



# Metropolitan State University of Denver

## SUSTAINABLE SYSTEMS ENGINEERING

The Sustainable Systems Engineering (SSE) program offers the Bachelor of Science degree major.

Sustainable Systems Engineering (SSE) is a broad discipline that addresses the engineering of large, complex systems and the integration of the many subsystems that comprise the larger system. The program integrates Civil Engineering Technology, Electrical Engineering Technology and Mechanical Engineering Technology programs with other Metropolitan State University of Denver (MSU Denver) programs such as Earth and Atmospheric Sciences, Political Science, Business Management, and Communication Arts and Sciences, etc. to prepare students for future large prospective and complex system sustainable development challenges.

The SSE Program focuses on the interactions of engineering, society and ecological systems. Specifically, the program studies the relationship of engineering to economic development, environmental impact, social structure, and the sustainability of natural resources. The program will examine how engineering activities influence human well-being as a whole complex system and will provide students with knowledge and methods to analyze and solve sustainable development problems. The program description of the Sustainable Systems Engineering (SSE) is: apply a holistic and systemic approach to solving problems and move beyond the tradition of breaking designs down into disconnected parts.

Sustainable development is considered to be one of the fundamental criteria for engineering practices. Engineers are required to play a leading role in planning, designing, building, manufacturing and ensuring a sustainable future. The SSE program will prepare our graduates in a better position in pursuing graduate studies or engineering licensure after graduating from MSU Denver. In addition, the graduates will be able to join the workforce as sustainable system engineers, who are expected to work on or lead projects requiring a systemic and interdisciplinary approach to prevent the mismatch between a sophistication of individual discipline decisions and complex situations.

**Faculty** – The top priority for faculty in the SSE program is teaching and advising. With many years of industrial experience, they bring their expertise, relevancy and currency to the classrooms.

**Students** – Faculty provide each student with individualized counseling, and advising in meeting graduation requirements. Many Sustainable Systems Engineering students are working part-time or full-time. The program offers several evening courses to accommodate the working student. The SSE program's collaboration with the Internship Center of the college offers possibilities for students to gain industrial experience and earn technical elective credits at the same time. All students who are considering a major in SSE are expected to consult with SSE faculty advisor.

**Sustainable Systems Engineering**  
**Department of Engineering and Engineering Technology**

Students majoring in Sustainable Systems Engineering must meet the following curriculum and are required to complete all general study courses, program pre-requisite courses and core courses with a grade required for graduation. Technical elective courses must be approved by the program coordinator or department chair. Students who are considering a major in Sustainable Systems Engineering are expected to consult with SSE faculty for advising. Students should note that programs differ in that a minimum grade of “C” or better is required.

	<b>Required Technical Studies –hours</b>	<b>Prerequisites</b>	<b>Credit Hours</b>
_____	SSE 1040 Life Cycle and Systems Engineering - An Introduction		3
_____	SSE 1215 Engineering Graphics: Solid Modeling		3
_____	SSE 2000 Engineering Safety and Quality Assurance		3
_____	SSE 2100 Basic Electronic Systems	PHY 2331 and PHY 2341	3
_____	SSE 2150 Mechanics of Static Systems	PHY 2311 and MTH 2410	3
_____	SSE 2200 Materials Science	CHE 1100/1150	3
_____	SSE 2350 Engineering Programming	SSE 2100	3
_____	SSE 3000 Applied Systems Design	SSE 2200, SSE 3135, and SSE 3160	3
_____	SSE 3070 Machine Element and Mechanical Systems	SSE 2200, SSE 3135, and SSE 3160	3
_____	SSE 3100 Mathematical Modeling	MTH 3420	1
_____	SSE 3135 Strength of Materials with Laboratory	SSE 2150	4
_____	SSE 3160 Mechanics of Dynamic Systems	SSE 2150 and MTH 3420	3
_____	SSE 3175 Modeling Structural Systems	SSE 3135	3
_____	SSE 3185 Fundamental Fluid Mechanics	SSE 3160	3
_____	SSE 3300 Thermodynamics and Heat Transfer	SSE 2200, SSE 3135, and SSE 3160	3
_____	SSE 3730 Control Systems	SSE 2100	2
_____	SSE 4000 Sustainable Systems Engineering	SSE 1040 and CET 3120	3
_____	SSE 4160 Geotechnical Engineering	SSE 3135 and SSE 3185	3
_____	SSE 4200 Sustainable Development Strategy		3
_____	SSE 4280 Energy and Power	SSE 3300, PHY 2310, and PHY 2320,	3
_____	SSE 4300 Probabilistic Design Methodology	SSE 3135	3
_____	SSE 4610 Capstone: Thesis in Sustainable Development	Departmental Permission	3
_____	CET 3120 Engineering Economy		3
_____	ECO 3800 Development Economics	ECO 1040 or ECO 2020	3
		<b>Subtotal:</b>	<b>70</b>

One of the following elective courses:

_____	SSE 3500 Humanitarian Engineering		3
_____	SSE 4500 Refurbishment of Structures	SSE 2150	3
_____	SSE 4700 Engineering Decision and Risk Analysis	SSE 4000	3
_____	MKT 3000 Principles of Marketing	ENG 1010, ENG 1020,	3
_____	PSC 3020 Introduction to Public Administration	PSC 1010 or PSC 1020	3
_____	ENV 4200 Environmental Policy & Planning	ENV 1200 and completion of General Studies	3
		<b>Subtotal:</b>	<b>3</b>

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## Additional Requirements:

___	CHE 1100	Principles of Chemistry	MTH 1110 or MTH 1120	4
___	CHE 1150	Principles of Chemistry Lab	CoReq: CHE 1100	1
___	MTH 1410	Calculus I	MTH 1110 & MTH 1120, or MTH 1400	4
___	MTH 2410	Calculus II	MTH 1410 or MTH 1450 or HON 2100	4
___	MTH 2420	Calculus III	MTH 2410	4
___	MTH 3420	Differential Equations	MTH 2420	*4
			<b>Subtotal:</b>	<b>17</b>

## General Studies Requirements

		Written Communication:		6
		Oral Communication:		3
		Quantitative Literacy (satisfied by Math requirements)		4
___	MTH 1410	Calculus I	MTH 1110 & MTH 1120, or MTH 1400	4
		Arts and Humanities		6
		Historical		3
		Natural and Physical Sciences		
___	PHY 2311	General Physics I	MTH 1410	4
___	PHY 2321	General Physics I Lab	concurrent with PHY 2311	1
___	PHY 2331	General Physics II	MTH 2410, PHY 2311/2321	4
___	PHY 2341	General Physics II Lab	concurrent with PHY 2331	1
		Social and Behavioral Sciences I		3
		Social and Behavioral Sciences II		3
		<b>Global Diversity Requirement:</b>		
		<b>Multicultural Requirement:</b>		
			<b>General Studies Total:</b>	<b>38</b>

**Total hours for Sustainable Systems Engineering Major**

**128**

**SSE 1040 - Life Cycle and Systems Engineering - An Introduction****Credits:** 3 (3+0)**Prerequisite(s):** None

Students in this course are introduced to life cycle analysis and systems engineering using principles and applications of systems analysis, life cycle cost analysis and basic quantitative methods. Classical and modern decision analysis techniques are employed for evaluating case studies in sustainable systems of mechanical, civil and electrical engineering.

**SSE 1215 – Engineering Graphics: Solid Modeling****Credits:** 3 (2+2)**Prerequisite(s):** None**Stacked With:** CET 1215

In this course students study solid modeling fundamentals, geometric constructions, multi-view projections, section views, and dimensioning using adequate CAD software.

**SSE 2000 - Engineering Safety and Quality Assurance****Credits:** 3 (3+0)**Prerequisite(s):** None**Stacked With:** MET 1310

Students in this course are introduced to the fundamentals of engineering safety and quality assurance. In this course, students study the regulatory and professional aspects of occupational safety and focus on the fundamental engineering laws and ethics. Engineering practices are reinforced by requiring students to apply basic engineering principles to safety-related problems. Students are also introduced to the scope and function of quality assurance, including basic definitions, statistics, quality policy and objectives, manuals and procedures, concept of variation, inspection and sampling techniques, metrology process control, methods and the elements of reliability. Current (TQM) and ISO 9000 standards are reviewed.

**SSE 2100 – Basic Electronic Systems****Credits:** 3 (2+2)**Prerequisite(s):** PHY 2331 and PHY 2341, with a grade of "C" or better, or permission of instructor**Stacked With:** EET 2000

In this course, students study DC and AC circuits, including electric components, classic network theorems, electric power and complex power, phasor, impedance, digital system, etc. The application and development of electronic systems is also discussed.

**SSE 2150 - Mechanics of Static Systems****Credits:** 3 (3+0)**Prerequisite(s):** PHY 2311 and MTR 2410 with "C" or better, or permission of instructor**Stacked With:** CET 2150

In this course, students study the principles of mechanics of static systems in two- and three-dimensions: static equilibrium of particles and rigid bodies; section properties; internal forces in statically determinate trusses and beams; friction; and virtual work.

**SSE 2200 – Materials Science****Credits:** 3 (2+2)**Prerequisite(s):** CHE 1100/1150 with "C" or better, or permission of instructor**Stacked With:** MET 2200

In this lecture/laboratory course, students are introduced to basic properties of materials, including the properties and behavior that govern their selection and design with emphasis on sustainable practices. Students study materials including ferrous and non-ferrous metals, composites, plastics, ceramics, glass, wood, rubber and adhesives.

**SSE 2350 - Engineering Programming****Credits:** 3 (3+0)**Prerequisite(s):** SSE 2100 with a grade of "C" or better, or permission of instructor**Stacked With:** EET 2350

In this course, students study methods for solving engineering problems using the C programming language and the use of Lab View. Students apply the C programming language and National Instruments Lab View virtual instrumentation software.

**SSE 3000 – Applied Systems Design****Credits:** 3 (2 + 2)**Prerequisite(s):** SSE 2200, SSE 3135 AND SSE 3160 with "C" or better grades, or permission of instructor

**Description:** In this course students will be introduced to the engineering design process and skills through project based learning. The course focuses on both systems and traditional design process and application of those through team projects. Students will learn both systems approach as well as the fundamental engineering design process. The students will apply the aforementioned methodology to a real-world project. Through this course the students will conceptualize, construct, test and present a deliverable project.

**SSE 3070 – Machine Element and Mechanical Systems****Credits:** 3 (3+0)**Prerequisite(s):** SSE 2200, SSE 3135 AND SSE 3160 with 'C' or better grades or permission of instructor

**Description:** The students will be introduced to the fundamental principles required to design the machine elements. The students will study combined stresses, gearing, brakes, curved beams, etc., and undertakes the design of a complete machine. The economics of design is stressed along with strength and safety considerations. The selected software will be utilized to perform engineering analyses and to produce preferred designs.

**SSE 3100 – Mathematical Modeling****Credits:** 1 (0 +0+1)**Prerequisite(s):** MTH 3420 with "C" or better or permission of instructor

**Description:** In this course students develop the ability to describe complex real-world engineering systems with mathematical concepts. Mathematical modeling is presented through engineering application problems that students will tackle by working in teams and applying the theory they have learnt in other courses.

**SSE 3135 – Strength of Materials with Laboratory****Credits:** 4 (3 + 2)**Prerequisite(s):** SSE 2150 with grade "C" or better, or permission of instructor

**Description:** Students in this course are introduced to the fundamentals in the strength and deformation of engineering materials. Students will focus on the development of constitutive relationships of materials under axial, torsion, transverse shear and bending loading conditions, and the engineering applications in the first part of the course. Students will be introduced to beam deflection and column buckling theories and engineering solutions in the second part of the course. Students will use laboratory time to enhance the knowledge and theories developed in the class and to use different equipment measuring engineering properties of various materials.

**SSE 3160 – Mechanics of Dynamic Systems****Credits:** 3 (3 + 0)**Prerequisite(s):** SSE 2150 AND MTH 3420 with 'C' or better grades or permission of instructor

**Description:** In this course students will be introduced to dynamics systems including kinematics, and kinetics of particles and rigid bodies with engineering applications. Students will also study the vibration systems in engineering applications.

**SSE 3175 – Modeling Structural Systems****Credits:** 3 (3 + 0)**Prerequisite(s):** SSE 3135 with "C" or better or permission of instructor

**Description:** In this course students study the modeling for structural analysis and design. It focuses on the interaction of the components and their behavior within a structural system. The basic concepts of structural modeling are introduced first, followed by the evolution of structural analysis, and then the analysis methods and types are presented along with the discussion of interactions within structural systems.

**SSE 3185 – Fundamental Fluid Mechanics****Credits:** 3 (3 + 0)**Prerequisite(s):** SSE 3160 with grade "C" or better, or permission of instructor

**Description:** Students in this course will study physical properties of ideal fluids and real fluids. Course material includes fluid statics, kinematics and dynamics, energy and momentum principles of fluid mechanics, dimensional analysis and the applications of the theories and principles in incompressible flow in pipes, ducts, forces on immersed bodies and steady flow in open channels.

**SSE 3300 – Thermodynamics and Heat Transfer****Credits:** 3 (3 + 0)**Prerequisite(s):** SSE 2200, SSE 3135 AND SSE 3160 with "C" or better or permission of instructor

**Description:** In this course students will examine the fundamental laws of thermodynamics. Students will be introduced to basic concepts of energy, thermodynamic systems, dimensions and units, and the ideal-gas equation of state. Students will be introduced to concepts through the study of closed and open systems. Students will analyze heat engines and reversible and irreversible processes. Additionally, students will learn and apply the three basic mechanisms of heat transmission. Conduction, convection (free and forced), plus radiant transmission are treated for both steady-state and transient conditions. Student learning will be aided by computer solutions.

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**SSE 3500 – Humanitarian Engineering****Credits:** 3 (3 + 0)

**Description:** In this course students will be introduced to Humanitarian Engineering through hands on instruction and project work in tandem with lectures. Students will design and implement a sustainable community project that helps an underrepresented community to meet the population's basic engineering needs. This project will be based on knowledge of relevant community development methodologies that students will be introduced to through lecture. Students will learn to apply Appropriate Design concepts as well as development implementation strategy with respect to sustainability, and design for community. Students will compare and contrast engineering for developing community systems strategies with the traditional design process.

**SSE 3730 – Control Systems****Credits:** 2 (1.5 + 1)

**Prerequisite(s):** SSE 2100 with a grade "C" or better, or permission of instructor  
**Description:** In this course students will study the applications of Proportional, Integral, & Derivative (PID) controllers in the process control industry. And the students will also structure of feedback, sensors, controllers, control valves, process dynamics, timing, piping and instrument drawing.

**SSE 4000 – Sustainable Systems Engineering****Credits:** 3 (3 + 0)

**Prerequisite(s):** SSE 1040 and CET 3120 with grades "C" or better, or permission of instructor  
**Description:** In this course, students study advanced theories and applications of sustainable systems engineering, life cycle analysis, quantitative methods and engineering economics, guided by sustainability principles. Classical and modern decision analysis methods are employed for evaluating case studies in systems of mechanical, civil and electrical engineering using current optimization techniques for detailed analysis and application.

**SSE 4160 – Geotechnical Engineering****Credits:** 3 (3 + 0)

**Prerequisite(s):** SSE 3135 and SSE 3185 both with grades "C" or better, or permission of instructor  
**Description:** Students in this course are introduced to the basic principles of soil mechanics and fundamentals of geotechnical engineering. Students will learn mechanical properties of soil, engineering classification of soil, permeability and seepage, consolidation and settlement, shear strength, lateral earth pressures, fundamentals of retaining structures, soil bearing capacity, slope stability and fundamentals of foundation designs.

**SSE 4200 – Sustainable Development Strategy****Credits:** 3 (3 + 0)

**Description:** In this course students will be introduced to the role of engineering in development, and will examine how actions lead to intended and unintended consequences. Emphasis will be placed on sustainability principles with regards to planning and design. Students will study development strategy on large, modern world scale and also for communities where the social, political, and economic systems differ from those most commonly experienced by engineers in the developed world. The students will also be introduced to a framework and guidelines for conducting both large and small scale development projects. The course will address analysis of communities in medium- to high-risk and low resilience environments. The framework combines concepts and tools that have been traditionally used by development agencies and other tools more specifically used in engineering project management. Finally, students will be introduced to the various leadership skills necessary to make decisions in complex and uncertain environments.

**SSE 4280 – Energy and Power****Credits:** 3 (2 + 2)

**Prerequisite(s):** SSE 3300, PHY 2310, and PHY 2320, with a grade "C" or better  
**Description:** In this course, the students will study global energy flow, sources and uses of energy. The students will be introduced to biological energy and ecosystems from the viewpoint of the engineering practice. The students will also deal with energy-related environment problems including air and thermal pollution plus radioactivity.

**SSE 4300 – Probabilistic Design Methodology****Credits:** 3 (3 + 0)

**Prerequisite(s):** SSE 3135 with "C" or better or permission of instructor  
**Description:** In this course students study engineering design methods that account for the stochastic nature of the design variables and provide means to quantify the inherent risk of a design. The students are introduced to basic concepts of stochastics, followed by the evolution of the probabilistic design, after which the design methods are discussed with emphasis on the Monte Carlo simulation and its applications to structural analysis and design.

**SSE 4500 – Refurbishment of Structures****Credits:** 3 (3+0)

**Prerequisite(s):** SSE 2150 with "C" or better, or permission of instructor  
 In this course, students study technologies used in restoration, repair, and strengthening of civil engineering structures in order to extend their service life for a sustainable built environment. This course addresses the refurbishment of contemporary steel, concrete, timber, and masonry structures, as well as bridges and historic structures.

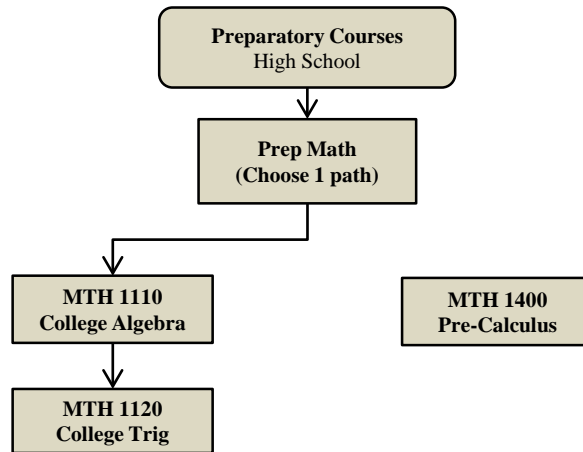
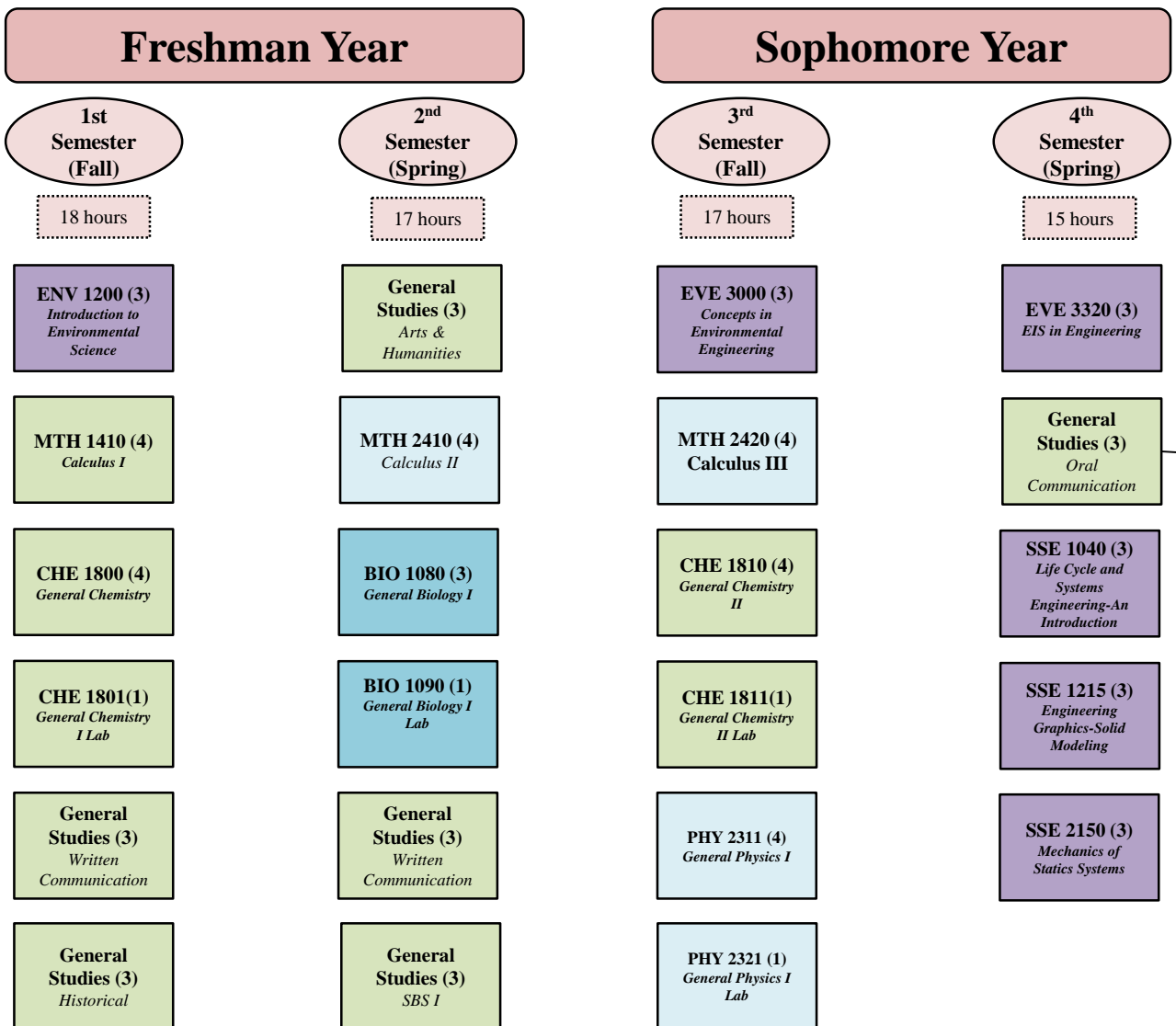
**SSE 4610 - Capstone: Thesis in Sustainable Development****Credits:** 3 (0+0+3)**Prerequisite(s):** Departmental Permission

Students in this course write a thesis of an undergraduate research project. The project should reflect the growth of the development of engineering, technology, and human society with regard to sustainability and to meet the needs of sustainable development of industry and the community. The senior thesis projects generally are selected by students and emerged from collaboration with faculty/advisor. The thesis should demonstrate the general understanding of concepts of sustainable system engineering, together with exposition that sets the work in a holistic and systemic approach to solving problems and move beyond the tradition of breaking designs down into disconnected parts.

**SSE 4700 – Engineering Decision and Risk Analysis****Credits:** 3 (3+0)

**Prerequisite(s):** SSE 4000 with a grade of "C" or better, or permission of instructor  
 Students learn the fundamental principles and practical techniques of risk and decision analysis in this course. The class is oriented toward project-level decisions where multiple variables and complex risks are present. The course introduces students to Monte Carlo analyses, and various types of multicriteria decision analyses. Students collaborate in a larger term project.

## See Prerequisites for all classes

*Recommended course rotation:*

## Junior Year

5th Semester  
(Fall)

16 hours

**SSE 3135 (4)**  
*Strength of Materials with Laboratory*

**MTH 3420 (4)**  
*Differential Equations*

**PHY 2331 (4)**  
*General Physics II*

**PHY 2341(1)**  
*General Physics II Lab*

**General Studies (3)**  
*SBS II*

6th Semester  
(Spring)

12 hours

**SSE 3160 (3)**  
*Mechanics of Dynamics Systems*

**General Studies (3)**  
*Arts and Humanities*

**Approved Elective**  
*3 credits*

**Approved Elective**  
*3 credits*

## Senior Year

7th Semester  
(Fall)

18 hours

**SSE 3185 (3)**  
*Fundamental Fluid Mechanics*

**EVE 3400 (3)**  
*Engineered Water*

**EVE 4200 (3)**  
*Environmental Policy in Engineering*

**EVE 4420 (3)**  
*Wetland Studies*

**Approved Elective**  
*3 credits*

**Approved Elective**  
*3 credits*

8th Semester  
(Spring)

16 hours

**SSE 4160 (3)**  
*Geotechnical Engineering*

**SSE 4610 (3)**  
*Capstone: Thesis in Sustainable Development*

**EVE 4450 (3)**  
*Wood in Engineering*

**GEL 3420 (4)**  
*Soil Resources*

**Approved Elective**  
*3 credits*