Civil and Environmental Engineering

Chair and Professor: Savage
Professors: Ebrahimpour, Leung, Sato
Associate Professor: Mashal
Senior Lecturer: Mahar

Affiliate/Graduate Allied Faculty: Mondal

Master of Science in Civil Engineering

The master's program in civil engineering is designed to provide advanced study, both theoretically and experimentally, in structures, mechanics, finite element methods, water resources, and geotechnics. This program prepares the student for advanced placement in the civil engineering field in industry, research, or development areas. Additionally, this program provides a suitable base for entrance into a doctoral program in a field related to civil engineering. The program is offered both at the Pocatello and the Idaho Falls campuses, primarily through the use of telecommunications/distance learning, which includes partial in-class instruction.

Goals

- Enhance the knowledge of graduates in the advanced concepts in civil engineering fields such as structures, mechanics, finite element methods, geotechnics, and water resources.
- Increase the ability of graduates to synthesize and apply these advanced concepts to develop realistic designs in fields related to civil engineering, solve identified problems, and design strategies for implementing them safely, ethically, and effectively.
- Enhance the ability of graduates to effectively communicate these concepts both in oral and written formats.

Master of Science in Environmental Engineering

This program is designed to provide the student with advanced technical training in environmental engineering, with an emphasis on hazardous waste treatment and control. The program fills a need in industry and government for professionals with a broad understanding of the technical aspects of environmental issues. Students enrolled in the program are generally expected to have a sufficient background in mathematics and chemistry (a minimum of one year of general chemistry). Students with an insufficient background in engineering and math are required to make up the deficiencies according to the advice of their advisory committee (usually includes ME 3307, CE 3332, CE 3341).

Goals

- Enhance the knowledge of graduates in the advanced concepts of environmental control and remediation, involving a significant fraction of the following: chemistry, water & wastewater quality, air quality, radioactive material handling and disposal, environmental laws and regulations, global environmental issues, and cost-benefit analyses.
- Increase the ability of graduates to synthesize and apply these advanced concepts to develop realistic environmental engineering designs and to solve identified problems, designing strategies for implementing them safely, ethically, and effectively.
- Enhance the ability of graduates to communicate these concepts effectively both in oral and written formats.
- Note: For lists of approved courses and elective courses, students should see an adviser. The approved and elective courses may be changed with the approval of the adviser.

Master of Science in Environmental Science and Management

The Environmental Science and Management (ENSM) Program is an interdisciplinary program designed to allow students to combine courses in environmental engineering with related courses in an interdisciplinary area of emphasis. Interdisciplinary coursework may come from a combination of courses in the following emphasis areas: geosciences, biological sciences, chemistry, mathematics, physics, pharmaceutical sciences, political science, and business. Students may also choose environmental engineering as the academic emphasis, thus maintaining the entire program of study within the Department of Civil and Environmental Engineering. The ENSM program is jointly sponsored by the University of Idaho and some of the courses are cross-listed. Students must complete at least ten credits in an interdisciplinary discipline (academic emphasis) and satisfy all departmental and Graduate School requirements.

Admission Requirements

The student must meet all criteria for admission and then apply to the Graduate School.

General Requirements

With the assistance of the Civil Engineering faculty, the student shall select an initial advisor during the first semester of residence to help in planning a program of studies and research. The student must also complete a Plan of Study and form a complete advisory committee by the time six credits of course work have been completed.

30 to 33 credit hours are required to complete the M.S. degree (at least 50% of the credits should be at 6000 level). Approximately half of the credits are engineering and technical electives, subject to the approval of the student’s advisory committee. The Thesis or Special Project should consist of study and research that complements the course work selected. Each student may also be required to complete two semesters of seminar, an important component in developing research and communication skills.

Doctor of Philosophy in Engineering and Applied Science

A doctoral program in Engineering and Applied Science, administered through the College of Science and Engineering, is available to Civil and Environmental Engineering students. The complete program description is provided elsewhere in the College of Science & Engineering section of the Graduate Catalog.

Master of Science in Civil Engineering

Thesis, Non-Thesis options

- Thesis option (30 credits): 15 credits from the approved list of courses, 9 credits of electives from the approved list of electives, and 6 credits of thesis.
- Non-thesis option (33 credits): 21 credits from the approved list of courses, 9 credits of electives from the approved list of electives, and 3 credits of Special Project in the related field and a written report. After completion of the course work and special project, students are required to take an oral
exam on their special project and other courses from the student’s approved M.S. program.

Note: For lists of approved courses and elective courses, students should see an advisor. The approved and elective courses may be changed with the approval of the advisor.

Master of Science in Environmental Engineering

Thesis, Non-Thesis options

- **Thesis option (30 credits):** 15 credits from the approved list of courses, 9 credits from the approved list of electives, and 6 credits of thesis.

- **Non-thesis option (33 credits):** 21 credits from the approved list of courses, 9 credits from the approved list of electives, and 3 credits of Special Project in the related field and a written report.

After completion of the course work and special project, students are required to take an oral exam on their special project and other courses from the student’s approved M.S. program.

Note: For lists of approved courses and elective courses, students should see an advisor. The approved and elective courses may be changed with the approval of the advisor (the link to the approved courses is: https://www.isu.edu/cse/programs/).

Master of Science in Environmental Science and Management

Students entering the ENSM program are required to obtain interdisciplinary admission into the Department of Civil and Environmental Engineering and one other academic discipline (emphasis). Admission requirements vary between academic units, and there may be departmental requirements beyond those of the Department of Civil and Environmental Engineering that the student must fulfill to gain departmental admission. At least 30 credits are required for the degree, of which at least 15 must be at the 6600 level. At least 10 credits must be completed within the academic emphasis, with the remainder of the course work representing ENSM course work. No more than 9 credits may be transferred from another university, with the exception of courses from the University of Idaho, which will be accepted as resident credits. Students must have completed coursework equivalent to Idaho State University’s MATH 1160 and Idaho State University’s CHEM 1111 and CHEM 1112 with grades of “C” or better. Students with prerequisite course deficiencies may be admitted as Classified with Performance Requirements with the understanding that these requirements must be satisfied prior to graduation, and such efforts may not necessarily count toward graduation. Classified with Performance Requirements (w/PR) admission into the ENSM program is the prerogative of individual departments.

Thesis and non-thesis options are available for the ENSM degree. For the thesis option, a maximum of ten thesis credits may be counted toward the degree. For the non-thesis option, a maximum of three “Special Project” credits may be counted toward the degree. These credits may apply toward the requirement of 15 credits at the 6600 level. There are program-wide and department-specific requirements for the thesis and non-thesis options, and students must create a program of study in conjunction with their advisory committee. Students will register for thesis credits or non-thesis project credits in the home department of the thesis/project advisor. Some departments’ “Special Project” courses may have a different title and/or course number.

Within the framework of the basic degree requirements, an advisory committee is chosen to work with the student to create an individualized program of study. The advisory committee consists of two faculty advisors: one from the Department of Civil and Environmental Engineering (CEE), and one from the student’s other academic discipline (emphasis). The student’s major advisor provides direction to the student regarding all relevant aspects of the program. All courses selected for fulfillment of the program of study must be approved by the advisory committee. The initial program of study must be submitted to the ENSM program director no later than the second semester of enrollment. Changes in the initial program of study may only be made with the approval of the student’s advisory committee. The final program of study is submitted to the Graduate School for graduation clearance in accordance with Graduate School policy.

Required Courses

The following courses are required for every student receiving the M.S. degree in Environmental Science and Management.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ENVE 5510</td>
<td>Introduction to Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 6655</td>
<td>Environmental Topics Seminar</td>
<td>1</td>
</tr>
<tr>
<td>ENGR 6650</td>
<td>Thesis</td>
<td>1-9</td>
</tr>
<tr>
<td>or ENGR 6660</td>
<td>Special Project</td>
<td></td>
</tr>
</tbody>
</table>

1 Course must be completed two times in order to satisfy requirement. A student may select a seminar other than ENGR 6655 offered in his/her interdisciplinary discipline with approval of the advisory committee.

2 Students will register for thesis or non-thesis “Special Project” credits in the home department of the thesis/non-thesis project advisor. Some departments’ “Special Project” courses may have a different title and/or course number.

In addition, the following courses are required for students choosing chemistry, environmental engineering, or mathematics as the second academic emphasis. Coursework in other emphasis areas will be selected from elective courses with the approval of the advisory committee.

Chemistry Emphasis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 5533</td>
<td>Environmental Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 5537</td>
<td>Environmental Chemistry Laboratory</td>
<td>1</td>
</tr>
</tbody>
</table>

Environmental Engineering Emphasis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVE 5508</td>
<td>Water and Waste Water Quality</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 5509</td>
<td>Water and Waste Water Lab</td>
<td>1</td>
</tr>
<tr>
<td>ENVE 5504</td>
<td>Environmental Risk Assessment</td>
<td>3</td>
</tr>
</tbody>
</table>

Mathematics Emphasis

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 5521</td>
<td>Advanced Engineering Mathematics I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 5522</td>
<td>Advanced Engineering Mathematics II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 5565</td>
<td>Partial Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>OR</td>
<td>Methods of Applied Mathematics I</td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td>Methods of Applied Mathematics II</td>
<td></td>
</tr>
</tbody>
</table>

Elective Courses

Students will select a core of courses from the following list. (Students may select one or more courses not on this list, with the approval of the advisory committee,
Chemistry Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 5507</td>
<td>Inorganic Chemistry II</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 6601</td>
<td>Seminar</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 6609</td>
<td>Advanced Inorganic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 6630</td>
<td>Advanced Analytical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 6621</td>
<td>Organic Reactions</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 6655</td>
<td>Advanced Physical Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 6671</td>
<td>Advanced Organic Chemistry</td>
<td>3</td>
</tr>
</tbody>
</table>

Environmental Engineering Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVE 5508</td>
<td>Water and Waste Water Quality</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 5509</td>
<td>Water and Waste Water Lab</td>
<td>1</td>
</tr>
<tr>
<td>ENVE 5530</td>
<td>Air Pollution and Solid Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6610</td>
<td>Introduction to Radioactive Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6611</td>
<td>Treatment Systems for Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6615</td>
<td>Water Quality Modeling and Control</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6617</td>
<td>Environmental Systems Engineering and Design</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6629</td>
<td>Physical and Chemical Treatment of Water and Waste Water</td>
<td>3</td>
</tr>
<tr>
<td>ENVE 6630</td>
<td>Air Pollution and Control</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 6606</td>
<td>Environmental Law and Regulations</td>
<td>3</td>
</tr>
<tr>
<td>CE 5599</td>
<td>Experimental Course (Open Channel Flow)</td>
<td>3</td>
</tr>
<tr>
<td>CE 5535</td>
<td>Hydraulic Design</td>
<td>3</td>
</tr>
<tr>
<td>CE 5554</td>
<td>Basic Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>CE 5555</td>
<td>Geologic Data Methods</td>
<td>3</td>
</tr>
<tr>
<td>NSEN 6618</td>
<td>Radioactive Waste Management</td>
<td>3</td>
</tr>
<tr>
<td>NSEN 6619</td>
<td>Materials Science of Radwaste</td>
<td>3</td>
</tr>
</tbody>
</table>

Geosciences Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 5504</td>
<td>Advanced Geographic Information Systems</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5506</td>
<td>Environmental Geology</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5509</td>
<td>Remote Sensing</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5515</td>
<td>Quaternary Global Change</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5516</td>
<td>Global Environmental Change</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5520</td>
<td>Principles of Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5530</td>
<td>Principles of Hydrogeology</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5554</td>
<td>Basic Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 5583</td>
<td>Earthquake Engineering</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 6602</td>
<td>Advanced Geomorphology</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 6608</td>
<td>Geostatistics Spatial Data Analysis and Modeling</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 6617</td>
<td>Environmental Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 6625</td>
<td>Quantitative Geochemistry Lab</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 6630</td>
<td>Advanced Hydrogeology</td>
<td>3</td>
</tr>
</tbody>
</table>

Civil Engineering Courses

**CE 5506 Green and Sustainable Engineering: 3 semester hours.**
Study of green engineering and sustainability, topics focused on design of processes to advance sustainability, manufacturing and disposal alternatives, energy and material life-cycle assessment, and environmental law and related issues. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: CHEM 1111.

**CE 5524 Open Channel Flow: 3 semester hours.**
Application of the principles of fluid mechanics to flow in open channels - natural and manmade. Topics include uniform flow, flow resistance, gradually varied flow, flow transitions, unsteady flow, and hydraulic structures (culverts, weirs, etc.) used in open channel control. Computer applications will be used in the analysis of open channel systems. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: CE 3341 or equivalent or permission of instructor.

**CE 5525 Water Resources: 3 semester hours.**
Overview of the general field of water resources engineering. Course topics covered in other courses such as CE 3351, Engineering Hydrology, CE 4435/5535, Hydraulic Design, and CE 4424/5524, Open Channel Flow, will be limited. The course is structured to give students a background in the diverse field of water resources and help prepare them for future careers in water supply, wastewater, floodplain, stormwater and groundwater management. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: CE 3341 or equivalent or permission of instructor.

**CE 5531 Advanced Mechanics of Solids: 3 semester hours.**
An introduction to elasticity, plasticity, and energy foundations, stability, plates. PREREQ: ENGR 3350 and MATH 3360.

**CE 5534 Geotechnical Design: 3 semester hours.**
Application of soil mechanics to design of foundations, retaining wall, stable slopes, buried conduits and pavement structures. Computer methods utilized. PREREQ: ENGR 3350 and CE 3332.

**CE 5535 Hydraulic Design: 3 semester hours.**
Hydraulic design of water control and transport structures, pipelines, and distribution systems. Computer methods utilized. PREREQ: CE 3351.

**CE 5536 Transportation Engineering: 3 semester hours.**
Fundamentals of earthwork, route location, drainage, and pavement materials with application to geometric and pavement design of highways, streets and rural roads. COREQ: CE 3332. PREREQ: ENGR 2224 and CE 3301.

**CE 5537 Geotechnical Engineering Laboratory: 1 semester hour.**
Field and laboratory work on site investigation, soil sampling classification and testing. Evaluation of soil properties. Design of experiment. PREREQ: CE 3332.

**CE 5554 Basic Engineering Geology: 3 semester hours.**
Geology applied to civil engineering projects rock engineering classification systems and geotechnical parameters such as joint set orientation ground behavior and underground construction. Preparation of baseline geotechnical reports. Equivalent to GEOL 5554. COREQ: CE 3332 or GEOL 3314.

**CE 5555 Geologic Data Methods: 3 semester hours.**
Geotechnical investigations for civil works projects. Geologic mapping for civil engineering purposes. Development of engineering geologic profiles. Core logging. Preparation of Geotechnical Data Reports for civil works projects. Equivalent to GEOL 5555. PREREQ: CE 5554 or CE 4454.
CE 5560 Project Management: 3 semester hours.
Knowledge, techniques and tools for management of civil, electrical, mechanical and environmental engineering projects and firms. Topics include contract organization/interpretation; project responsibility/authority; cost estimating; scheduling; quality control; construction safety; environmental requirements and project closeout. Examples from actual construction projects used as teaching aid. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: CE 3360 or CE 3361.

CE 5561 Project Management: 3 semester hours.
Analysis of statically indeterminate structures. Continuation of the use of classical methods. Introduction to computer methods in structural analysis including the use of commercially available software, and lateral load effects. PREREQ: CE 3362.

CE 5562 Design of Steel Structures: 3 semester hours.
Design of steel members and connections with emphasis on the AISC specifications. PREREQ: CE 3362.

CE 5564 Design of Concrete Structures: 3 semester hours.

CE 5565 Design of Prestressed Concrete Structures: 3 semester hours.
Basic concepts in prestressed concrete design, full versus partial prestressing, flexural design, ultimate load design, beams with constant and variable tendon eccentricity, design of reinforcement for shear and torsion. PREREQ: CE 5564 or CE 4464.

CE 5566 Design of Wood Structures: 3 semester hours.
Design of solid and laminated wood members and connections. Includes the design of wooden diaphragms for resisting lateral loads. PREREQ: CE 3362.

CE 5567 Structural Engineering Laboratory: 1 semester hour.

CE 5568 Behavior of Composite Materials: 3 semester hours.
Macro and micromechanical behavior of laminae and laminates bending, buckling and vibration of laminated beams and plates. Equivalent to ME 5568. PREREQ: ENGR 3350 and MATH 2240.

CE 5575 Essentials of Geomechanics: 3 semester hours.
Essentials of rock fracture relevant to geological engineering including stress and strain, properties and classification of rock masses, rock fracture mechanisms. Equivalent to GEOL 5575. PREREQ: GEOL 4421 or ENGR 3350.

CE 5576 Engineering Geology Project: 1 semester hour.
Team projects studying actual problems in engineering geology. Equivalent to GEOL 5576. PREREQ: GEOL 5554, GEOL 4454, CE 5554, or CE 4454.

CE 5580 Earthquake Engineering: 3 semester hours.
Topics include: mechanism and characterization of earthquakes; seismic risk analysis; site and structural response; applications from points of view of engineer and geologist. Equivalent to GEOL 5583. PREREQ: GEOL 3313 or CE 3332, or permission of instructor.

CE 5599 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

CE 6626 Introduction to Computational Fluid Dynamics: 3 semester hours.
Introduction to the governing equations of fluid flow, their application to solve fluid flow problems and the traditional numerical methods used to solve the equations. Numerical methods will cover basic techniques in the solutions of parabolic, hyperbolic and elliptical type equations. In addition, students will be introduced to an industry Computational Fluid Dynamics (CFD) code. Application of the code and its limitations will be covered. PREREQ: CE/ME 3341 or equivalent.

CE 6628 Hydraulics of Pipelines: 3 semester hours.
A study and application of the principles and procedures involved in the design and operation of pipeline systems. Topics include a feasibility assessment, economic analysis, design of pipe size/pressure class, cavitation, hydraulic transients and the selection of pumps and valves. Comprehensive design problems are used to demonstrate pipeline design and operational problems. PREREQ: CE/ME 3341 or equivalent.

CE 6650 Thesis: 1-6 semester hours.
Thesis research must be approved by the student's advisory committee. Total of six credits are required to satisfy the research requirements for the degree. May be repeated. Graded S/U.

CE 6652 Advanced Topics: 3 semester hours.
Advanced topics in Civil Engineering and related fields, depending upon the interest of students and faculty. May be repeated for credit when topics vary. PREREQ: Permission of instructor.

CE 6660 Special Project: 1-3 semester hours.
A significant project, involving engineering applications, toward the completion of M.S. program with non-thesis option. Includes a report and oral examination. Total of three credits may be used to satisfy the degree requirement. May be repeated. Graded S/U.

CE 6664 Dynamics of Structures: 3 semester hours.
Evaluation of response of structures subjected to dynamic forces including earthquake-induced forces and deformations. Applications include single- and multi-degree of freedom systems, and continuous systems. PREREQ: ME 4440 or ME 5540 or permission of instructor.

CE 6665 Finite Element Methods: 3 semester hours.
Introduction to finite element methods applied to linear one- and two-dimensional problems. Application of the concept to specific problems in various fields of engineering and applied sciences. Equivalent to ME 6665. PREREQ: ENGR/CE/ME 3350 and MATH 3360.

CE 6667 Structures and Mechanics Laboratory: 3 semester hours.
Strain gauge installation and circuitry. Strain measurements and analysis of variety of structural and mechanical systems. Dynamic measurements of various structures. PREREQ: CE 5531 or CE 4431 or permission of instructor.

CE 6699 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

CE 8850 Doctoral Dissertation: 1-24 semester hours.
Research toward completion of the dissertation for Ph.D. in Engineering and Applied Science. Variable credits. May be repeated. Graded S/U.

Env Engr Courses

ENVE 5504 Environmental Risk Assessment: 3 semester hours.
Quantitative and qualitative approaches to characterizing and controlling contaminant pathways. Risk assessment requirements and implications in superfund projects for engineers working on remediation. PREREQ: BIOL 5521 and ENGR 5501.
ENVE 5508 Water and Waste Water Quality: 3 semester hours.
Principles of chemistry in applications to water and waste water treatment systems for water quality control and reuse. COREQ: ENVE 5509. PREREQ: CHEM 1111 or equivalent.

ENVE 5509 Water and Waste Water Lab: 1 semester hour.
Fundamental analytical procedures for measurement of water and wastewater quality. Introduction to materials and protocols associated with general environmental analytical techniques. COREQ: ENVE 5508.

ENVE 5510 Introduction to Environmental Engineering: 3 semester hours.
Introduction to physical, chemical, and biological principles of solid and hazardous waste management, water and waste water treatment, air pollution control, and national environmental regulation. PREREQ: ENVE 5508, ENVE 4408, or equivalent.

ENVE 5530 Air Pollution and Solid Waste: 3 semester hours.
Sources, characteristics, regulations, and effects of air pollution and solid waste on environmental quality analysis and design of control systems, including the recovery of resources from solid waste. PREREQ: Permission of instructor.

ENVE 5599 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

ENVE 6610 Introduction to Radioactive Waste Management: 3 semester hours.
Principles and practices of radioactive waste storage, transportation and disposal. Evolution of government regulations and current solutions developed in response to the regulations. PREREQ: ENGR 5501.

ENVE 6611 Treatment Systems for Environmental Engineering: 3 semester hours.
Fundamental principles and processes for physical, chemical, and biological treatment of wastes including mixing, flocculation, sedimentation, stripping, aeration, sorption and leaching. Some experiments required. PREREQ: ENVE 5510 or ENVE 4410.

ENVE 6615 Water Quality Modeling and Control: 3 semester hours.
Fundamental principles for mathematical modeling and analysis of environmental contaminant's fate and transport in lakes, rivers, estuaries, and groundwater. PREREQ: ENVE 5510 or ENVE 4410.

ENVE 6616 Biological Treatment of Wastewater: 3 semester hours.
Fundamental principles, design, and operation of aerobic and anaerobic biological waste treatment processes. PREREQ: ENVE 5510 or ENVE 4410.

ENVE 6617 Environmental Systems Engineering and Design: 3 semester hours.
Application of physical, chemical, and biological operations and processes to the design of water, waste water, and industrial waste treatment systems. PREREQ: ENVE 5510, ENVE 4410 or previous design experience.

ENVE 6629 Physical and Chemical Treatment of Water and Waste Water: 3 semester hours.
Fundamental principles, design and operations of physical and chemical water and waste water treatment processes. Removal of hazardous materials emphasized. PREREQ: ENVE 5510 or ENVE 4410.

ENVE 6630 Air Pollution and Control: 3 semester hours.
An introductory air pollution course. Regulations, atmospheric dispersion models, control of emissions and sources and human health effects are emphasized. PREREQ: ENVE 5510 or ENVE 4410.

ENVE 6650 Thesis: 1-6 semester hours.
Thesis research must be approved by the student's advisory committee. Total of six credits are required to satisfy the research requirements for the degree. May be repeated. Graded S/U.

ENVE 6652 Advanced Topics: 3 semester hours.
Advanced topics in Environmental Engineering and related fields, depending upon the interest of students and faculty. May be repeated for credit when topics vary. PREREQ: Permission of instructor.

ENVE 6660 Special Project: 1-3 semester hours.
A significant project, involving engineering applications, toward the completion of M.S. program with non-thesis options. Includes a report and oral examination. Total of three credits may be used to satisfy the degree requirement. May be repeated. Graded S/U.

ENVE 6699 Experimental Course: 1-6 semester hours.
The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

ENVE 8850 Doctoral Dissertation: 1-24 semester hours.
Research toward completion of the dissertation for Ph.D. in Engineering and Applied Science. Variable credits. May be repeated. Graded S/U.