Civil Engineering

Bachelor of Science—BSCE—2008-2009

Civil and Environmental Engineering Department

www.civil.northwestern.edu

Civil Engineering 

Civil Engineering serves the basic needs of society through construction and operation of the public infrastructure. Civil engineers research, plan, design, construct, manage, and maintain one-of-a-kind infrastructure systems such as roads, airports, tunnels, bridges, and seaports; residential, office, commercial, and manufacturing buildings; water supply and reclamation networks; and power generation and distribution facilities. Each system has unique characteristics that challenge the civil engineer to combine engineering knowledge with initiative and creativity to satisfy project objectives, protect the well-being of society, and meet budget constraints.

Civil Engineers

Civil Engineers must also explore the social, economic, managerial sciences, and collaborate with other experts and the public. The work of civil engineers may extend to biotechnology to support environmental restoration, and to materials science to develop new building materials. In addition, students at Northwestern learn about application and development of computer models and analytical and experimental methods to explore the response of infrastructure systems to normal and extreme stresses in advance of construction. Civil engineers use advanced sensors and communications devices to monitor performance of bridges, tunnels, buildings in real time, over long distances, and under extreme conditions.

Curriculum

The civil engineering curriculum (accredited by the Accrediting Board for Engineering and Technology) is designed to satisfy a diversity of interests and professional goals. Students construct study plans suited to their unique interests, including extensive options for courses outside the engineering school to address the social and physical challenges of constructing and managing the nation’s infrastructure.

* Environmental Engineering
* Geotechnics
* Structural Engineering and Materials
* Transportation Systems Analysis and Planning
* Mechanics of Materials and Solids
* Construction Management
* introducing Architectural Engineering and Design

After Northwestern

Graduates of civil engineering enter a wide range of careers. City engineers may manage water and wastewater treatment facilities or devise traffic control plans. Engineers in structures and geotechnics design foundation and structures for billion dollar mega-projects such as subway systems, airports, and industrial complexes. Transportation engineers work for private carriers and units of federal, state, and local governments to plan and manage transit, highways, railroads, and airlines. Many civil engineers work in consulting firms, governmental agencies, and manufacturing firms. About half of civil engineering majors go on to graduate school, and about half of these enter graduate programs in other fields to expand their capabilities. A Bachelor of Science in Civil Engineering combined with an advanced degree in law, business, or biochemistry provides an excellent foundation for exciting careers in research, teaching, and development in university, industrial, and governmental settings.

Your contact for declaring Civil Engineering as your Major: Prof. Charles Dowding c-dowding@northwestern.edu
The Bachelor of Science in Civil Engineering (BSCE) degree is awarded upon satisfactory completion of the following 48-course curriculum. Of the 48 course requirements, 32 courses must follow the McCormick School Basic Studies Program; and 16 courses follow the Civil and Environmental Engineering Department’s (CEE) Civil Engineering Major.

Most of the 48 courses must be satisfied by taking courses at Northwestern University (NU); however, a few of the requirements are sometimes satisfied by advanced placement upon entering NU and/or transfer credit from other universities. The last 23 courses must be taken while enrolled at NU and the last three quarters must be completed while the student is enrolled in The Robert R. McCormick School of Engineering and Applied Science (McC or McCormick).

McCormick School Basic Studies Program

(32 courses)

Engineering Analysis (4 courses)
- GEN_ENG 205-1
- GEN_ENG 205-2
- GEN_ENG 205-3
- GEN_ENG 205-4

Mathematics (4 courses)
- MATH 220  Calculus I
- MATH 224  Calculus II
- MATH 230  Calculus III
- MATH 234  Multiple Integration and Vector Calculus

Basic Sciences (4 courses)
- PHYSICS 135-2 General Physics
- CHEM 101 General Chemistry
- CHEM 102 General Chemistry
- CHEM 103 or PHYSICS 135-3. Successful completion of CHEM 171 and 172 is equivalent to completion of CHEM 101 and CHEM 102, and CHEM 103. Students may elect to complete a 5th Basic Science course as a part of the 16-course CEE departmental program.

Basic Engineering (5 courses)
- Thermodynamics: MECH_ENG 220 or CHEM 342-1
- Fluids and Solids: CIV_ENG 216 and MECH_ENG 241
- Electrical Science: ECE 202 or ECE 270
- Materials Science: 1 course from materials science, systems engineering and analysis, computer architecture and numerical analysis or computer programming

Design and Communications (3 course units): IDEA 106-1, 2 (0.5 units each) and English 106-1, 2 (0.5 units each); these half-courses are taught concurrently by a faculty member from Engineering and from English. In the Winter, the courses are IDEA 106-1 and ENGLISH 106-1. In the Spring, the courses are IDEA 106-2 and ENGLISH 106-2. In addition, all engineering students are required to complete one speaking course before graduation: GEN_CMN 102 or 103.

Social Science/Humanities (7 courses): See Social Science/Humanities details.

Unrestricted Electives (5 courses): Any course offered for credit by the University is acceptable for this category.

Note: The CEE faculty recommends the selection of GEN_ENG 220, Analytic and Computer Graphics (CAD), as an unrestricted or technical elective. This course will help prepare you for Capstone Design in your Senior Year.
Design and Communications Requirement

All freshman engineering students are required to complete a two-quarter course sequence in which they are introduced to the process of engineering design and concurrently to techniques for effective writing in the context of engineering reports as well as communications with clients and among team members. The sequence is taken during the winter and spring quarters of the freshman year.

In winter quarter, the student registers for IDEA 106-1 (0.5 units) and ENGLISH 106-1 (0.5 units), and these half-courses are taught concurrently by a faculty member from Engineering and from English. In spring, the courses are IDEA 106-2 and English 106-2. These courses may not be taken P/N.

In addition, all engineering students are required to complete one of the following speaking courses before graduation (higher level courses may be approved to satisfy this requirement on an individual basis):

- GEN CMN 102-0  Public Speaking
- GEN CMN 103-0  Analysis and Performance of Literature

Social Science-Humanities Requirement

Seven courses chosen according to either of the following two options:

Option A. At least two courses must be chosen in each of three areas:

- Social and Behavioral Science (SBS)
- Historical Studies and Values (HSV)
- Fine Arts, Language and Literature (FAL)

Of the seven courses, only three 100-level introductory courses may be presented and three courses must be thematically related to provide depth.

Option B. Five of the seven courses must clearly have a thematic relatedness. For breadth, no more than five courses may come from a single area.

The courses taken for a student's Social Science-Humanities Requirement must be approved in advance by the McCormick Humanities Panel. Foreign language study can be incorporated into the program, but should be started as early as possible, preferably in the Freshman year.

Details of the program are available in the theme listings. If you have misplaced your copy, a replacement copy can be obtained from the Undergraduate Engineering Office—McCormick L269.
Basic Civil Engineering (7 courses)
- CIV_ENG 221 Theory of Structures 1
- CIV_ENG 222 Structural Steel Design
- CIV_ENG 250 Introductory Soil Mechanics
- CIV_ENG 260 Fundamentals of Environmental Engineering
- CIV_ENG 330 Construction Management
- CIV_ENG 340 Fluid Mechanics II
- CIV_ENG 371 Introduction to Transportation Planning and Analysis
  or
- CIV_ENG 376 Transportation Systems Operations

Mathematical Techniques and Science (MTS) (1 course from the list in the following paragraph; plus 1 course from the Approved List – Additional Mathematical Techniques and Science (MTS).

One of the courses must be a calculus-based probability/statistics course such as IEMS 201, IEMS 202, MATH 310-1, MECH_ENG 359, STAT 210, STAT 330-1, STAT 302. CEE faculty recommends the selection of CIV_ENG 306, Uncertainty Analysis in Civil Engineering.

Technical Electives (TE) (5 courses from Approved List TE).

Note: The CEE faculty recommends the selection of GEN_ENG 220, Analytic and Computer Graphics (CAD) and IEMS 326 Economics and Finance for Engineers as either Technical or Unrestricted Electives.

Design and Synthesis (DS) (2 courses from Approved List DS).

Note: In addition to the required CIV_ENG 222, at least 2 additional course units of ABET-accredited design must be completed from the list of Design and Synthesis courses, one of which must be the currently designated “Capstone Design course” (CIV_ENG 382) taken in the “senior” year. Transfer students who do not take IDEA 106-1,2 and GEN_ENG 205-1,2,3,4 require an additional 3.5 (i.e., 2.0 + 1.5) design units (see Approved List DS and/or your advisor).

Additional Guidelines

(i) At Least 10 of the 16 BSCE—CEE Departmental program courses must be CEE courses.
(ii) The 16 departmental courses must have a cumulative GPA of 2.00 or higher.
(iii) Any two courses that are part of the BSCE—CEE Departmental program may be taken P/N. However, no more than two courses in the BSCE—CEE Departmental program may have grades of D. Courses taken abroad for a grade, but recorded by the Northwestern University Registrar as P/N, may be exempted from this requirement. Go to http://www.mccormick.northwestern.edu/undergraduate/pass_fail.php for full McCormick policy.
(iv) The only courses in the 32 McC Basic Studies Program requirements that are eligible for P/N are the speech, 7 social science/humanities, and 5 unrestricted elective courses. No more than 8 courses with a grade of P will be accepted in satisfaction of the graduation requirements. Courses taken abroad for a grade, but recorded by the Northwestern University Registrar as a P, may be exempted from this requirement.
(v) All students pursuing an ABET-accredited undergraduate engineering degree must accumulate a total of 18 course-credits of “Engineering Topics” in fulfillment of their degree. Several courses offered by engineering departments of the McCormick School are classified as providing less than a full unit of credit in the category of “Engineering Topics.” See your advisor.
Approved List — Additional Mathematical Techniques and Science (MTS)

Mathematical Techniques and Science

Note: One Science course from the list may be substituted for one of the two MTS courses.

Math Department - Any course 300 level or above.

Engineering

CIV_ENG 304 Civil and Environmental Engineering Systems Analysis
CIV_ENG 327 Finite Element Methods in Mechanics
CIV_ENG 423 (1) Matrix Analysis of Structures
EECS 310 Mathematical Foundations of Computer Science
EECS 328 Numerical Methods for Engineers
IEMS 310 Operations Research
IEMS 313 Deterministic Models and Optimization
IEMS 315 Stochastic Models and Simulation
ES_APPM Any course 300 level or above

(1) 400-level courses require Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

Science

Any course 200 level or above in Biological Sciences, Chemistry, Geological Sciences or Physics, plus CHEM 103 or PHYSICS 135-3, whichever is not used to satisfy the Basic Sciences requirement.
Approved List — Technical Electives (TE)

Technical Electives Supporting Student’s Specialty

1. Any course, 200-level or above in the McCormick School or in the Weinberg College of Arts and Sciences, Departments of Astronomy, Biological Sciences, Chemistry, Geological Science, Physics, Mathematics, provided the course supports the student’s field of specialty.

2. Economics—for students concentrating in Transportation, the following courses are approved electives.

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON 310-1</td>
<td>Microeconomics I</td>
</tr>
<tr>
<td>ECON 354</td>
<td>Issues in Urban and Regional Economics</td>
</tr>
<tr>
<td>ECON 355</td>
<td>Transportation Economics and Public Policy</td>
</tr>
<tr>
<td>ECON 381-1, 2</td>
<td>Econometrics I and II</td>
</tr>
</tbody>
</table>

3. Other courses from Weinberg College of Arts and Sciences may be approved upon petition.

Approved List — Design and Synthesis (DS)

Courses in Design and Synthesis

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 322</td>
<td>Structural Design  (offered Spring of odd calendar years)</td>
</tr>
<tr>
<td>CIV_ENG 325</td>
<td>Reinforced Concrete (offered Spring of even calendar years)</td>
</tr>
<tr>
<td>CIV_ENG 336</td>
<td>Project Scheduling</td>
</tr>
<tr>
<td>CIV_ENG 352</td>
<td>Elements of Foundation Engineering (offered Winter of odd calendar years)</td>
</tr>
<tr>
<td>CIV_ENG 360</td>
<td>Environmental Impact Evaluation</td>
</tr>
<tr>
<td>CIV_ENG 370</td>
<td>Environmental Engineering Design</td>
</tr>
<tr>
<td>CIV_ENG 382</td>
<td>Infrastructure of Facilities and Systems (Capstone Design Course)</td>
</tr>
<tr>
<td>CIV_ENG 395</td>
<td>Special Topics (must be design class)</td>
</tr>
<tr>
<td>CIV_ENG 399</td>
<td>Projects (must be design project)</td>
</tr>
<tr>
<td>CIV_ENG 421</td>
<td>Prestressed Concrete (Requires permission of instructor and a permission number from <a href="mailto:j-soule@northwestern.edu">j-soule@northwestern.edu</a>. Not offered every year.)</td>
</tr>
</tbody>
</table>

Many courses in other departments of the University may be used to satisfy the design requirement. The Dean of Undergraduate Affairs of McCormick maintains a listing of the design content (credit units) of all undergraduate courses offered by the school.

Note — Students graduating in academic year 2007-08 and subsequently are required to take the course designated as the Capstone Design course (CEE 382—Infrastructure of Facilities and Systems) in the student’s senior year of study.
HONORS PROGRAMS

Outstanding students in the BSCE—CEE Departmental program – may be selected for the following Undergraduate Honors Program.

Undergraduate Honors Program: A student with a good scholastic record can be admitted to the Undergraduate Honors Program any time during the junior or pre-senior year. A cumulative Grade Point Average of 3.50 or better is required at the time of admission to the Honors Program. Any student who is eligible will be notified by the Dean.

An honors student participating in the program must:

(a) complete at least three units of approved advanced study (including courses normally accepted at the graduate level) with an average grade of B or better;
(b) complete an extended Independent Study (at least two quarters on the same topic) leading to an acceptable report.

A student wishing to participate must petition the Civil and Environmental Engineering faculty for approval. The petition must indicate the three units of advanced study and the faculty advisor for the independent study project.

Successful completion of the Undergraduate Honors Program will be entered on the student's transcript. Recognition will also be given in the graduation program. If a student's individually evaluated performance is judged not to meet the standards of success required for the Undergraduate Honors Program, the student will still receive course grades and credits as earned.
Civil and Environmental Engineering Department
—— BSCE—CEE Departmental program ———

*Freshman / Sophomore Years*

**Freshman Year** *(more or less common for all engineering students)*

<table>
<thead>
<tr>
<th>Quarter 1</th>
<th>Quarter 2</th>
<th>Quarter 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN_ENG 205-1</td>
<td>GEN_ENG 205-2</td>
<td>GEN_ENG 205-3</td>
</tr>
<tr>
<td>MATH 220-0</td>
<td>MATH 224-0</td>
<td>MATH 230-0</td>
</tr>
<tr>
<td>CHEM 101*</td>
<td>CHEM 102 *</td>
<td>Elective or CHEM 103 *</td>
</tr>
<tr>
<td>Elective #</td>
<td>IDEA 106-1</td>
<td>IDEA 106-2</td>
</tr>
<tr>
<td></td>
<td>and ENGLISH 106-1</td>
<td>and ENGLISH 106-2</td>
</tr>
</tbody>
</table>

**Sophomore Year** *(more or less common for all engineering students)*

<table>
<thead>
<tr>
<th>Quarter 4</th>
<th>Quarter 5</th>
<th>Quarter 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 234-0</td>
<td>CIV_ENG 216-0</td>
<td>MECH_ENG 241</td>
</tr>
<tr>
<td>PHYSICS 135-2</td>
<td>PHYSICS 135-3 or Elective</td>
<td>Basic Engr or Elective</td>
</tr>
<tr>
<td>GEN_ENG 205-4</td>
<td>Basic Engr or Elective</td>
<td>CIV_ENG 260</td>
</tr>
<tr>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
</tr>
<tr>
<td></td>
<td>GEN_ENG 220-1**</td>
<td>GEN_ENG 220-2**</td>
</tr>
</tbody>
</table>

#One of the electives must satisfy the oral communications requirement (see Design and Communications Requirement).

*Successful completion of CHEM 171 is equivalent to completion of CHEM 101 and CHEM 102; CHEM 171 and 172 are equivalent to CHEM 101, 102, 103.

**Highly Recommended by CEE Faculty -- GEN ENG 220-1,2 is a 0.5 credit AutoCAD course that must be taken P/N both quarters to accumulate 1.0 units of credit as a Technical Elective after Spring Quarter grades are posted.
Example BSCE Specialty Programs — Jr and Sr Years devoted to Specialty
(Course offerings vary year to year: Consult your advisor)

1. For students interested in a BS in Civil Engineering with an Environmental Engineering concentration (see also the BS in Environmental Engineering program for suggested electives).

<table>
<thead>
<tr>
<th>Quarter 7</th>
<th>Quarter 8</th>
<th>Quarter 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG Requirement—CIV_ENG 250</td>
<td>CIV_ENG Elective or Basic Engineering</td>
<td>Basic Engineering</td>
</tr>
<tr>
<td>CIV_ENG Requirement—CIV_ENG 221</td>
<td>CIV_ENG Requirement—CIV_ENG 222</td>
<td>CIV_ENG 340</td>
</tr>
<tr>
<td>CIV_ENG 363</td>
<td>CIV_ENG Elective—CIV_ENG 364</td>
<td>Math Techniques</td>
</tr>
<tr>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Quarter 10</th>
<th>Quarter 11</th>
<th>Quarter 12</th>
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</thead>
<tbody>
<tr>
<td>CIV_ENG Requirement—CIV_ENG 371 or 376</td>
<td>CIV_ENG Elective—CIV_ENG 361</td>
<td>CIV_ENG Design Elective—CIV_ENG 370</td>
</tr>
<tr>
<td>CIV_ENG Elective—CIV_ENG 367</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 382 (Capstone)</td>
</tr>
<tr>
<td>CIV ENG 330</td>
<td>CIV_ENG Elective—CIV_ENG 365</td>
<td>Elective</td>
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<td>Elective</td>
<td>Elective</td>
<td>Elective</td>
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</tbody>
</table>

Typical Electives in Civil Engineering: 302, 306, 346, 355, 356, 359, 360, 361, 363, 364, 365, 367, 370. Selected 400-level courses, such as 440, 441, and 444 may be taken with permission of the instructor, and a permission number from j-soule@northwestern.edu.
Example BSCE Specialty Programs — Jr and Sr Years devoted to Specialty
(continued)

2. For students interested in BS in Civil Engineering with a **Geotechnics concentration**. This program is only a sample.

<table>
<thead>
<tr>
<th>Quarter 7</th>
<th>Quarter 8</th>
<th>Quarter 9</th>
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</thead>
<tbody>
<tr>
<td>CIV_ENG 221</td>
<td>CIV_ENG 222</td>
<td>CIV_ENG 340</td>
</tr>
<tr>
<td>CIV_ENG 250</td>
<td>Math Technique$^3$</td>
<td>Basic Engineering or CIV_ENG Elective$^1$</td>
</tr>
<tr>
<td>CIV_ENG Elective</td>
<td>CIV_ENG Elective$^1$</td>
<td>CIV_ENG Requirement$^2$</td>
</tr>
<tr>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
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</tbody>
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<tr>
<th>Quarter 10</th>
<th>Quarter 11</th>
<th>Quarter 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 371 or 376</td>
<td>CIV_ENG Elective$^2$</td>
<td>CIV_ENG Requirement$^1$</td>
</tr>
<tr>
<td>CIV_ENG 330</td>
<td>CIV_ENG Elective</td>
<td>Elective$^5$ or Math Techniques</td>
</tr>
<tr>
<td>CIV_ENG Elective$^{3,4}$</td>
<td>Elective$^3$</td>
<td>Elective$^1$</td>
</tr>
<tr>
<td>Elective</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 382 (Capstone)</td>
</tr>
</tbody>
</table>


**Note:** CIV_ENG 352 is offered only in the winter of odd calendar years. # Selected graduate courses such as 413, 417, 423 and 451 may be taken with the permission of instructor and a permission number from j-soule@northwestern.edu.

$^1$ CIV_ENG 322, 325, CIV_ENG construction elective recommended.

$^2$ CIV_ENG 355 or 352 recommended.

$^3$ CIV_ENG 306 or 423 recommended.

$^4$ CIV_ENG 358, 413 or 417 recommended.
3. For students interested in BS in Civil Engineering with a **Structural Engineering concentration** and/or **Mechanics of Materials and Solids concentration**: To qualify for future registration as a structural engineer in the State of Illinois, the courses 320, 322, 325, and either 352 or 421 must be completed.

<table>
<thead>
<tr>
<th>Quarter 7</th>
<th>Quarter 8</th>
<th>Quarter 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 221</td>
<td>Basic Engineering or Elective</td>
<td>Basic Engineering or Elective 1</td>
</tr>
<tr>
<td>CIV_ENG 250</td>
<td>CIV_ENG 222</td>
<td>CIV_ENG Elective 1</td>
</tr>
<tr>
<td>Math Techniques 4</td>
<td>CIV_ENG Elective 3</td>
<td>CIV_ENG 340</td>
</tr>
<tr>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
<td>Elective (Humanities)</td>
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<thead>
<tr>
<th>Quarter 10</th>
<th>Quarter 11</th>
<th>Quarter 12</th>
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</thead>
<tbody>
<tr>
<td>CIV_ENG 371 (or 376)</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG Requirement</td>
</tr>
<tr>
<td>Math Techniques 4</td>
<td>CIV_ENG Elective 3</td>
<td>Elective 2</td>
</tr>
<tr>
<td>CIV_ENG 330</td>
<td>Elective 3</td>
<td>Elective 2</td>
</tr>
<tr>
<td>Elective</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 382 (Capstone)</td>
</tr>
</tbody>
</table>

**Typical Electives in Civil Engineering**: 302, 306, 307, 318, 319, 320, 321, 322, 325, 327, 330, 332, 334, 336, 338, 352, (413, 417, 421, 423 with permission of the instructor and a permission number from j-soule@northwestern.edu.)

**Note**: CIV_ENG 319 has been offered only in winter quarter of even calendar years. CIV_ENG 320 and 352 have been offered only in winter quarter of odd calendar years. CIV_ENG 421 may not be offered in some years. Students interested in solid mechanics are urged to choose some electives from the following group CIV_ENG: 318, 327, 413, 417.

1. CIV_ENG 302 recommended.

2. CIV_ENG 325 or 322 recommended.

3. CIV_ENG 319, 320, 321 or 352 recommended.

4. CIV_ENG 306 or CIV_ENG 423 recommended.
Example BSCE Specialty Programs — Jr and Sr Years devoted to Specialty

(continued)

4. For students interested in BS in Civil Engineering with a Transportation Systems Analysis and Planning concentration

<table>
<thead>
<tr>
<th>Quarter 7</th>
<th>Quarter 8</th>
<th>Quarter 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 371</td>
<td>Basic Engineering (Thermodynamics)</td>
<td>Math Tech (CIV_ENG 304)</td>
</tr>
<tr>
<td>Math Techniques</td>
<td>Tech Elective (ECON 310-1)</td>
<td>CIV_ENG Elective</td>
</tr>
<tr>
<td>(CIV_ENG 306)</td>
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</tr>
<tr>
<td>CIV_ENG 250</td>
<td>Basic Engineering (Electrical Science)</td>
<td>CIV_ENG 340 or Tech Elective</td>
</tr>
<tr>
<td>Humanities Elective</td>
<td>Humanities Elective</td>
<td>Humanities Elective</td>
</tr>
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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 221</td>
<td>CIV_ENG 222</td>
<td>CIV_ENG 340 or Tech Elective</td>
</tr>
<tr>
<td>Tech Elective</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 382 (Capstone)</td>
</tr>
<tr>
<td>(IEMS 304)</td>
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</tr>
<tr>
<td>CIV_ENG Elective</td>
<td>Tech Elective (ECON 355)</td>
<td>Tech Elective</td>
</tr>
<tr>
<td>(CIV_ENG 376)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIV ENG 330</td>
<td>Humanities Elective</td>
<td>Elective</td>
</tr>
</tbody>
</table>

Note: At least 9 of the courses above must be CEE departmental courses. Required Capstone Design Course, CIV_ENG 382, is offered only in spring quarter. Other suggested design electives include CIV_ENG 322, 325, 352, and 360.
Civil and Environmental Engineering Department

Example BSCE Specialty Programs — Jr and Sr Years devoted to Specialty

(continued)

5. For students interested in BS in Civil Engineering with a Construction Management concentration.

<table>
<thead>
<tr>
<th>Quarter 7</th>
<th>Quarter 8</th>
<th>Quarter 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 221</td>
<td>CIV_ENG 222</td>
<td>CIV_ENG 325</td>
</tr>
<tr>
<td>CIV_ENG 250</td>
<td>Basic Engineering or CIV_ENG Elective</td>
<td>Basic Engineering or CIV_ENG Elective</td>
</tr>
<tr>
<td>CIV_ENG 306</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 340</td>
</tr>
<tr>
<td>Humanities Elective</td>
<td>Humanities Elective</td>
<td>Humanities Elective</td>
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<th>Quarter 10</th>
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<tr>
<td>CIV_ENG 371 or 376</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 302</td>
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<td>CIV_ENG 330</td>
<td>CIV_ENG Elective</td>
<td>CIV_ENG 382 (Capstone)</td>
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<td>CIV_ENG 338 or</td>
<td>CIV_ENG 336 or</td>
<td>CIV_ENG 332</td>
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Typical Electives in Civil Engineering: 319, 320, 321, 322, 325, 336, 338, 346, 352, 355, 358, 359, 360, 363, 364, 366, 367, 370. Selected graduate courses such as 413, 417-1, 423, 434, and 451 with permission of instructor and permission number from j-soule@northwestern.edu.

Note: Construction management courses CIV_ENG 332 and CIV_ENG 336 have CIV_ENG 330 as a prerequisite; CIV_ENG 338 has a prerequisite of senior or pre-senior standing. CIV_ENG 319 is offered only in winter quarter of even calendar years. CIV_ENG 322 is offered only in spring of odd calendar years. CIV_ENG 325 is offered only in spring of even calendar years. CIV_ENG 320 and 352 are offered only in winter quarter of odd calendar years. CIV_ENG 421 may not be offered in some years.

Typical Electives in Industrial Engineering: 306, 326, 340, 342
An Option to Combine Academics With Real-World Experience:
The Northwestern University CO-Op Program

At Northwestern University, The Walter P. Murphy Cooperative Engineering Education Program (CO-OP) is a 5-year educational program which gives undergraduate students in engineering an opportunity to alternate periods of academic study with periods of full-time paid work—a real-world experience related to their academic degree and their professional goals. A CO-OP student completes 12 academic quarters in addition to industry experience—the time grid below

The CO-OP program is accredited by ABET, and some or all of your CO-OP experience may count toward the experience required to become a licensed professional engineer, depending upon the state in which you apply after graduation.

You will receive an engineering degree from one of the best universities in the country PLUS one and one half years of engineering experience in industry. Because of its national standing, McCormick School of Engineering and Applied Science attracts Fortune 500 companies, as well as the best and fastest growing mid-size and small companies in the country.

The Employer Evaluations, which are completed each quarter that you work, serve as documentation of how you performed in the workplace and can complement your academic transcript for future employers and graduate schools. The Program provides a campus coordinator to work with you in all aspects of your participation in the CO-OP Program.

You will be registered in a non-credit course so that your CO-OP experience becomes part of your academic history; you are continuously enrolled at Northwestern while you are working on a CO-OP assignment. Therefore, you can remain covered by your family's health insurance and automobile insurance at student rates. In addition, your student loans do not go into repayment. Your experience is documented for future professional licensing.

It is important to note that you do not pay tuition or fees during the quarters that you are on a CO-OP assignment and registered in the CO-OP course. The Tuition Rebate Program assures that you pay the same amount of tuition that you would have paid if you went straight through in four years.

<table>
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<td>4</td>
<td>CO-OP</td>
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<td>DONE !!!</td>
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Course Descriptions
200s = Undergraduates; 300s = Undergraduates (meeting Prerequisites) and Graduates;
400s = Graduates and Undergraduates (with permission of instructor and permission number from the
CEE Academic Coordinator, j-soule@northwestern.edu)

ENVR_SCI 201 Earth: An Habitable Planet  Presents a broad description of Earth System Sciences focused on the physical, chemical, and biological processes that have made the planet habitable. The first area of focus is to retrace the evolution of the planet from the early ages, when the laws of physics and chemistry ruled, to the apparition of life and the homeostatic conditions that resulted. The second is to describe, and show how we can quantify, the major biogeochemical cycles that are key in this homeostatic equilibrium. The third component is to assess the impact of human activities that can lead to minor or major perturbations and the policy efforts that have been implemented for their control.  Prerequisites: MATH 224; CHEM 103 or CHEM 172.

ENVR_SCI 202 The Health of the Biosphere
Three main foci in this course:  1. Understanding mathematics of population growth (economics of harvested populations, history and projections of human population growth, impacts of growth and increased resource use, etc);  2. Distilling important concepts from ecology and evolution (ecological interactions, trophic structure/energy flow, overhunting, diversity-stability relationship, etc);  3. Applying environmental economics (cost-benefit analysis, the values of biodiversity and ecosystem function; destruction and fragmentation of habitats, etc. Prerequisites: MATH 224 or equivalent.

ENVR_SCI 203 Energy and the Environment:  The Automobile
Using the automobile as example, this course provides an integrated study of fundamental chemistry (thermodynamics, atmospheric chemistry, free radical mechanisms of reaction), industrial production, energy use, and public policy from an environmental perspective.  Prerequisites: MATH 224 or equivalent.

Highly recommended by CEE Faculty -- GEN_ENG 220-1,2 : Analytic and Computer Graphics (2-quarters)
Microcomputer-aided drawing (CAD) for graphical three-dimensional problem solving and presentation—2-Qrtr course (.50 credit each quarter).  Winter Quarter results in a “K” grade; Spring Quarter results in a Final Grade for the two quarters on a mandatory P/N only basis (Winter “K” is converted to a P at the end of the Spring Quarter).

CIV_ENG 212-0 Mechanics

CIV_ENG 216-0 Mechanics of Materials I
Analytical and experimental study of stresses and deformations and their application to the design of machine and structural elements subjected to static, dynamic, and repeated loads. Prerequisite: CIV_ENG 212 or GEN_ENG 205-2.

CIV_ENG 221-0 Theory of Structures I
Deflections of structures, energy concepts, idealization of structures, truss analysis, column stability, and influence lines. Introduction to indeterminate truss and frame analyses, slope-deflection analysis, and moment distribution. Portal method. Prerequisite: CIV_ENG 216.

CIV_ENG 222-0 Structural Steel Design
Rational basis of structural design. Design approach for structural steel components of a building system. Prerequisite: CIV_ENG 221.

MECH_ENG 241-0 Fluid Mechanics I

CIV_ENG 250-0 Introductory Soil Mechanics
Fundamental properties and behavior of soils as engineering materials. Origin of soils through the properties of soil components to the strength, permeability, and deformation of soil masses. Prerequisite: CIV_ENG 216, completion of MECH_ENG 141 is recommended.

CIV_ENG 260-0 Fundamentals of Environmental Engineering
Mass and energy concepts applied to major issues facing environmental engineers: safe drinking water, surface water quality, ambient air quality, global atmosphere, managing solid and hazardous wastes. Prerequisites: CHEM 101 and MATH 224 (take concurrently).

CIV_ENG 302-0 Engineering Law
The American legal system from an engineer’s perspective.  Socratic-method analysis of statutory and case law.  Contract, patent, corporation, antitrust, property, and environmental law. Prerequisite: Senior standing.
CIV_ENG 303-0 Environmental Law and Policy
An introduction to many important and interesting aspects of environmental law and policy. A wide range of environmental topics are covered focusing on national environmental policy as implemented through major federal environmental statutes. Prerequisite: Junior or Senior standing.

CIV_ENG 304-0 Civil and Environmental Engineering Systems Analysis
Explores problems that arise in planning and managing engineering projects/systems. Integrates methodological tools, often used in the management sciences, with applications in civil and environmental engineering—engineering economics, decision making under uncertainty (decision analysis and dynamic programming), and optimization (constrained optimization and linear programming). Prerequisite: Junior or Senior standing; MATH 224 or equivalent (calculus and probability).

CIV_ENG 306-0 Uncertainty Analysis in Civil Engineering
Probability, statistics, and decision theory. Discrete and continuous random variables, marginal and conditional distributions, moments, statistical model selection and significance tests, hypothesis testing, and elementary Bayesian decision theory. Application to problems in soil mechanics, water resources, transportation, and structures. Prerequisite Math 230-0

CIV_ENG 307-0 Microstructure of Cement-Based Materials
Chemistry of the principal silicate and aluminate cements used in building and civil and environmental engineering. Emphasis on underlying science rather than on practical application. Experimental and theoretical aspects of cement chemistry; relationships between processing, microstructure, and properties. Prerequisite Permission of instructor.

CIV_ENG 314-0 Mechanics of Crustal Processes
Application of elementary mechanics to geological processes of crustal deformation, including faulting, earthquake generation and deformation, and folding and coupling of fluid flow with deformation. Prerequisite Permission of instructor.

CIV_ENG 318-0 Mechanics of Fracture
Stress concentration: analysis of the stress field near a crack tip; fracture modes; brittle and ductile fracture; fracture toughness; fracture criteria; fracture mechanics design; fatigue; dynamic effects. Prerequisites: CIV_ENG 216 or GEN_ENG 205-4.

CIV_ENG 319-0 Theory of Structures II
Shear center, nonprismatic members, nonlinear materials, influence lines, Mueller-Breslau Principle, approximate methods of analysis, energy methods, stiffness matrix, and computer methods of analysis. Prerequisite: CIV_ENG 221.

CIV_ENG 320-0 Structural Analysis
Single and multiple degree of freedom systems subjected to period, seismic, and general loadings. Time history analysis of linear and nonlinear systems. Design methods for earthquakes. Prerequisite: CIV_ENG 221

CIV_ENG 321-0 Properties of Concrete
Concrete as a composite material; relationship between constitutive laws and microstructure; failure theories, fracture; fatigue; strain rate effects; destructive and nondestructive testing; creep and shrinkage; chemistry of cement hydration; admixtures; aggregates; proportioning; new materials. Prerequisite: CIV_ENG 216.

CIV_ENG 322-0 Structural Design
Design criteria; planning and design aspects of structural systems for gravity and lateral loads; an integral part of the class is a total design project involving the analysis and design of a structure. Prerequisite: CIV_ENG 222 or equivalent.

CIV_ENG 325-0 Reinforced Concrete

CIV_ENG 327-0 Finite Element Methods in Mechanics
Development of finite elements from variational principles and application to static stress analysis. Introduction to techniques for transient and generalized field problems. Computer implementation. Prerequisite: MECH_ENG 262, MATH 215, or CIV_ENG 216, and permission of instructor.

CIV_ENG 330-0 Construction Management
Techniques for coordinating decisions and actions of various parties in the design and construction of civil and environmental engineering projects. Delivery systems; preconstruction services; project planning; cost control and value engineering; bidding. Prerequisite: Senior standing in engineering, or permission of instructor.

CIV_ENG 332-0 Construction Estimating
Estimation of cost at different stages of design; conceptual estimating, quantity take-off of various elements, such as materials, labor, equipment. Prerequisite: CIV_ENG 330 or permission of instructor.

CIV_ENG 336-0 Project Scheduling
Project planning, scheduling, and control using CPM arrow and precedence networks; resource allocation and leveling; earned-value
analysis, linear scheduling; PERT; hands-on experience in using computer tools. **Prerequisite:** CIV_ENG 330 or permission of instructor.

**CIV_ENG 338-0 Public Infrastructure Management**
Explores the complexity of managing public infrastructure facilities by means of a five-part interactive model of infrastructure management. Aims to impart a realistic appreciation of contemporary public infrastructure management policies and practices. **Prerequisite:** Senior standing.

**CIV_ENG 340-0 Fluid Mechanics II**
Civil engineering applications of fluid mechanics. Turbulent flow in pipes, pipe networks, and open channels. Water waves and coastal engineering. **Prerequisite:** MECH_ENG 241 or CHEM_ENG 321 or permission of instructor.

**CIV_ENG 352-0 Foundation Engineering**
Application of soil mechanics to analysis and design of foundations and embankments. Settlement of structures, bearing capacities of shallow and deep foundations, earth pressures on retaining structures and slope stability. **Prerequisite:** CIV_ENG 250.

**CIV_ENG 355-0 Engineering Aspects of Groundwater Flow**
Applied aspects of groundwater flow and seepage, including Darcy’s law, parameter determination, aquifer test analysis, flow-net construction and application, modeling techniques, slope-stability analysis, drainage, and filter design. **Prerequisite:** MECH_ENG 241, CIV_ENG 340, and Pre-senior or senior standing.

**CIV_ENG 356-0 Transport Processes in Porous Media**
Transport processes in porous media, including unsaturated flow, flow in deformable porous media, convective transport of solutes with hydrodynamic dispersion effects and coupled flow phenomena with particular emphasis on electrokinetics. **Prerequisite:** CIV_ENG 355.

**CIV_ENG 358-0 Airphoto Interpretation**
Principles and practice of using aerial photographs to obtain information about natural features of the earth's surface, with emphasis on earth materials. Landforms, geological processes, rocks, and soils. Stereoscopic photographs, elements of photogrammetry. **Prerequisite:** Junior standing or permission of instructor.

**CIV_ENG 361-0 Environmental Microbiology and Public Health**
Basic principles of microbiology; etiology of infectious and noninfectious diseases; control of environmentally-based health hazards. **Prerequisite:** Junior standing.

**CIV_ENG 362-0 Ethics, Engineering, and Environment**
A broad introduction to ethics for scientists and engineers required to make both personal and professional ethical decisions that include complexity and issues of environment. **Prerequisite:** Junior standing.

**CIV_ENG 363-0 Environmental Engineering Applications I: Air & Land**
Nature and control of community air pollution. Sources, physical and chemical properties, and effects of major air pollutants; analytical measurements and monitoring of air pollutants; engineering and legislative control. **Prerequisite:** Junior standing.

**CIV_ENG 364-0 Environmental Engineering Applications II: Water**
Engineering elements of water supply and water pollution abatement. Water quality standards, water and wastewater treatment processes, and the management of receiving waters to control pollution. **Prerequisite:** MECH_ENG 241 and CIV_ENG 340.

**CIV_ENG 365-0 Environmental Laboratory**
Chemical and microbiological aspects of environmental engineering and science are explored through an integrated laboratory course. Junior standing.

**CIV_ENG 367-0 Aquatic Chemistry**
Chemical equilibria in natural waters. Development of the theoretical basis for the investigation of chemical behavior of aquatic systems emphasizing a problem-solving approach. **Prerequisite:** CHEM 103, or permission of instructor.

**CIV_ENG 369-0 The Industrial Ecology of Materials of Products**
This course increases student knowledge of eco-design, green products, environmentally friendly manufacturing, reuse of various materials, and recycling. **Prerequisite:** Junior or Senior standing.

**CIV_ENG 370-0 Environmental Engineering Design (Capstone Design for BSEEs)**
Culminating student team design experience in Environmental Engineering: decision-making in selection and implementation of environmental control measures, including evaluation of economic, social and environmental impacts of alternative proposed projects. **Prerequisite:** Senior standing in Civil and Environmental Engineering, or permission of instructor.
CIV_ENG 371-0 Introduction to Transportation Planning and Analysis
Analysis and design of solutions to transportation problems; introduction to selected operations research and statistical analysis techniques; extensive use of case studies in urban transportation, intercity passenger transport, and freight movements. Prerequisite: Junior standing in engineering or permission of instructor.

CIV_ENG 376-0 Transportation System Operations
Traffic flow theory; vehicle and human factors, capacity analysis; intersection performance and control; management and control of arterial streets and networks; neighborhood traffic restraint, urban transit operations. Operations concepts and theories applied to actual problems through laboratory practice. Prerequisite: Junior standing, and basic knowledge of calculus and statistics. Knowledge of MATLAB is desirable, but not required.

CIV_ENG 382-0 Infrastructure of Facilities and Systems (Capstone Design for BSCEs)
Culminating student team design experience in Civil Engineering, with overview of function, design, and operation of modern infrastructure systems, through lecture-discussions and weekly field trips to working systems. Prerequisite: Senior standing in Civil and Environmental Engineering, or permission of instructor.

CIV_ENG 395-0 Special Topics in Civil Engineering
Undergraduate level experimental courses.

CIV_ENG 398-1,2 Community-based Design
Year-long participation in two- or three-person team projects involving research, analysis, and/or design in the solution of environmental problems affecting primarily low-income communities. Grade assigned only on completion of both units. Prerequisite: Junior or senior standing in BSCE or BSEE and permission of instructor.

CIV_ENG 399-0 Projects
Special projects under faculty direction. Credit to be arranged. Each instructor has own section—student must obtain permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 411-0 Micromechanics
Mechanics of microstructures of materials, such as continuum theory of dislocations, inclusions, inhomogeneities, cracks, and composite materials. Unified eigenstrain method employed. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 413-0 Experimental Stress Analysis
Experimental techniques in measuring stress and strain. Strain gauge, photoelastic, brittle coating, and Moire techniques studies and applied with selected laboratory experiments. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 414-1,2 Mechanics of Composite Materials I, II
Introduction to basic concepts: fabrication of composite materials, micromechanics, macromechanics of uni-directional lamina, failure theories, mechanics of multi-directional laminate, lamination theory, hydrotough interactions, interlaminar stresses, stress concentrations, structural design and optimization, and nondestructive evaluation. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 415-0 Theory of Elasticity
Notions of stress and strain. Basic equations of the linear theory of elastic media. Stress function and displacement potentials. Applications to specific classes of problems such as plate strain, contact stresses, and axisymmetric problems. Stress concentration. Singular states of stress. Dislocations and residual stresses. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 417-1 Mechanics of Continua I
Introduction to the mechanics of continuous media. Cartesian tensors; kinematics of deformable media; stress; balance laws; constitutive relations for selected solids and fluids. Prerequisites: GEN_ENG 205-2,3 or CIV_ENG 212 and MATH 240. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 417-2 Mechanics of Continua II
Kinematics of deformable media, thermodynamics and balance laws of continua, general theory of constitutive equations. Emphasis on large deformation theories; objective stress and deformation measures with applications in finite strain elasticity. Introduction to nonlinear and inelastic material behavior including applications in plasticity and viscoelasticity. Prerequisite: CIV_ENG 417-1 or equivalent. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 420 Advanced Structural Analysis
Solution of nonlinear equations for structures, shear center and center of twist of open and multicell cross sections, shear stresses in multicell closed cross sections, restrained warping torsion stresses. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).
CIV_ENG 421 Prestressed Concrete
Principles of prestressed concrete. Prestressing systems, end anchorage, and loss of prestress. Analysis and design of sections for flexure, shear, bond, bearing, and deflection. Continuous beams, slab, tension, and compression members. Circular prestressing. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 422 Inelastic Analysis of Structures
Inelastic analysis of frames, plates, and shells. Plastic behavior and limit analysis theorems. Static and kinematic methods for calculating collapse loads. Yield surfaces for plates and shells, plastic potential flow law, and load capacity. Viscoelastic behavior and rheologic models. Creep of concrete and its effects in structures. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).

CIV_ENG 423-0 Matrix Analysis of Structures
Use of matrix methods for analysis of articulated structural systems, geometric matrices, stability, analysis of geometrically nonlinear systems, introduction to the finite element method. Prerequisite: CIV_ENG 221. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 424 Stability of Structures
Buckling of perfect and imperfect columns, mathematical treatment of various types of stability problems and stability criteria, dynamic and static instability, and energy methods. Buckling of frames, trusses, and beams. Snap-through, elastic-plastic columns, creep buckling, and basic approach to buckling of two- and three-dimensional bodies. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).

CIV_ENG 426-1,2 Advanced Finite Element Methods I, II
Methods for treating material and geometric nonlinearities by finite elements; transient analysis: explicit and implicit time integration, partitioned methods, and stability; hybrid and mixed elements; finite elements for plates and shells; convergence, efficiency, and computer implementation. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).

CIV_ENG 430 Cohesive Fracture and Scaling

CIV_ENG 435 Cost Engineering and Control
Application of cost engineering for construction companies and projects; time and cost integration; estimating process and bid preparation; labor estimates; accounting for equipment; cost-control concepts; changes and extras; claims. Prerequisites: IEMS 423 and IEMS 425 Prerequisite: Permission of instructor.

CIV_ENG 436 Construction Contracts and Dispute Resolutions

CIV_ENG 440-0 Environmental Transport Processes (formerly Physical Principles in Environmental Engineering)
Processes controlling transport and fate of dissolved and suspended substances in natural and engineered environmental systems. Mass balances, hydrodynamic transport, phase and mass transfers; the fate of reactive species in complex environmental systems. Prerequisites: PHYS 135-1,2 and CHEM_ENG 321, MECH_ENG 241, or equivalent. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).

CIV_ENG 441-0 Methods in Microbial Complexity
Principles of microbial physiology and biochemistry applied to microorganisms of environmental interest. Prerequisite: CIV_ENG 367. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).

CIV_ENG 442 Processes in Environmental Biotechnology
Theory and practice of microbiological processes used in pollution control: kinetics of suspended growth and fixed-film processes, activated sludge, biofilm processes, nitrogen and phosphorus removal, methanogenesis. Prerequisites: CIV_ENG 440, CIV_ENG 441, and CIV_ENG 467. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (l-soule@northwestern.edu).
CIV_ENG 444 Physical/Chemical Processes in Environmental Control
Theory and practice of separations and conversions in water quality and residuals management. Water quality, coagulation, adsorption, ion exchange, membranes, oxidation, sedimentation, flocculation, filtration. Prerequisite: CIV_ENG 367, CIV_ENG 440 or equivalent. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 445 Environmental Systems Laboratory
Mechanistic aspects of the performance of selected unit processes typically used in drinking water treatment: coagulation, filtration, reactor hydraulics, disinfection, chemical reaction and other physicochemical phenomena to elucidate parameters and conditions critical for controlling treatment effectiveness and efficiency. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 447-0 Biogeochemistry
The cycling of biogenic elements (C, N, S, Fe, Mn) in surficial environments is the focus of this course. Emphasis will be placed on microbial processes and isotopic signatures. Prerequisite: Undergraduates must have permission of instructor and a permission number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 448-0 Biophysicochemical Processes in Environmental Systems
Microbiological and engineering fundamentals of bioremediation, with emphasis on current and emerging technologies for major classes of environmental contaminants and contaminated sites. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 449-1,2,3 Environmental Laboratory Experience
A combined year-long laboratory experience that is coupled to classroom learning. Three laboratory exercises will be conducted each quarter and these are designed to reinforce the fundamentals of environmental transport, chemistry and microbiology that are taught in the core curriculum. Students will learn how to make selected measurements, collect and analyze data, design experiments, and draw conclusions based on their observations. The labs will parallel materials presented in coursework and provide students with hands-on learning opportunity. In the fall, the labs will be focused on environmental chemistry and transport, in the winter, environmental microbiology and advanced environmental chemistry, and in the spring the labs will stress integration of these basic principles to look at the behavior of environmental systems. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 450-1,2,3 Soil Mechanics I, II, III

CIV_ENG 451-0 Engineering Properties of Soils
Determination and interpretation of engineering properties of soils. Laboratory testing procedures and methods of evaluation and control. Report writing. Prerequisite: CIV_ENG 250. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 453 Rock Mechanics
Engineering properties and behavior of rock masses. Shear strength of rock, in situ and laboratory tests of strength, rock fracture, three-dimensional geometry of joint systems, stability of rock masses, in situ stress determination, and deformability of rock masses. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 454 Constitutive Models for Soils
Numerical models of effective and total stress-strain response of soils; non-linear pseudo-elastic, elasto-plastic and bounding surface models; parameter identification and applications. Prerequisite: CIV_ENG 450-1 or Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 457-0 Environmental Geotechnics
Site characterization and geotechnical aspects of waste containment and remediation. Geological setting and the heterogeneous nature of soils. Design, testing, and quality control of geosynthetics. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 458 Soil Dynamics
Dynamics of soils and soil-foundation systems; nuclear weapons effects, earthquake response, vibrations of machine foundations, reactions due to impact equipment, industrial noise and blast effects, fatigue concepts, wave propagation and attenuation, blast-resistant construction, and linear and nonlinear systems. Prerequisite: Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).
CIV_ENG 461 Soil Science for Environmental Engineering
Fundamental properties and behavior of soil systems, with emphasis on soil physics, soil chemistry, and soil microbiological and biochemical reactions applied to contaminant transport and fate. Includes laboratory experience with soil. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 467 Advanced Environmental Chemistry
Principles and applications needed to develop advanced problem-solving techniques in environmental chemistry. Major topics include applied thermodynamics, environmental organic chemistry, and problem solving for acid/base, complexation, precipitation/dissolution, and redox. **Prerequisite:** CIV_ENG 367. Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 468 Chemical Speciation in Aquatic Systems
Advanced theories, computerized methods, and chemical tools for investigating the chemical speciation of natural waters. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 471-1,2 Transportation Systems Analysis I, II
Applications of optimization methods to the analysis, design, and operation of transportation logistics networks. Network equilibrium. Flow prediction in congested multi-commodity networks. Vehicle routing and fleet management. Dynamic and stochastic transportation network modeling. **Prerequisite:** IEMS 310 or equivalent background. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 479 Transportation Systems Planning and Management
Functional and structural description of transportation systems; characteristics of major U.S. transportation modes; transportation analysis, planning, problem-solving, and decision-making methods illustrated through urban, freight, and intercity case studies. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 480-1,2 Travel Demand Analysis and Forecasting I, II
Introduction and application of statistical, econometric, and marketing research techniques to study and forecast travel behavior. First Quarter: introduction to theory, analysis, and model development. Second Quarter: advanced theory, disaggregate choice models, and prediction methods. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 482 Evaluation and Decision-Making for Infrastructure Systems
Theories and methods of evaluation and choice from alternatives for transportation and other infrastructure projects and systems. Economic, quantitative, and judgmental methods for both a priori and before-and-after evaluation. Measurement, modeling, analysis, and presentation problems. **Prerequisite:** CIV_ENG 306. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 483 Infrastructure Systems Analysis
Quantitative techniques to develop prescriptive models that can be used to support efficient planning and management of civil infrastructure systems. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 495 Selected Topics in Civil Engineering
Graduate-level experimental courses. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 497 Selected Topics in Civil Engineering
Half-unit special courses under faculty direction. **Prerequisite:** Permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).

CIV_ENG 499 Projects
Special projects under faculty direction (1, 2, or 3 units). Each instructor has own section—student must obtain permission from instructor and Permission Number from the Academic Coordinator in Tech A236 (j-soule@northwestern.edu).
# Design Content and Prerequisites for Courses in your Civil Engineering Major

**Note:** * Course offered only in odd-numbered calendar years;  # Course offered only in even-numbered calendar years.

<table>
<thead>
<tr>
<th>Course</th>
<th>Design Units</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV_ENG 212</td>
<td>(0)</td>
<td>PHYSICS 135-1, registration in MATH 234</td>
</tr>
<tr>
<td>CIV_ENG 216</td>
<td>(0.125)</td>
<td>CIV_ENG 212 or GEN_ENG 205-2</td>
</tr>
<tr>
<td>CIV_ENG 221</td>
<td>(0)</td>
<td>CIV_ENG 216</td>
</tr>
<tr>
<td>CIV_ENG 222</td>
<td>(1.0)</td>
<td>CIV_ENG 221</td>
</tr>
<tr>
<td>CIV_ENG 250</td>
<td>(0.25)</td>
<td>CIV_ENG 216, completion of MECH_ENG 241 is recommended</td>
</tr>
<tr>
<td>CIV_ENG 260</td>
<td>(0.25)</td>
<td>CHEM 101 and MATH 224-0 (concurrently)</td>
</tr>
<tr>
<td>CIV_ENG 302</td>
<td>(0.25)</td>
<td>Senior Standing</td>
</tr>
<tr>
<td>CIV_ENG 304</td>
<td>(0)</td>
<td>Jrs / Srs / MATH 224 or equivalent (calculus and probability)</td>
</tr>
<tr>
<td>CIV_ENG 306</td>
<td>(0)</td>
<td>MATH 230-0</td>
</tr>
<tr>
<td>CIV_ENG 307</td>
<td>(0.5)</td>
<td>Permission of Instructor</td>
</tr>
<tr>
<td>CIV_ENG 314</td>
<td>(0)</td>
<td>CIV_ENG 216, MATH 250, or GEN_ENG 205-4</td>
</tr>
<tr>
<td>CIV_ENG 318</td>
<td>(0.125)</td>
<td>CIV_ENG 216, or GEN_ENG. 205-4</td>
</tr>
<tr>
<td>CIV_ENG 319 #</td>
<td>(0)</td>
<td>CIV_ENG 221</td>
</tr>
<tr>
<td>CIV_ENG 320 *</td>
<td>(0.5)</td>
<td>CIV_ENG 221</td>
</tr>
<tr>
<td>CIV_ENG 321</td>
<td>(0)</td>
<td>CIV_ENG 216</td>
</tr>
<tr>
<td>CIV_ENG 322 *</td>
<td>(1.0)</td>
<td>CIV_ENG 222</td>
</tr>
<tr>
<td>CIV_ENG 325 #</td>
<td>(1.0)</td>
<td>CIV_ENG 221</td>
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<tr>
<td>CIV_ENG 327</td>
<td>(0.125)</td>
<td>MECH_ENG 262, MATH 215, or CIV_ENG 216. Permission of instructor</td>
</tr>
<tr>
<td>CIV_ENG 330</td>
<td>(0.5)</td>
<td>Senior standing in Engineering or Permission of Instructor</td>
</tr>
<tr>
<td>CIV_ENG 332</td>
<td>(0.25)</td>
<td>CIV_ENG 330 or permission of instructor.</td>
</tr>
<tr>
<td>CIV_ENG 336</td>
<td>(1.0)</td>
<td>CIV_ENG 330 or permission of instructor.</td>
</tr>
<tr>
<td>CIV_ENG 338</td>
<td>(0.5)</td>
<td>Senior standing.</td>
</tr>
<tr>
<td>CIV_ENG 340</td>
<td>(0.25)</td>
<td>BMD_ENG 270, CHEM_ENG 321, or MECH_ENG 241</td>
</tr>
<tr>
<td>CIV_ENG 346</td>
<td>(0.5)</td>
<td>MECH_ENG 241, CIV_ENG 340 recommended</td>
</tr>
<tr>
<td>CIV_ENG 349</td>
<td>(0)</td>
<td>Pre-senior or senior standing</td>
</tr>
<tr>
<td>CIV_ENG 352 *</td>
<td>(1.0)</td>
<td>CIV_ENG 250</td>
</tr>
<tr>
<td>CIV_ENG 355</td>
<td>(0.5)</td>
<td>Pre-senior or senior standing; CIV_ENG 340</td>
</tr>
<tr>
<td>CIV_ENG 356</td>
<td>(0.5)</td>
<td>CIV_ENG 355</td>
</tr>
<tr>
<td>CIV_ENG 358</td>
<td>(0.25)</td>
<td>Junior standing or permission of instructor.</td>
</tr>
<tr>
<td>CIV_ENG 359</td>
<td>(0.25)</td>
<td>Senior standing in engineering or science</td>
</tr>
</tbody>
</table>
CIV_ENG 360  (1.0)  Junior Standing
CIV_ENG 361  (0.25)  Junior Standing
CIV_ENG 363  (0.5)  Junior Standing
CIV_ENG 364  (0.5)  MECH_ENG 241, CIV_ENG 340 recommended
CIV_ENG 365  (0.125)  Junior Standing.
CIV_ENG 367  (0.125)  CHEM 103
CIV_ENG 370  (1.0)  Culminating student team design experience in Environmental Engineering. Senior standing in Environmental Engineering (BSEE) or permission of instructor.
CIV_ENG 371  0.25)  Junior Standing in engineering or permission of instructor
CIV_ENG 376  (0.75)  Junior Standing and basic knowledge of calculus and statistics. Knowledge of MATLAB is desirable, but not required.
CIV_ENG 382  (1.0)  Culminating student team design experience in Civil Engineering. Senior standing in Civil Engineering (BSCE) or permission of instructor.
CIV_ENG 395  (1.0 or varies)  (1.0)  Varies
CIV_ENG398-1,2  Jr/Sr Standing in BSEE or BSCE and permission of instructor
CIV_ENG 399  (Varies)  Permission of instructor

NOTE  The following courses require permission of the instructor and a permission numbers from Academic Coordinator, j-soule@northwestern.edu

CIV_ENG 413  (0.25)  CIV_ENG 216
CIV_ENG 417-1  (0)  GEN_ENG 205-2,3 or CIV_ENG 212 and MATH 240
CIV_ENG 421  (1.0)  CIV_ENG 325
CIV_ENG 423  (0)  CIV_ENG 221
CIV_ENG 434  (0)  CIV_ENG 330
CIV_ENG 440  (0.25)  PHYSICS 135-2; MECH_ENG 241 or equivalent
CIV_ENG 441  (0.125)  CIV_ENG 367
CIV_ENG 446  (0)  CIV_ENG 367
CIV_ENG 451  (0.5)  CIV_ENG 250 or equivalent
CIV_ENG 457  (0.25)  Permission of Instructor
McCormick School’s Mission Statement – Excellence at All Levels

The Robert R. McCormick School of Engineering and Applied Science seeks excellence at all levels from its students, faculty, and staff. Our goal is to be a recognized world leader in science and technology-driven initiatives, such as materials and nanotechnology, bioengineering and biotechnology, infrastructure and critical infrastructure and systems. We aspire to be a world leader in societal-driven initiatives that positively impact our world. We actively collaborate with industry, governmental and peer institutions to assist us in accomplishing these goals.

Department of Civil and Environmental Engineering’s Undergraduate Programs

The McCormick School’s Mission Statement provides the foundation for articulating the Educational Objectives and Outcomes of the Department of Civil and Environmental Engineering’s (CEE) Bachelor of Science in Civil Engineering program.

The Educational Objectives and Outcomes and how they meet ABET (Accrediting Board for Engineering and Technology) criteria “a-k” for Civil Engineering is presented on the two following pages with the American Society of Civil Engineers emphases. Each year, the CEE Department uses a Program Enhancement Cycle to assess student learning and improve program outcomes.

Bachelor of Science in Civil Engineering (BSCE) Educational Objectives and Program Outcomes

<table>
<thead>
<tr>
<th>BSCE Educational Objectives</th>
<th>BSCE Program Outcomes described with Accrediting Board for Engineering and Technology (ABET)’s Criteria (a-k)</th>
</tr>
</thead>
</table>
| A. Graduates employ their knowledge of science, mathematics, and engineering in civil and environmental engineering practice, research, and management as well as other professional fields such as law, medicine, finance and management. | (a) Ability to apply knowledge of mathematics, science, and engineering (including probability and statistics).  
(b) Ability to design and conduct experiments, as well as to analyze and interpret data in at least 4 recognized areas.*  
(e) Ability to identify, formulate and solve engineering problems in at least 4 recognized areas.*  
(k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice. |
| B. Graduates become leaders in organizations that focus on advanced problem solving for complex systems in multidisciplinary settings. | (c) Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.  
(d) Ability to function on multidisciplinary teams.  
(e) ability to identify, formulate and solve engineering problems in at least 4 recognized areas.*  
(g) Ability to communicate effectively.  
(h) Ability to understand the impact of engineering solutions in a global, economic, environmental and societal context.  
(k) Ability to use the techniques, skills, and modern engineering tools necessary for professional engineering practice. |
<table>
<thead>
<tr>
<th>BSCE Educational Objectives</th>
<th>BSCE Program Outcomes described with Accrediting Board for Engineering and Technology (ABET)'s Criteria (a-k)</th>
</tr>
</thead>
</table>
| C. Graduates play key roles in the process of constructing and managing local and global civil and environmental infrastructure systems | (d) Ability to function on multidisciplinary teams.  
(f) Understanding of professional and ethical responsibility.  
(g) Ability to communicate effectively.  
(h) Ability to understand the impact of engineering solutions in a global, economic, environmental and societal context.  
(j) Knowledge of contemporary issues. |
| D. Graduates are involved in broadly conceived organizations that require a diversity of thought, creativity, and curiosity. | (d) Ability to function on multidisciplinary teams.  
(f) Understanding of professional and ethical responsibility.  
(g) Ability to communicate effectively.  
(h) Ability to understand the impact of engineering solutions in a global, economic, environmental and societal context.  
(i) Recognition of the need for, and an ability to engage in lifelong learning.  
(j) Knowledge of contemporary issues |

Emboldened Outcomes are part of the American Society of Civil Engineers (ASCE) definition of Professional Practice: Procurement of work, bidding versus quality-based selection processes, how design professionals and construction professionals interact to construct a project, the importance of professional licensure and continuing education, and other professional practice issues. *ASCE recognized areas include Environment, Fluids, Geotechnics, Structures, and Transportation.*