if applicable) level(s). Students with more advanced training and experience will need fewer courses to complete their PhD program. General requirements for the PhD are based on a period of residency, writing of a satisfactory research proposal and dissertation, and passing the comprehensive and the final oral examinations. The candidate's doctoral program will consist of a combination of doctoral committee-approved formal courses, seminars, individual study, and research credits as needed by the student.

Research Proposal. Advancement to degree candidacy requires successful oral defense of a research proposal. The proposal will be submitted to the doctoral committee at least ten working days prior to the scheduled defense. The student will give an oral presentation summarizing the proposal. The committee members will question the student to verify that the student understands the research problem and the experimental approaches needed to address it. The committee will also ensure that the student has the proper training and resources to do the research. As a result of the meeting, the student may be required to revise the proposal and/or take additional course work. The research proposal defense should precede the comprehensive examination.

Comprehensive Examination. Successful completion of the comprehensive examination is required of all PhD students prior to their admission to candidacy. The examination normally is given to the student after completion of all course work and selection of a dissertation topic. The student is required to have a minimum grade point average of 3.0 at the time of the examination. The examination will cover the student's major and minor (if applicable) areas of study. Each member of the student's doctoral committee will submit examination questions to the student via the advisor who will administer the written portion of the comprehensive examination. Following completion of the written exam, the advisor will return the student responses to the appropriate committee member for their evaluation. Students passing the written examination may continue for the oral portion of the comprehensive examination generally given within one month of the completion of the written examination. In the oral portion of the comprehensive examination, the student must appear before all committee members and demonstrate competency in this forum. A favorable vote by a majority of the committee including the major advisor is required for passing. Based on the performance of the student in the comprehensive examination, the committee may recommend one of the following actions:

1. The student be admitted to candidacy, without qualification or subject to fulfillment of certain conditions.
2. The student be reexamined at later date.
3. The student be disapproved unconditionally for the degree.

Dissertation. The ability to conduct independent research and competence in scholarly writing must be demonstrated by the preparation of a dissertation on a topic related to the major area of specialization in accordance with the regulations of the Office of Graduate Studies. The contents and conclusions of the dissertation must be defended at the time of the Final Oral Examination (see below) and approved by the doctoral committee. Copies of the dissertation must be available in the departmental office at least ten working days before the date of the Final Oral Examination. Preparation of (a) manuscript(s) for publication of the information contained within the dissertation is expected prior to, or within one month after, approval of the dissertation by the committee at the Final Oral Examination.

Final Oral Examination. Upon recommendation of the doctoral committee, a Final Oral Examination of the dissertation will be scheduled for the doctoral candidate who has satisfied all other requirements for the degree. The examination must be scheduled at least three weeks prior to the time the examination is to be held. The examination shall be related in a large part to the dissertation but it may cover the entire field of study of the candidate. The examination will be administered by the student's doctoral committee. The student will give an oral presentation (seminar) summarizing the dissertation research. Committee members will question the student about the dissertation and related subject areas to verify that the candidate fully understands the research findings and their implications. A favorable vote of a majority of the members of the committee is required for passing. If the candidate fails, it is the responsibility of the doctoral committee to determine whether he/she may take another examination.

BIORESOURCES ENGINEERING

Telephone: (302) 831-2468
For more information, http://ag.udel.edu/
Faculty Listing: http://ag.udel.edu/breg/faculty/facultyStaff.htm

PROGRAM OVERVIEW

The Master of Science in Bioresources Engineering is a vibrant and diverse program that allows students to study land and water resources or plant and animal systems. The program especially encourages interdisciplinary education and research and provides the students with a greater choice and flexibility in shaping their education. Students are encouraged to address "real world" problems and participate in "hands-on" field and laboratory experiences so that they are better prepared to take on future challenges in industry, government, and academia.

RESEARCH AREAS

The BREG Masters Degree program focuses on two areas: land and water resources and plant and animal systems. Potential research areas for students concentrating on land and water resources include projects in nonpoint pollution, stormwater and watershed management, water quality modeling, bioremediation, land application of wastewater, irrigation water management and vegetative control on drainage ditches. Representative projects for students focusing on plant and animal systems include plant and animal systems includes projects on vegetable harvesting, mushroom environmental management, poultry house environmental management and sensor technology.

Research Facilities

The department maintains research laboratories equipped for soil and water analysis, machine design and fabrication, and applied poultry research in Worrilow Hall. Students have access to mainframe and microcomputers for data collection, analysis and presentation and an excellent library in the College of Agriculture and Natural Resources.

Requirements for Admission

An applicant for graduate study in Bioresources Engineering should have an appropriate Baccalaureate degree in engineering or a related field with a minimum cumulative grade point average of 2.80 and a 3.00 average in his/her major. Applicants should have a strong science or engineering background and have completed mathematics through differential equations. For students lacking appropriate preparatory course work, additional courses applicable to certain areas of study may be required prior to admission. A Graduate Record Examination combined score (quantitative + verbal sections) of 1050 on the general exam is desirable. Students need to supply a minimum of at least three letters of recommendation that address the student's likelihood of successfully completing graduate education from former instructors or supervisors. Exceptions may be made for students with special backgrounds, abilities, and interests. International students must demonstrate competence in the use of the English language by a minimum score of 550 / 213 on the paper based/computer based TOEFL. Admission to the graduate program may be dependent upon availability of an appropriate faculty advisor in the student's area of study.

Financial Aid

Graduate students in good standing generally receive financial support from a research assistantship, departmental assistantship or fellowship. Graduate students on an assistantship or fellowship are expected to give their full-time attention to graduate study. Please refer to the chapter "Graduate Fellowships and Assistantships" in this catalog.

Master of Science Degree Requirements

A minimum of 30 credits are required for the Bioresources Engineering Master of Science degree. It is to include 24 credits of approved course work and 6 credits of thesis (BREG 869). All students enrolled in the program will be required to take BREG 631 Experimental Methods for Engineers and a graduate level advanced mathematics or statistics course.

Students may choose their advanced mathematics or statistics course from the following list including, but not limited to:

CIEG 601	Introduction to the Finite Element Methods
CIEG 605	Intermediate Topics in Finite Element Analysis
MATH 503	Advanced Calculus for Applications
MATH 508	Introduction to Complex Variables and Applications
MATH 535	Introduction to Partial Differential Equations
MATH 611	Introduction to Numerical Analysis and Scientific Computing
MEEG 891	Advanced Engineering Mathematics
STAT 601	Probability Theory for Operations Research and Statistics
STAT 611	Regression Analysis
STAT 635	Statistical Quality Control
STAT 657	Statistics for Earth Scientists

Only graduate level courses (500-599), (600-699), (800-899) are applicable towards the course requirements. Selection of courses will be done in consultation with the chair of the thesis committee based upon the student's interest and area of research. The programs are usually expected to be completed in two years of full-time study.

Following completion of the research outlined in the proposal, the MS degree candidate will prepare a written thesis according to the guidelines set forth by the Office of Graduate Studies. A thesis defense, preceded by a seminar, will be held. The student's advisor and graduate committee will administer and evaluate the thesis defense.

Graduate students must maintain a minimum GPA of 3.00 to remain in good academic standing. GPA requirements are monitored by the Office of Graduate Studies according to the Graduate Studies Academic Probation Policy.

Entomology And Wildlife Ecology

Telephone: (302) 831-2526
http://ag.udel.edu/
Faculty Listing: http://ag.udel.edu/enwc/faculty/facultyStaff.htm

Program Overview

The Department offers programs leading to the Master of Science (MS) in Entomology, MS in Wildlife Ecology, and the Doctorate of Philosophy (PhD) in Entomology and Wildlife Ecology. Graduate students in these fields couple a focus on insects or vertebrates with a broad knowledge of other related fields of biology, especially ecology. The MS degree programs prepare students for pursuit of the PhD. While it is possible to go directly to the PhD program, the Department Faculty prefers that students complete the MS degree before being admitted or reclassified into the doctoral degree program in Entomology and Wildlife Ecology.

Research Facilities

Facilities to support graduate study in the department include laboratories; an insectary; programmed growth chambers; a greenhouse; field plots and a 35-acre woodlot on the experimental farm; collections of pinned, liquid, and slide specimens of insects, amphibians and reptiles; bird and mammal skins; a high performance liquid chromatograph; a thin layer chromatography scanning system; a capillary gas chromatograph; advanced optical systems; and an excellent library collection of pertinent journals and books. The USDA Beneficial Insects Introduction Research Unit located on the campus and several preserves, parks, and wildlife areas, research centers, governmental organizations, and companies located nearby offer additional opportunities for field and laboratory study.

Requirements For Admission

Minimum requirements for admission to the master's and doctoral degree programs are an undergraduate academic index of 2.8 overall and 3.0 in the major field of study and a combined score of 1050 on the verbal and quantitative portions of the GRE. Graduate GPA (if applicable) should be at least 3.2. A paper-based TOEFL score of at least 550 (or 213 computer-based, 79 on IBET) is required for international students. The Advanced GRE in Biology is required with a minimum score of 580 for PhD applicants.

Financial Aid

Graduate students in good standing generally receive financial support from a research assistantship, teaching assistantship or fellowship. Graduate students on an assistantship or fellowship are expected to give their full-time attention to graduate study. Please refer to the chapter "Graduate Fellowships and Assistantships" in this catalog.

Master of Science Degree Requirements

General requirements for both MS majors are: (1) completion of at least 30 graduate credit hours, including a thesis describing independent research (6 credit hours); (2) passing an oral, general knowledge examination centering on the student's program of study; (3) presenting the thesis research in a formal departmental seminar; and (4) passing a thesis defense. Students in the Entomology major also must pass an Insect Family Recognition Test.

Core MS Degree Courses for Both Majors

ENWC 814	Advanced Ecology	3
ENWC 870	Graduate Research Seminar	0
ENWC 888	Topics in Entomology & Wildlife Ecology	0
ENWC 869	Master's Thesis	6
A graduate-level statistics course		3

Entomology Major

ENWC 605	Insect Structure & Function	4
ENWC 606	Insect ID – Taxonomy	3
One other graduate level course primarily on insects		3

(Obtain list from department for qualified courses)

Wildlife Ecology Major

Two of the following:

ENWC 615	Wildlife Research Techniques	3
ENWC 618	Ornithology	3
ENWC 620	Behavioral Ecology	3
ENWC 624	Herpetology	3
ENWC 625	Mammalogy	3
ENWC 635	Wildlife Population Dynamics	3

Additional Coursework (both MS programs)

Students must earn additional graduate credit hours appropriate to the major to bring the total earned to at least 30 credits. A maximum of 3 credits in ENWC 666, 668, 866, and 868 and 6 credits of 869 can be applied to the degree.

Doctor of Philosopy Degree Requirements

Doctoral students entering the program with an MS must complete a total of at least 30 graduate credits.

Doctoral Students in Entomology and Wildlife Ecology must complete the following courses or their equivalent for both concentrations, either before or during their program at Delaware:

ENWC 814	Advanced Ecology	3
ENWC 870	Graduate Research Seminar	0
ENWC 888	Topics in Entomology & Applied Ecology	0
6 credits of graduate statistics (600-level or above)		6
9 credits of Doctoral Dissertation (ENWC 969)		9

Doctoral students must satisfy the requirements of at least one of two concentrations, Entomology or Wildlife Ecology, by completing the following courses or their equivalent under the selected concentration, either before or during their program at Delaware.

Entomology Concentration

ENWC 605	Insect Structure & Function	4
ENWC 606	Insect ID – Taxonomy	3
One other graduate level course primarily on insects		3

(Obtain list from department office for qualified courses)

Wildlife Ecology Concentration

Two of the following:

ENWC 615	Wildlife Research Techniques	3
ENWC 618	Ornithology	3
ENWC 620	Behavioral Ecology	3
ENWC 624	Herpetology	3
ENWC 625	Mammalogy	3
ENWC 635	Wildlife Population Dynamics	3

If any of the above course requirements are completed before starting the PhD program, substitute courses counting toward the total minimum credits must be approved by the student's graduate committee. Students entering with a B.S. must complete a total of at least 60 graduate credits while enrolled in the program. A maximum of 3 credits in ENWC 666, 668, 866, 868, and 9 credits of 969 can be applied to the doctoral degree.

Food And Resource Economics

Telephone: (302) 831-2511
http://ag.udel.edu/
Faculty Listing: http://ag.udel.edu/frec/faculty/facultyStaff.htm

The Department of Food and Resource Economics administers graduate programs in Agricultural and Resource Economics, Operations Research, and in Statistics.

Agricultural And Resource Economics

Program Overview

The program in Agricultural and Resource Economics leads to the Master of Science degree and offers students the perspectives and skills necessary to understand and work in the agribusiness or government sectors of the economy. Also, a strong intermediate level of training is offered so that students may continue graduate work and obtain the PhD degree. The department has ready access to computer terminals for mainframe computer connection and microcomputers.

Requirements For Admission

Students making application are required to have satisfactorily completed an approved undergraduate program of study. On a 4.0 system, applicants must have a general academic index of 2.5. Students who have an academic index below 2.5 may be granted provisional admission if they have Graduate Record Examination scores above 1050 with good letters of reference. Students for whom English is not their first language must attain a minimum score of 550/213/79 on the paper based/computer based/IBET on the TOEFL examination. Admission is selective and competitive based on the number of well-qualified applicants and the limits of available faculty and facilities. Those who meet stated minimum academic requirements are not guaranteed admission, nor are those who fail to meet those requirements necessarily precluded from admission if they offer other appropriate strengths.

Requirements For The Degree

Students are required to complete a minimum of 30 credit hours including either a thesis or a non-thesis option. Under the thesis option, students complete 24 hours of course work and 6 hours of thesis work. Under the non-thesis option, students complete 27 hours of course work and 3 hours of a directed project. All students must take ECON 801 and either ECON 552 or ECON 802. All students must take four of the following quantitative courses: FREC 608, FREC 615, FREC 674, FREC 682, FREC 801, ECON 822 and ECON 823. Students writing a thesis must take two 800-level FREC courses while students under the non-thesis option must take three 800-level FREC courses from the following: FREC 810, FREC 826, FREC 827, and FREC 834. In addition, no more than three credits of independent study may be taken unless approved by the department chair, advisor and the department graduate committee. Agricultural and resource economics courses taken previously may partially meet the requirements if they do not count towards the fulfillment of another degree.

The student plans a course program in consultation with the major professor, in order to attain competency in economics, quantitative methods, and agricultural and resource economics.

Students must achieve an overall index of 3.0 on a 4.0 scale for all graduate course work taken. The student's progress toward the degree will be monitored by the academic adviser and the department graduate committee.

A student choosing the thesis option is required to prepare a thesis that reflects a substantive analysis of a subject in the field of agricultural and resource economics. An oral examination covering both course work and thesis will be given to determine whether the student has a breadth of understanding of the field. A student selecting the non-thesis option is required to complete a directed research project to be presented at a department seminar.

Operations Research

Telephone: (302) 831-6242
http://ag.udel.edu/frec/grad/ORprograms.htm

Program Overview

The Operations Research Program at the University of Delaware is an interdisciplinary graduate program, drawing its faculty and students from various participating academic units that include: the College of Agriculture and Natural Resources (Bioresources Engineering and Food and Resource Economics), the College of Business and Economics (Business Administration and Economics), the College of Engineering (Civil and Environmental Engineering and Electrical and Computing Engineering), the College of Arts and Sciences (Computer and Information Sciences, Mathematical Sciences), the College of Human Services, Education and Public Policy (School of Urban Affairs and Public Policy), and the College of Marine and Earth Studies. Programs of study are tailored to student and faculty interests and emphasize research and internship. Course work includes a core in operations research, mathematical optimization, statistics, and applied probability, in addition to supporting courses related to areas of application.

Requirements For Admission

Admission to the Operations Research Program is selective and competitive based on the number of well qualified applicants and the limits of available faculty and facilities. Those applicants who meet the stated minimum academic requirements are not guaranteed admission, nor are those applicants who fail to meet those minimum requirements necessarily precluded from admission if they offer other appropriate strengths.

A student must have a minimum average grade of B in undergraduate studies with a grade of B or higher in calculus and linear algebra and a minimum combined verbal and quantitative score of 1150 on the Graduate Record Examination. Foreign students must have a minimum TOEFL score of 600/250/100 on the paper based/computer based IBET for admission to the Operations Research Program, and are encouraged to take the TSE.

Students should send all application materials to the office of Graduate Studies. The Director of Operations Research will assist the applicant in selecting a suitable home department (unit). Applicants should meet that unit's admission requirements. For fall admission, the application deadline is April 1. For spring admission, the application deadline is October 1.

Financial Aid

Various forms of partial and comprehensive financial aid are available on a competitive basis to students with excellent credentials. Applications for aid should be made along with the application for admission. At present, a high proportion of full time students receive some financial support after having initially established very good academic records in the Operations Research Program at the University of Delaware. In most cases, individual home departments (units) are responsible for granting assistantships.

Teaching assistantships and research assistantships provide a stipend plus full tuition for fall and spring semesters. Additional stipends are sometimes available for summer. Students on teaching or research assistantships work up to 20 hours per week (partially funded students work 10 hours per week) and are expected to maintain full time status (9 credit hours per semester). Teaching assistants help with departmental instruction. Research assistants typically work on faculty research projects. Assistantships are normally awarded on the semester basis, are reviewed after each semester, and are renewed if the student's overall performance (academic performance and work responsibilities) in the program is satisfactory.

A graduate assistant financially supported by the home department has the obligation to work for and finish his or her degree in that department. If, in an exceptional and compelling case, a transfer is in the interest of all parties (current and future home department, the OR Program, and the student), an orderly transfer should be sought after discussion among the principals involved.

Students can also work for 20 hours per week during the academic year and 40 hours during the summer and Winter Sessions as corporate interns in the Corporate Operations Research Program (CORP). The intern's performance is evaluated each semester and the internship is continued subject to performance, availability of funds, and corporate needs. Normally, students intern after their first year of study. Interns are expected to maintain full-time graduate student status. In most cases internships are paid work experiences and if the company participates in the CORP program the tuition for interns is borne by the University.

Requirements For The Degrees

Students should acquire through the program:

1. Standard working knowledge of OR models and solution techniques including:
   a. assumptions and limitations of models
   b. an understanding of why analysis of a model should yield the results received
   c. ability to question results for consistency and logic
   d. appreciation of sensitivity analysis
2. Art of model building (i.e., ability to fit models to problems)
3. Computer skills (such as programming and software applications)
4. Presentation skills
5. Appreciation of recent literature on:
   a. A problem domain of student's choice and
   b. Advances in an OR technique and relations to practical problem solving.

The student is encouraged to select an advisor among the affiliated or core faculty at the early stage of enrollment. The director of the program will assist in the search. After the first semester, but no later than during the second semester, a student should have an advisor for course selection and thesis/dissertation purposes. Changes in the advisor are possible with special justification, but all concerned, including the director of the program, must agree. The program encourages co-advisors for students, if it is in their interest.

The Master's Program allows students to take either of the thesis or non-thesis option. The thesis option requires a research-oriented thesis (six credits) and course work including the ORES 600 level sequence, OR related courses, two semesters of seminar attendance, and course offerings in the area of application, for a total of 33 credit hours. A thesis committee consisting of at least four members, two of which are OR faculty, should be formed after the first year of study to advise the candidate and administer the thesis defense exam. One member should be external to the student's home department. The non-thesis option requires an internship and a related report in place of the thesis. Students can also participate in a formalized internship program called CORP (Corporate Operations Research Program). Students in this program usually intern at the corporation during the academic year (September to May), for 20 hours per week and for 40 hours per week during the Summer and Winter sessions.

The PhD Program prepares well qualified students for management, research or teaching careers in industry, government or academia. Dissertations for the PhD degree are a blend of empirical and theoretical research combining OR methodologies with application from a particular discipline. A dissertation committee consisting of at least five members, three of whom are OR faculty, should be formed after the second year of study to advise the candidate and administer the final dissertation defense exam. The

degree requires at least 51 credit hours, with nine credits fulfilling the dissertation requirement and the remainder about equally divided among OR related courses and course offerings from the area of application. PhD candidates must take the ORES 800 level course sequence and register for two semesters of seminar attendance. Comprehensive exams are administered in three areas (OR and two of the student's chosen concentration areas) after a majority of the course work has been successfully completed.

Statistics

Requirements For Admission

Candidates for admission to the statistics program need not have majored in any specific undergraduate field as a prerequisite for admission. However, competence is expected in linear algebra, advanced calculus, and computer programming. On a 4.0 system, applicants should have a GPA of at least 2.5 and an average of at least 3.0 in mathematics and related areas. Applicants who have completed an advanced degree must have done so with a GPA of at least 3.0. In addition, applicants must take the GRE Aptitude Test.

Requirements For The Master's Degree In Statistics

Candidates for the MS degree choose one of the following programs:

I. Master's with Thesis
II. Master's without Thesis
III. Master's Internship Program

The student pursuing any of these programs must complete the following courses:

1. STAT 601, STAT 602, STAT 603, STAT 611, STAT 615 and STAT 617.
2. Three semesters of the one credit-hour course STAT 641 (Statistical Laboratory).

A student who has taken any of the 600 level statistics requirements as an undergraduate must substitute other statistics courses subject to his or her advisor's approval.

Program I

In addition to the required courses above, Program I requires six additional credits of course work and six hours of thesis credits. The department maintains a list of approved courses. The completed thesis will be presented at a departmental seminar.

Program II

In addition to the required courses above, Program II requires 12 additional credits of course work. The department maintains a list of approved courses.

Program III

In addition to the required courses above, Program III requires six additional credits of course work and six hours of internship credit. The department maintains a policy for internship requirements and procedures.

Plant And Soil Sciences

Telephone: (302) 831-8153
http://ag.udel.edu/
Faculty Listing: http://ag.udel.edu/plsc/faculty/facultyStaff.htm

Program Overview

The Department of Plant and Soil Sciences offers graduate programs that lead to degrees of Master of Science and Doctor of Philosophy in plant and soil sciences. The objectives of the programs are to equip the student with background and techniques necessary for degree completion, opportunities for advanced study in the plant and soil sciences, and for job placement.

In addition to modern research facilities in Worrilow Hall and at the Delaware Biotechnology Institute (DBI), special items available for student research include field, state-of-the-art greenhouse and growth chamber facilities, radioisotope room, scintillation counters, gas and liquid chromatographs, x-ray diffractometer, Fourier transform infrared spectrometer, pressure-jump relaxation apparatus, atomic absorption spectrophotometers, inductively coupled plasma spectrometer, low- and high-speed centrifuges, microtomes, electrophoretic apparatus, cold rooms, atomic force and electron microscopes, carbon-nitrogen-sulfur analyzer, and gene sequencers.

Requirements For Admission

Students seeking admission must provide Graduate Record Examination scores, grade transcripts, evaluation by three professionals, evidence of English language proficiency for applicants whose native tongue is not English, and a completed Graduate Studies application form. A member of the department also must agree to serve as the faculty advisor or rotation coordinator for the student.

Financial Aid

Please refer to the chapter "Graduate Fellowships and Assistantships" in this catalog.

Requirements For The Degrees

A minimum of 30 semester hours is required for the Master of Science degree, to include 24 semester hours of approved course work and 6 hours of thesis 869. All MS students must take a minimum of 12 hours in one of two research areas (plant biology or soil science), and they must register in PLSC 802 Professional Development. In addition to the University general requirements for advanced degrees, the awarding of the Master of Science degree is contingent upon an approved research proposal, the successful oral defense of research performed, and an acceptable thesis. A non-thesis Master's degree is also offered. Students must complete 30 credits of coursework, present a seminar (PLSC 865) that is based on a required independent study project (PLSC 666), complete PLSC 802, and pass an oral examination administered by the student's graduate advisory committee at the end of the degree program. Advancement to PhD degree candidacy is contingent upon an approved research proposal and successful completion of written and oral qualifying examinations administered by the student's advisory committee. There is no minimum number of course credits required, but candidates must register for nine credits of Dissertation (969), must register for PLSC 802 Professional Development, and must present an acceptable dissertation.

An approved program of study is required for all degrees. The program is developed with close supervision and assistance of a faculty adviser and advisory committee and arranged according to the academic and professional needs of the student. The program is usually developed by the end of the first semester of study. There is no language requirement other than English proficiency for the Master of Science or Doctor of Philosophy degree.

Public Horticulture (Longwood)

Telephone: (302) 831-2517
http://www.udel.edu/longwoodgrad

Program Overview

The Graduate Program in Public Horticulture was established at the University in 1967 with the support of the Longwood Foundation. The Program is thesis driven and leads to the Master of Science degree; it is unique in its educational approach to leadership in the public horticulture profession. Graduates have found employment in

arboreta, botanical gardens, display gardens, horticultural societies, Cooperative Extension, park systems, and garden-related foundations. Graduate Fellows participate at the University in an academic course of study tailored to their individual needs, and they may choose to take courses to prepare for a PhD program. Additionally, all students work closely with the management staff in administration, business, education and visitor services, horticulture and maintenance at Longwood Gardens. This joint effort of the University and Longwood Gardens uniquely prepares students for professions in a wide variety of careers in public horticulture.

Students participate in symposium planning, a multi-week internship in an international region, as well as intensive visits to North American institutions with public horticulture emphasis. A generous stipend is an integral part of the Fellowship and all tuition is paid by the Program.

Requirements For Admission

Applicants should demonstrate experience and interest in public horticulture and leadership potential. Applicants should submit a Graduate Record Examination combined score (verbal and quantitative) of at least 1050, an analytical writing score of at least 3, three letters of recommendation, and one official transcript of the undergraduate record. Admission is selective and competitive. Those who meet stated minimum academic requirements are not guaranteed admission, nor are those who fail to meet those requirements necessarily precluded from admission if they offer other appropriate strengths. Applicants must apply on-line via the UD Graduate School, which can be accessed from the Program's website.

Financial Aid

All students admitted to the Program are awarded a Longwood Fellowship that provides a stipend and tuition scholarship for two years.

Requirements For The Degree

The following is required for the Master of Science degree in Public Horticulture

PLSC 630	Collections Management and Curation	3
PLSC 832	Botanic Garden Management, Section 11	3
PLSC 864	Seminar Planning and Development	1+1
PLSC 868	Research	4
PLSC 869	Master's Thesis	2
MSST 802	Leadership and Management of Museums	3
MSST 804	Museum Internship	3
Research Methodology or Statistics Course		3
Another Museum Studies Course		3
Management and Leadership Courses		12
Total Credits		**38**

Longwood Fellows may, with the assistance of their research committee, choose other course credits from disciplines that will support the research area.

The Program begins July 1. Fellows participate directly in staff rotations associated with the daily operations of Longwood Gardens during the first summer. Academic study begins at the University with the opening of the fall term.