

## Civil Engineering Optional Clusters

You can select electives in the Civil Engineering program to broaden your background, to emphasize subfields within the discipline, or some of both.

Civil Engineering students seeking a broad background can select any electives that are listed in the Undergraduate Bulletin requirements for their catalog year. For the catalog year listed above, the electives include the following categories:

- Basic Science Elective: 1 course (3 hours)
- Foundational Math Elective: 1 course (3 hours)
- Statistics Choice: 1 course (3 hours)
- Foundational Math/Science Elective: 1 course (3-4 hours)
- ECIV Laboratory Elective: 2 courses (2 hours)
- ECIV Distribution Elective: 4 courses (12 hours)
- Engineering Science or Mathematics (ESM) Electives: 4 courses (12-14 hours)
- Other Elective: 2 courses (6-8 hours)

Students seeking to specialize their program of study can do so by selecting specific courses that satisfy the requirements outlined above. Some possible course clusters are described below. It is important to know that it is not necessary to take all the courses within a cluster to increase expertise in a particular area. Clusters are not a formal part of the degree and are not listed on transcripts or diplomas.

Optional clusters described in this document include:

- Environmental Engineering
- Geotechnical Engineering
- Railway Engineering
- Structural Engineering
- Transportation Engineering
- Water Resources Engineering

### Environmental Engineering Cluster

What is environmental engineering?

Environmental engineering is the application of scientific and engineering principles to improve and maintain the environment in order to: (i) protect human health, (ii) protect nature's beneficial ecosystems, and (iii) improve environmental-related enhancement of the quality of human life. Environmental engineering uses broad scientific topics such as engineering, soil science, microbiology, ecology, geology, hydraulics, hydrology, mathematics, and chemistry to develop solutions to environmental problems.

## What do environmental engineers do?

Environmental engineers work in a variety of settings to develop solutions to environmental problems such as wastewater management, water and air pollution control, recycling, waste disposal, and public health. For example, environmental engineers (i) design municipal water supply and municipal/industrial wastewater treatment systems, and design plans to prevent waterborne diseases and improve sanitation in urban, rural and recreational areas, (ii) evaluate hazardous-waste management systems to evaluate the severity of such hazards, advise on treatment and containment, and develop regulations to prevent mishaps, and (iii) implement environmental engineering law, as in assessing the environmental impact of proposed construction projects.

## Recommended Courses

Category	Recommended Courses
Basic Science Elective	ENVR 321 or BIOL 270
Math (3 <sup>rd</sup> semester)	MATH 241
Statistics	STAT 509 or STAT 511
Foundational Math/Science Elective	CHEM 112
ECIV Laboratory Elective	ECIV 350L and ECIV 362L
ECIV Distribution Elective	<u>One from:</u> ECIV 551, 555, 556, 558. <u>One from:</u> ECIV 560, 562, 563. <u>Two from:</u> ECIV 325, 327, 520, 521, 530, 531, 533, 535, 539, 540, 541, 542, 580, 582, 588.
ESM Elective	<u>Two from:</u> ECIV 551, 555, 556, 558. <u>One from:</u> ECIV 560, 562, 563. <u>One from:</u> ECIV 405, GEOG 563, above CHEM 112.
Other Elective	ECON 224 and ECON 548

## Geotechnical Engineering Cluster

### What is geotechnical engineering?

Geotechnical engineering is concerned with the engineering behavior of earth materials. It utilizes knowledge of soil and rock mechanics in the analysis, design and construction of foundations, earth structures, tunnels, roads/railways, and other systems that are made of or are supported by soil or rock, both on- and offshore.

### What do geotechnical engineers do?

Geotechnical engineers design and construct geosystems such as foundations for bridges and buildings, earth structures (dams, embankments, landfills, retaining structures), underground structures (tunnels, basements, subways), and roads/railways (sub-grades, base courses, embankments). They typically work as part of interdisciplinary teams comprised of structural, transportation, water resources, and environmental engineers; as well as with construction managers, hydrologists, geologists, planners, etc. Types of applications include energy (offshore energy, petroleum, CO<sub>2</sub> storage), landfill design, mining technology, environment technology and sustainability, natural hazards, and instrumentation and monitoring of structures and facilities.

## Recommended Courses

Category	Recommended Courses
Basic Science Elective	GEOL 101 or GEOL 103
Math (3 <sup>rd</sup> semester)	MATH 241
Statistics	STAT 509
Foundational Math/Science Elective	CHEM 112 or PHYS 212
ECIV Laboratory Elective	ECIV 330L, plus one other lab
ECIV Distribution Elective	ECIV 327. <u>One from:</u> ECIV 530, 531. <u>One from:</u> ECIV 560, 562, 563. <u>One from:</u> ECIV 541, 551, 555, 557, 580.
ESM Elective	2 options: <u>Four from:</u> ECIV 530, 531, 533, 535, 539. OR <u>Two from:</u> ECIV 530, 531, 533, 535, 539 and <u>One from:</u> GEOL 302, 548, 555 and <u>One from:</u> ECIV 541, 555, 557, 580, 588; GEOG 563.
Other Elective	<u>Two from:</u> ESM Elective list, MGMT 371.

## Railway Engineering Cluster

### What is Railroad Engineering?

Railroad Engineering, also known as Railway Engineering, is a branch of engineering dealing with the planning, design, construction, operation, and maintenance of the railroad network for the safe, secure, efficient, and economic transportation of goods and people. It is concerned with the interaction between moving vehicles (mechanical systems) and the infrastructure (structural/civil systems) and it includes elements of civil, mechanical, industrial, electrical and computer engineering. Railway engineers are involved in activities related to both infrastructure and operations. Examples include the planning, design and construction of railroad tracks and other railway specific structures (bridges, viaducts, culverts, tunnels, earth retaining structures), health monitoring and assessment of infrastructure components, repair and maintenance activities, terminal and yard operations, intermodal terminal design and operation, train scheduling, and big data analytics. Key skills for railway engineers include creativity, understanding of fundamentals across many engineering disciplines, excellent IT and analytical competencies, teamworking and communication skills, project and budget management skills and excellent attention to detail.

### What do Railroad Engineers Do?

Railroad engineers work mainly for freight, passenger and transit railroad companies, engineering consultancies who cater to the railway industry, as well as local, state, and federal authorities. Qualified and experienced engineers in the railway industry advance swiftly in their career paths to mid- and upper-level management positions like senior technical leads, project managers, division heads and directors. Although licensure is not required in general, a Professional Engineering (PE) license, allows for higher levels of leadership and independence.

### Recommended Courses

Category	Recommended Courses
Basic Science Elective	GEOL 101
Math (3 <sup>rd</sup> semester)	MATH 241
Statistics	STAT 509
Foundational Math/Science Elective	MATH 344
ECIV Laboratory Elective	ECIV 330L and ECIV 303L
ECIV Distribution Elective	<u>One from:</u> ECIV 540, <b>580</b> <sup>1</sup> . <u>One from:</u> ECIV 325, 327. <u>Two from:</u> Remaining ECIV Distribution courses to satisfy curriculum requirements.
ESM Elective	ECIV <b>582</b> <sup>1</sup> , and ECIV <b>588</b> <sup>2</sup> . <u>Two from:</u> ECIV 325, 327, 580, 535, 531, ECIV 524, ECIV 520 ECIV 530, ECIV 540/541/542
Other Elective	MGMT 371, ECON 224 or one from above ECIV Distribution and ESM lists.

1. Either course fulfills three credit hours for Railway Certification (graduate program)
2. Fulfills 3 of the six credit hours for Railway Certification (graduate program)

## Structural Engineering Cluster

### What is structural engineering?

Structural Engineering is the branch of engineering that plans, designs, builds and studies the behavior of manmade structures that form a safe and functional environment in which people live and work. Structural engineers are involved with activities related to new structures but also to alterations, retrofit and rehabilitation of existing structures. Examples of such structures include buildings, bridges, dams, towers, tunnels and other specialty structures (e.g. oil rigs, aircrafts and spacecrafts), facilities and features of the built environment. Structural engineering involves broad scientific topics such as engineering, physics, mathematics, and material science. Key skills for structural engineers include creativity, excellent mathematical, IT and analytical competencies, teamworking and communication skills, project and budget management skills and excellent attention to detail.

### What do structural engineers do?

Structural engineers work mainly for engineering contractors and engineering consultancies, but also for utility companies, and local, state, and federal authorities. They plan, analyze, design, and oversee construction of new and/or existing structural systems in compliance with local and national codes to ensure the safety of all occupants and/or users. Structural engineers often work alongside other civil engineers and architects as part of a design and construction team. Structural engineers with ample experience may move into senior positions, such as project managers or functional managers of design, construction, operation, or maintenance.

## Recommended Courses

Category	Recommended Courses
Basic Science Elective	GEOL 101

Math (3 <sup>rd</sup> semester)	MATH 241
Statistics	STAT 509 or STAT 511
Foundational Math/Science Elective	CHEM 112 or MATH 344
ECIV Laboratory Elective	ECIV 303L, plus one other lab
ECIV Distribution Elective	ECIV 325 or 327 and ECIV 530. <u>Two from:</u> Remaining ECIV Distribution courses to satisfy curriculum requirements.
ESM Elective	<u>Four from:</u> ECIV 325, 327, 520, 524, 526, 530, 588.
Other Elective	<u>Two from:</u> ESM Elective list, MGMT 371.

---

## Transportation Engineering Cluster

### What is transportation engineering?

Transportation engineering involves the planning, construction, and management of transportation facilities to provide efficient and safe movement of people and goods. There are six divisions related to transportation engineering: highway, air, waterway, aerospace, coastal & ocean, and urban transportation.

### What do transportation engineers do?

They develop plans for surface transportation projects, according to established engineering standards and state or federal construction policy. They prepare designs, specifications, or estimates for transportation facilities. They develop modification plans for existing streets, highways, or freeways to improve traffic flow. They do this by analyzing data, identifying problems, and solving them with innovative solutions. Solving these complex problems typically requires the collection and evaluation of systems, traffic flow, accidents, costs, and other statistics. Transportation Engineers are often required to collaborate with other parties on certain projects, including utility companies and government agencies. Transportation engineers also need to consider how the developed projects will affect certain communities in terms of environmental and health hazards. Job titles include transportation engineer, construction engineer, transportation planner, port engineer, and traffic engineer.

## Recommended Courses

Category	Recommended Courses
Basic Science Elective	ENVR 321
Math (3 <sup>rd</sup> semester)	MATH 241
Statistics	STAT 511
Foundational Math/Science Elective	MATH 344
ECIV Laboratory Elective	ECIV 340L, plus one other lab
ECIV Distribution Elective	<u>ECIV 556. One from:</u> ECIV 540, 541, 542, 580. <u>Two from:</u> ECIV 325, 327, 530, 531, 562.
ESM Elective	GEOG 563 and CSCE 145. <u>One From:</u> MATH 300, STAT 512. <u>One from:</u> ECIV 540, 541, 542, 580, 582.
Other Elective	ECON 224 and <u>One from:</u> ECIV Distribution or ESM list.

---

## Water Resources Cluster

### What is Water Resources Engineering?

Water resources engineering can be broadly divided into the three categories of groundwater, hydraulics, and hydrology. Groundwater engineering focuses on modeling and managing subsurface water and designing extraction systems; hydraulics emphasizes the mechanics of water flow, including pressurized flow, open channel flow, sediment and contaminant transport, and flow-structure interactions; hydrology is primarily associated with watershed and river flow modeling and understanding interactions between atmospheric, surface, and subsurface water.

### What do Water Resources engineers do?

Water resources engineers fulfill a wide variety of roles in designing and managing water-based systems. These roles include designing distribution systems that transport water to users, designing collection systems that convey wastewater and stormwater, managing surface and ground water resources, modeling and designing major water resources projects (e.g., canals, reservoirs, and hydroelectric works), and many other water-related engineering functions.

### Recommended Courses

Category	Recommended Courses
Basic Science Elective	GEOL 101, 103; MSCI 210, 215
Math (3 <sup>rd</sup> semester)	MATH 241 or MATH 344
Statistics	STAT 511 (strongly recommended) or STAT 509
Foundational Math/Science Elective	MATH 344 or MATH 241
ECIV Laboratory Elective	ECIV 362L, plus one other lab
ECIV Distribution Elective	<u>One from:</u> ECIV 560, 562, 563. <u>One from:</u> ECIV 327, 530, 531. <u>One from:</u> ECIV 551, 558. <u>One from:</u> Any distribution area.
ESM Elective	<u>One from:</u> ECIV 560, 562, 563. <u>One from:</u> ECIV 530, 531, 560, 562, 563. <u>Two from:</u> ECIV 210 <sup>1</sup> , ECIV 325 <sup>1</sup> , ECIV 327 <sup>1</sup> , ECIV 500 and above <sup>1</sup> , CSCE 145 <sup>2</sup> and CSCE 146 <sup>2</sup> , STAT 512 <sup>3</sup> , STAT 516 <sup>3</sup> , STAT 520 <sup>3</sup> , GEOL 315 <sup>4</sup> , GEOL 501 <sup>4</sup> , GEOL 557 <sup>4</sup> , MSCI 314 <sup>5</sup> , MSCI 502 <sup>5</sup> , MSCI 581 <sup>5</sup> , MSCI 582 <sup>5</sup> , GEOL 567 <sup>4,5,6</sup> , GEOL 570 <sup>7</sup> , GEOG 551 <sup>8</sup> , GEOG 554 <sup>8</sup> , GEOG 563 <sup>8</sup> , MATH 544 <sup>9</sup>
Other Elective	<u>Two from</u> ESM Elective list, ECON 224 <sup>10</sup> , MGMT 371 <sup>10</sup> .

### Notes

- 1 – for students interested in the engineering aspect of water resources
- 2 – for students interested in some experience with computer modeling
- 3 – for students interested in statistics and analysis of data and measurements
- 4 – for students interested in river engineering

- 5 – for students interested in coastal engineering
- 6 – for students interested in past and potential impacts of changes in climate
- 7 – for students interested in groundwater hydrology and modeling
- 8 – for students interested in learning about GIS and remote sensing
- 9 – for students interested in mathematics and computer modeling
- 10 – for students interested in the economic and managerial aspect of water resources