Environmental and Water Resource Engineering (EWRS)

Graduate Programs for Civil and Environmental Engineering

The Environmental and Water Resources Systems (EWRS) Engineering area program represents one of the major areas within the School of Civil and Environmental Engineering. Research activities in this area address the development and application of quantitative systems methods for the analysis, evaluation, planning, and operation of water resource and environmental systems.

Courses and research consider the integration and analysis of systems engineering and of economic-policy issues posed by the need to manage water, land, air and human resources, as well as environmental remediation efforts. Such analyses are based upon an understanding of hydrology, hydraulics, environmental sciences, biology and environmental engineering. For this reason, we frequently interact with the other environmentally-orientated groups within our School and within the Dept. of Biological and Environmental Engineering, as well as with other departments in the College of Agriculture and Life Sciences.

The analytical methods employed to address environmental issues fall within the realm of systems sciences, which include operations research, computer science, statistics, risk analysis, economics and engineering management. By examining engineering, socio-economics, ecology, and public policy issues using analytic model-oriented frameworks, EWRS projects strive to develop and communicate estimates of the impact and risks of alternative decisions to the many stakeholders associated with environmental management issues. Members of the EWRS faculty are also members of the CEE Schools' Engineering Systems and Management (ESM) mission area. EWRS students often take courses offered by that group. The Operations Research department and the Applied Systems Engineering Program within the Engineering College provides additional opportunities.

Student projects in the EWRS area have addressed regional water resources management issues in across the US, North Africa, Europe and parts of Asia including the Mekong basin and China. Projects have developed specialized software packages for visualization, water resources system simulation, support of negotiations, multi-objective analysis, stochastic stream flow generation, and flood frequency analysis that have been used around the world.

The beginning of the 21st century is a time of quantum leaps in computing technology. At the same time, local and national governments face tight budgets. As a whole, society has a desire for economic efficiency and sustainability, an interest in the intelligent use of environmental resources, and a concern for risks to human health. Energy generation and climate change are important international issues with local impacts. This is the challenge and the opportunity for environmental systems engineering, and is why this is an important and promising area for study and research.

With these goals in mind, the EWRS program seeks to advance the quality and capability of analytical methodologies for environmental management and to facilitate the application of such techniques to the solution of real problems. In collaboration with faculty from fields across the Cornell campus, research and course offerings represent one of the strongest environmental systems programs in the country.

Cornell University offers 3 degree programs in EWRS: Master of Engineering (Civil), Master of Science, and Doctor of Philosophy. The ME(C) is a compact and intense program that students usually complete in one year. They can go on to a PhD program here or elsewhere. The orientation is often more toward engineering practice, and an engineering project is a key part of the program.

The MS program is orientated toward research and is generally a two-year program. The PhD program has a strong research emphasis. Most students in the MS/PhD and PhD programs currently receive financial support in the form of a fellowship, research assistant or teaching assistant. Two-year MS programs have more time than those in the ME(C) professionally-orientated degree, which allows for a wider range of courses and the experience of a research-orientated thesis. Funding is very limited for 2-year MS candidates, and such students are often directed to the 1-year ME(C) degree program.

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Additional information can be found at:
http://www.cee.cornell.edu
http://www.cee.cornell.edu/cee/research/environment.cfm?area=112

Faculty

The EWRS faculty is committed to providing the highest quality graduate education and to preparing engineers and scholars who will educate the students of the future, placing them on the cutting edge of developments in their fields. Faculty associated with the EWRS program include:

Oliver Gao
- Transportation, air quality and energy systems and their interactions
- Transportation/environment planning and clean transportation-energy alternatives
- Emissions and health impacts of transportation-fuel technologies
- Mathematical models and statistical data analysis

Douglas Haith
- Environmental Systems Analysis
- Land Disposal of Wastes
- Nonpoint Source Water Pollution
- Solid Waste Management

Peter Loucks (emeritus)
- Water Resource and Environmental Management Systems
- Interactive Simulation Modeling
- Decision Support Systems
- Sustainability and Water Resource Management

Patrick Reed
- Water Resource and Environmental Management Systems
- Multi-objective planning and management
- Evolutionary computation and high-performance computing
- Uncertainty and decision making

Christine Shoemaker
- Water Resource and Water Quality Modeling
- Modeling Groundwater Contamination and Remediation
- Pesticide Source Reduction
- Optimization Algorithms and Supercomputing

Jery Stedinger
- Water Resource Systems Operations and Planning
- Risk Analysis
- Environmental Statistics
- Flood Risk Management

Master of Engineering ME(C) Degree Program

The ME(C) degree program in Environmental Systems Engineering is a professionally-oriented graduate program preparing students for careers in an environmental engineering firm or in government service. It may be used as an entry program before a subsequent research degree, such as the PhD.

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Candidates without a Civil or Environmental Engineering bachelor's degree may need to include courses that provide needed background. This is a way for individuals without an accredited engineering Bachelor of Science degree to earn a Master of Engineering degree.

ME(C) degree requirements consist of 30 semester hours of graduate-level courses or courses beyond the equivalent of the typical undergraduate civil engineering curriculum.

ME(C) students can take one three-hour project course, or a six-hour two-course engineering design project sequence. In the design project, students work on a realistic engineering systems problem, often in cooperation with a consulting firm or government agency. In total, students must take a minimum of 30 semester hours of technical course work, generally 5000, 6000 and 7000-level courses. A strength of our ME(C) program is its roots in all of our environmental engineering programs, coupled with support from the engineering management program in the School of Civil and Environmental Engineering.

Master of Engineering ME(C) Degree Program

Master of Engineering students majoring in Environ. Systems Engineering should take 5 courses in the EWRS major area, generally including CEE 5930 and at least 2-3 others from of the following list:

CEE 5930 (Fall) Engineering Management Methods: Data, Information, and Modeling

CEE 5970 (Spring) Risk Analysis and Management

CEE 5980 (Fall) Decision Analysis

CEE 6200 (Spring) Water-Resources Systems Engineering

CEE 6550 (Fall) Transport, Mixing, & Transformation in the Environment

CEE 6650 (Spring) Transportation, Energy and the Environment

BEE 4730 (Fall) Watershed Engineering

BEE 6880 (Spring) Applied Modeling and Simulation for Renewable Energy Systems

Students and their advisors should decide upon additional courses. Suitable courses include those above and:

CEE 4540 (Fall) Sustainable Municipal Drinking Water Treatment

CEE 5290 (Fall) Heuristic Methods for Optimization

CEE 6360 or 6370 (Spring) Environmental Fluid Mechanics

CEE 6100 (fall) Remote Sensing Fundamentals

CEE 6530 (fall) Water Chemistry for Environmental Engineering

BEE 4740 (Spring) Water and Landscape Engineering Applications

NTRES 3240 (Spring) Sustainable, Ecologically Based Management of Water Resources (S)

AEM 6510 (Spring) Environmental and Resource Economics

Students should also take the fall and spring seminar series listed in the sample program below.

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Graduate Programs for Civil and Environmental Engineering

Sample of ME(C) EWRS Degree Program

Fall Semester

CEE 5010 (3 Credits) Design Project

CEE 5930 (3 Credits) Engineering Management Methods: Data, Information, and Modeling

CEE 4540 (3 Credits) Sustainable Municipal Drinking Water Treatment

CEE 6550 (3 Credits) Transport, Mixing, and Transformation in the Environment

BEE 4730 (3 Credits) Watershed Engineering or **CEE 5980** (3 credits) Decision Analysis

CEE 6010 (1 Credit) Environmental Seminar

Spring Semester

CEE 5020 (3 Credits) Design Project II

CEE 5970 (3 Credits) Risk Analysis and Management

CEE 6200 (3 Credits) Water-Resources Systems Engineering

CEE 6310 (3 Credits) Computational Simulation of Flow and Transport in the Environment

AEM 6510 (4 Credits) Environmental and Resource Economics

CEE 6280 (1 Credit) Environmental and Water Resources Systems Analysis Seminar

MS Graduate Programs

At Cornell, MS and PhD programs are administered by the Graduate School, which is subdivided into over 90 fields or subject areas. The Graduate School sets no course, credit-hour or grade requirements. It leaves such responsibilities to each student's Special Committee. Thus, the MS and PhD programs are very flexible and can be tailored to each student's background and objectives.

Candidates for the MS degree choose two (or more) faculty members to serve as their Special Committee representing a major and at least one minor study area. The Special Committee approves the student's course program, oversees the thesis work, and administers the final examination for the Master's Degree. The Special Committee provides considerable guidance to graduate students. Students are free to change their Committee members when and as appropriate.

(1) Course work, which is generally required by the special committee, depends upon a student's background, educational objectives, and the proposed research area. Often a student will take 5 courses as part of their major, and 2-3 courses in a minor area. Courses listed at the end of this document describe opportunities that reflect different interest areas.

(2) A research thesis, an intensive report or an independent study that is normally a research project. The topic of the thesis should be of mutual interest to both the student and the Special Committee. Information on faculty research interests is available at *www.cee.cornell.edu*. For students in the MS/PhD program, the MS thesis can be a precursor to topics covered in more depth in the PhD thesis. Funding is very limited for 2-year MS program.

Environmental and Water Resource Engineering (EWRS)

Graduate Programs for Civil and Environmental Engineering

Doctor of Philosophy (PhD)

The PhD program in EWRS prepares students for research careers in universities or in government agencies and consulting firms. It is a demanding program that ultimately assures a mastery of the major subject area. Candidates must exhibit the ability to grasp theoretical concepts, to apply such concepts in the management of the environment, and to undertake independent research of high caliber.

The PhD program, like the MS program, is administered by the Graduate School and the student's Special Committee. There are no absolute course or grade requirements, because the program is individualized. Students choose at least three faculty to serve as the Special Committee. The Committee Chairman must be chosen from the EWRS faculty.

The Committee administers three required examinations: (1) the Qualifying Exam, (2) the Examination for Admission to PhD candidacy, and (3) the Final Examination for PhD candidates. They also ap- prove course work in support of the major areas, examine the student's qualifications, oversee the dissertation, and recommend that the degree be awarded when earned. Most students do an MS before the PhD. An example of the first year of course work for an MS is given above. The typical time for a student with an assistantship to do an MS, followed by a PhD, is about five years, although some students have been able to complete the program more quickly.

Course work, which may be required, depends on a student's background, as well as the particular research project selected. Doctoral students are expected to demonstrate the ability to pursue the PhD program during the Qualifying Exam, some- time at the end of the first year of study, and to demonstrate knowledge of the major subject material during a comprehensive written and oral Admission-to-Candidacy exam at the end of the formal course work.

Graduate Elective Courses in EWRS

One of the strengths of Cornell's graduate pro- gram in EWRS engineering is the abundance of supporting courses offered by other units within the University, as well as by CEE's faculty. A course catalog is available upon registration or on -line at www.cornell.edu/academics/courses.cfm. Students should review this catalog to identify elective courses of possible interest. Courses taken by graduate students in EWRS include:

Applied Systems Engineering

SYSEN 5100 ... Applied Systems Engineering (F)
SYSEN 5200 ... Systems Architecture, Behavior, and Optimization (S)
SYSEN 5300 ... Systems Engineering for Design of Reliable Systems (F)

Biological and Environmental Engineering

BEE 3710 ..... Physical Hydrology for Ecosystems
BEE 4010 ..... Renewable Energy Systems (S)
BEE 4730 ..... Watershed Engineering (F)
BEE 4740 ..... Water and Landscape Engineering Applications (S)
BEE 4760 ..... Solid Waste Engineering (S)
BEE 4800 ..... Our Changing Atmosphere: Global Change and Atmospheric Chemistry (F)
BEE 4870 ..... Sustainable Bioenergy Systems (F)
BEE 6510 ..... Analysis of the Flow of Water and Chemicals in Soils (F)
BEE 6740 ..... Ecohydrology (S)
BEE 6880 ..... Applied Modeling and Simulation for Renewable Energy Systems (S)

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Applied Economics and Management
AEM 6510 ..... Environmental and Resource Economics (S)
AEM 6600 ..... Agroecosystems, Economic Development, and Environment (S)
AEM 7010 ..... Econometrics I (S)
AEM 7110 ..... Econometrics II (F)
AEM 7510 ..... Environmental Economics (S)

City and Regional Planning
CRP 3800..... Environmental Politics (S)
CRP 4440..... Resource Management and Environmental Law
CRP 5190..... Urban Theory and Spatial Development (S)
CRP 5440..... Resource Management and Environmental Law (S)
CRP 6700..... Regional Planning and Development in Developing Nations (F,S)

Environmental Engineering
CEE 4510..... Microbiology for Environmental Engineering (F)
CEE 4540..... Sustainable Municipal Drinking Water Treatment (F)
CEE 4550..... Aguaclara: Sustainable Water Supply Project (F)
CEE 6530..... Water Chemistry for Environmental Engineering (F)
CEE 6550..... Transport, Mixing, and Transformation in the Environment (F)
CEE 6570..... Biological Processes (S)
CEE 6580..... Biodegradation and Biocatalysis (S)

Computer Science-Numerical Analysis
CEE 6310..... Computational Simulation of Flow and Transport in the Environment (S)
CS 4210 ..... Numerical Analysis and Differential Equations (F)
CS 6210 ..... Matrix Computations (F)
CS 6220..... Data-Sparse Matrix Computations (F)

Earth & Atmospheric Sciences
EAS 2680..... Climate and Global Warming (S)
EAS 3030..... Introduction to Biogeochemistry (F)
EAS 4350..... Statistical Methods in Meteorology and Climatology (F)
EAS 4570..... Atmospheric Air Pollution (F)
EAS 5051..... Climate Dynamics (F)
EAS 5350..... Statistical Methods in Meteorology and Climatology (F)
EAS 6660..... Applied Multivariate Statistics

Economic & Econometrics
ECON 3130 ..... Intermediate Microeconomic Theory (F, S)
ECON 3140 ..... Intermediate Macroeconomic Theory (F, S)
ECON 6090 ..... Microeconomic Theory I (F)
ECON 6190 ..... Econometrics I (F)
ECON 6200 ..... Econometrics II (S)
ECON 7190 ..... Advanced Topics in Econometrics I (F)

Engineering Management
CEE 4630 ..... Future Transportation Technologies and Systems (F)
CEE 5900 ..... Project Management (F, S)
CEE 5930 ..... Engineering Management Methods: Data, Information, and Modeling (F)
CEE 5970 ..... Risk Analysis & Management (S)
CEE 5980 ..... Decision Analysis (F)
CEE 6900 ..... Creativity, Innovation and Leadership (S)

Environmental and Water Resource Engineering (EWRS)

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Envir. Fluid Mechanics and Hydrology
EAS 4710 ..... Intro Groundwater Hydrology (S)
CEE 4350 ..... Coastal Engineering (S)
CEE 6310 ..... Computational Simulation of Flow and Transport in the Environment (S)
CEE 6360 ..... Env. Fluid Mechanics (S; alternate years with 6370)
CEE 6370 ..... Experimental Methods in Env. Fluid Dynamics (S)

Natural Resources
NTRES 3240 - Sustainable, Ecologically Based Management of Water Resources (S)
NTRES 4220/4221 - Wetland Ecology Lecture/laboratory (F)
NTRES 4560 - Stream Ecology (F)
NTRES 6200 - Spatial Modeling and Analysis (S)
NTRES 6700 - Spatial Statistics (S)

Operations Research & Information Engineering
CEE 5290..... Heuristic Methods for Optimization (S)
OR&IE 5300 ..... Operations Research 1: Optimization I (F)
OR&IE 5310 ..... Optimization II (S)
OR&IE 5550 ..... Applied Time-Series Analysis (F)
OR&IE 5580 ..... Simulation Modeling & Analysis (F)
OR&IE 6300 ..... Mathematical Programming I (F)
OR&IE 6310 ..... Mathematical Programming II (S)
OR&IE 6510 ..... Probability (S)
OR&IE 6700 ..... Statistical Principles (F)
OR&IE 6780 ..... Bayesian Statistics & Data Analysis (S)

Remote Sensing and Spatial Modeling
CEE 6100..... Remote Sensing Fundamentals (F)
CEE 6150..... Digital Image Processing (S)
CSS 6200..... Spatial Modeling and Analysis (S)

Application Forms and Information

Applications are available at the Graduate School's website: www.gradschool.cornell.edu. Additional information concerning graduate programs in Civil & Environmental Engineering can be obtained from the CEE web site

http://www.cee.cornell.edu/cee/academics/graduate/index.cfm

or by contacting our Graduate Program Coordinator at:

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School of Civil and Environmental Engineering
Cornell University
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