| | |
|---|---|
| **From:** | May, Andy |
| **To:** | Smith, Randy; Lenhart, John |
| **Cc:** | Sutherland, Sue; Marzette, Russell; Griffiths, Rob; Reed, Katie; Duffy, Lisa; Hunt, Ryan; MacKay, Allison; Matyas, Cory; Tomasko, David; Metzler, Sandra |
| **Subject:** | RE: Proposal to revise the Environmental Engineering undergraduate program |
| **Date:** | Tuesday, July 14, 2026 4:18:41 PM |
| **Attachments:** | image001.png<br>proposal for revised ENVENG curriculum final.docx |

Dear Randy,

I am retaining all recipients of your initial email in this reply for their records. I have added Dr. Sandra Metzler, the College of Engineering's incoming Associate Dean of Academic Programs and Student Services, for her awareness.

Attached, please find an updated version of the full proposal for the revisions to the BS in Environmental Engineering. The primary change was to Appendix A, which now includes the completed proficiency map. There were also some minor editorial changes, which included 1) reordering the list immediately preceding the table; 2) small edits to some of the proficiencies; and 3) changing the color of some text in Appendix C from red to black. Regarding the edits to some of the proficiencies – which I mention for transparency – these arose during our mapping process and were made clarifications to make the edited proficiencies more interpretable for assessment.

Please let us know if you have any questions or if any additional information is needed.

Thank you,

Andy

THE OHIO STATE UNIVERSITY

**Andrew A. May, PhD**
Associate Professor, Department of Civil, Environmental and Geodetic Engineering
Affiliated Faculty, Environmental Science Graduate Program
Affiliated Faculty, Sustainability Institute
Affiliated Faculty, Translational Data Analytics Institute
483A Hitchcock Hall | 2070 Neil Ave, Columbus, OH 43210
614-688-1206 Office
may.561@osu.edu
u.osu.edu/may.561/

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**From:** Smith, Randy <smith.70@osu.edu>
**Sent:** Tuesday, June 2, 2026 9:38 AM
**To:** Lenhart, John <lenhart.49@osu.edu>; May, Andy <may.561@osu.edu>
**Cc:** Sutherland, Sue <sutherland.43@osu.edu>; Marzette, Russell <marzette.1@osu.edu>; Smith,

Randy <smith.70@osu.edu>; Griffiths, Rob <griffiths.44@osu.edu>; Reed, Katie <reed.901@osu.edu>; Duffy, Lisa <duffy.262@osu.edu>; Hunt, Ryan <hunt.781@osu.edu>; MacKay, Allison <mackay.49@osu.edu>; Matyas, Cory <matyas.3@osu.edu>; Tomasko, David <tomasko.1@osu.edu>
**Subject:** Proposal to revise the Environmental Engineering undergraduate program

Andy and John:

The proposal from the Department of Civil, Environmental and Geodetic Engineering to revise the Bachelor of Science in Environmental Engineering was approved by the Council on Academic Affairs at its meeting on May 28, 2026. Thank you for attending the meeting to respond to questions/comments.

During the Council's discussion, it was noted that you should complete Appendix A: Proficiency Mapping so that the fully completed proposal can be sent to the Board of Trustees for review/approval. Please send me that Appendix by **July 24, 2026.** Let me know if you have any questions about this.

No additional level of internal review/approval is necessary. This action will be included in the Council's next Annual Activities Report to the University Senate (July 2026).

The Office of the University Registrar will work with you on any implementation issues.

Please keep a copy of this message for your file on the proposal and I will do the same for the file in the Office of Academic Affairs.

If you have any questions please contact the Chair of the Council, Professor Sue Sutherland (.43), or me.

I wish you success with this important program development.

Randy

THE OHIO STATE UNIVERSITY

**W. Randy Smith, Ph.D.**
Vice Provost for Academic Programs
Office of Academic Affairs
University Square South, 15 E. 15th Avenue, Columbus, OH 43201
614-292-5881 Office
smith.70@osu.edu
**Assisted by:**
**Katie Reed**

Executive Assistant
(614) 292-5672

# A Proposal for a New Structure in the Environmental Engineering (ENVENG) Curriculum

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# 1. Background

During the Autumn 2019 faculty retreat, the faculty within the Department of Civil, Environmental, and Geodetic Engineering (CEGE) brainstormed knowledge and skills that we felt were important for our graduates, which was followed by conversations in the departmental Undergraduate Studies Committee. Then, in Spring 2020, a committee was formed to initiate the process of renewing the undergraduate curriculum. This committee was comprised of Drs. John Lenhart (Chair; 2020 – 2022), Andy May (Chair; 2023 – present), Lisa Burris, Gil Bohrer, Jordan Clark, Anthony Massari, and Daniel Pradel from the CEGE faculty, as well as Ms. Liz Riter and Mr. Barry Tolchin, the CEGE academic advisors. This committee received support from the Michael V. Drake Institute for Teaching and Learning, initially with the assistance of Dr. Teresa Johnson and then Dr. Larry Hurtubise.

Initially, this committee focused on both undergraduate programs within CEGE – Civil Engineering and Environmental Engineering. During Autumn 2023, a separate committee was formed to focus on the Environmental Engineering curriculum, including Drs. Andy May (Chair; 2023 – present), Karen Dannemiller, and Linda Weavers. In Autumn 2024, Drs. Daniel Gingerich and John Lenhart were added to this committee. In preparation of this proposal, the committee both requested and received input from the CEGE academic advisors.

# 2. Process

The committee followed a backward-design approach in their process. The committee developed a set of educational goals, outcomes, and proficiencies (see Appendix A), which was designed to be independent of any specific technical content. The goals represent higher-order learning objectives for the program, and the outcomes organize sets of knowledge and skills within each goal; proficiencies are learning objectives that can be assessed directly within the curriculum.

During the Spring 2024 faculty retreat, Environmental Engineering faculty discussed the needs for our students within a new curriculum. We agreed that using the National Academies of Sciences, Engineering, and Medicine (NASEM) Grand Challenges for Environmental Engineering in the 21st Century will provide guidance for shaping this curriculum. Thus, the vision for the proposed curriculum is for students to develop skills to address at least one NASEM Grand Challenge in their future careers. Briefly, these Grand Challenges are:

1. Sustainably supply food, water, and energy
2. Curb climate change and adapt to its impacts
3. Design a future without pollution or waste
4. Create efficient, healthy, resilient cities
5. Foster informed decisions and actions

Our redesign follows the "T" structure outlined in this NASEM report, as the curriculum is designed to provide depth in Environmental Engineering and breadth in related disciplines. Specifically, that report lists "systems analysis, data science, social sciences, policy, law, humanities, health, global cultures, and engagement" as topics that provide this broader context. Breadth in the curriculum will be addressed through a combination of course re-design (e.g., ENVENG 3200: Fundamentals of Environmental Engineering; see Section 3.3.2.1), breadth electives (see Section 3.4.2), a data science elective (see Section 3.4.3), and the OSU General Education requirements (see Section 3.6).

We then considered criteria set forth by ABET, which establishes minimum standards that are essential for Environmental Engineering graduates. We drew upon the commentary on the ABET criteria that was prepared by the American Academy of Environmental Engineers and Scientists (AAEES), as well as the Environmental Engineering Body of Knowledge, also prepared by AAEES. We present how we satisfy both ABET criteria and our vision to meet the NASEM Grand Challenges in Appendix B.

Ultimately, we believe that the revised curriculum will deliver technical depth that spans sufficient breadth in Environmental Engineering to support preparation for any career or the FE exam. Moreover, the flexibility provided within the new curriculum will support technical training that supports any number of different career directions that a student may wish to follow after graduation.

Moreover, as a committee, we sought an emphasis in data analysis. Not only is data science specifically called out in the NASEM report, but also data are more prevalent than they ever have been, and how to analyze and interpret data is becoming an important skill for the modern environmental engineer.

This proposal was distributed to CEGE faculty for review, as well as CEGE Academic Advisors Barry Tolchin and Liz Riter. The CEGE Faculty voted to approve the proposed curriculum change on May 12, 2025.

# 3. Summary of Changes and Rationale

The following sections describe the proposed changes and associated justification. The net, high-level result is a degree program that enables more flexibility for student choice, while enabling sufficient coverage of core content that is necessary for Environmental Engineers.

## 3.1. Math and Basic Science

ABET requires that Environmental Engineering students complete mathematics through differential equations, calculus-based physics, chemistry (including stoichiometry, equilibrium and kinetics), earth science, and biological science. Environmental Engineering students must also apply probability and statistics to address uncertainty. The minimum requirement for math and basic science courses, per ABET, is 30 credit hours.

The College of Engineering requires that all students take PHYSICS 1250 (Mechanics, Work and Energy, Thermal Physics), the equivalent course for honors students (PHYSICS 1260), or the equivalent course for physics majors (PHYSICS 1270), the latter of which applies to Engineering Physics students. Each of these courses are 5 credit hours.

Our proposed ABET math and science requirements for the new Environmental Engineering curriculum is summarized in Table 1.

*Table 1. Summary of ABET math and science hours in the proposed Environmental Engineering curriculum.*

| Course | Credit Hours |
|---|---|
| MATH 1151 | 5 |
| MATH 1172 | 5 |
| MATH 2173 | 3 |
| MATH 2174 | 3 |
| PHYSICS 1250 | 5 |
| CHEM 1210 | 5 |
| CHEM 1220 | 5 |
| STAT 3470 | 3 |
| Earth Science Elective | 3 |
| ENVENG 5110 | 3 |
| Total | 40 |

The earth science electives represent a broad set of courses from various disciplines (see Section 3.1.4).

Note that this new course sequence removes the previous requirement of MICRBIO 4000.0x (Basic and Practical Microbiology). In place of that course, we propose a modified form of ENVENG 5110 (Environmental Engineering Bioprocesses) to provide students with fundamental microbiology content (see Section 3.1.5).

### 3.1.1. Math Sequence

The new curriculum follows a 4-course sequence of courses from the Department of Mathematics. As a faculty, we have observed deficiencies in our students' math performance, and the new sequence is in alignment with the recent change to the undergraduate Civil Engineering curriculum.

The new sequence includes:

1. MATH 1151: Calculus 1
2. MATH 1172: Engineering Math A
3. MATH 2173: Engineering Math B
4. MATH 2174: Linear Algebra and Differential Equations

MATH 2173 and MATH 2174 replace the old requirement of MATH 2177 (Math Topics for Engineers). The new sequence covers the same material, but MATH 2173 + MATH 2174 cover the same content, spread across two semesters. Other programs in the College of Engineering (e.g., Biomedical Engineering, Chemical Engineering, Integrated Systems Engineering, and Welding Engineering) have made a similar change in their curricula related to this math sequence in recent years.

An acceptable alternative pathway to MATH 2173 + MATH 2174 is MATH 2153 (Calculus 3), MATH 2568 (Linear Algebra), and MATH 2415 (Differential Equations). This pathway is most likely to apply to students transferring into the program from outside of the university, but it may apply to some major changers within the university as well.

### 3.1.2. Physics

We propose to retain the requirement of calculus-based physics, specifically through PHYSICS 1250 (Mechanics, Work and Energy, Thermal Physics) or an equivalent course[*].

### 3.1.3. Chemistry

The current Environmental Engineering curriculum required students to take CHEM 1210 (General Chemistry I), CHEM 1220 (General Chemistry II), and CHEM 2510 (Organic Chemistry I). CHEM 2310 (Introductory Organic Chemistry) was an acceptable alternative to CHEM 2510. CHEM 2310 combines Organic Chemistry I and Organic Chemistry II, which provides a broader range of knowledge of this content. Both CHEM 2310 and CHEM 2510 are 4 credit-hour courses.

We propose to maintain the requirements of CHEM 1210 and CHEM 1220 but to remove the requirement that Environmental Engineering students take an organic chemistry course, because there are many possible career paths for our graduates, and not all of them will be related to organic contaminants in the environment. CHEM 2310 and CHEM 2510 remain options for students to take to satisfy a "Foundational Elective" (see Section 3.3.1).

### 3.1.4. Earth Science

In the current Environmental Engineering curriculum, students have the option to take EARTHSC 1121 (The Dynamic Earth) and EARTHSC 1200 (Introduction to Earth Science Laboratory); or EARTHSC 1151 (Natural Hazards) and EARTHSC 1200; or ENR 3000 (Soil Science Lecture) and 3001 (Soil Science Lab). These courses provide both content related to earth science and a hands-on laboratory experience.

The AAEES Commentary on ABET states that "Earth sciences include but are not limited to the disciplines of geology, soil science, hydrologic science, meteorology, oceanography, and limnology. The emphasis of an earth science is on basic science rather than engineering, and therefore courses such as geotechnical engineering, soil mechanics, and engineering hydrology might not normally have sufficient earth science coverage to meet this criterion." With this commentary in mind, in the new curriculum, we propose a revised list of options that span the breadth of earth sciences included within the commentary. Further, we no longer require a hands-on laboratory experience associated with this earth science course due to proposed modifications to ENVENG 4200 (Environmental Engineering Unit Operations Lab; see Section 3.3.3). We propose an initial list of earth science elective courses in Table 2; some of these courses satisfy OSU General Education requirements (indicated with a pound sign #; see Section 3.6 for more discussion on General Education). This list will be maintained by the departmental Undergraduate Studies Committee, and any updates to the list will be shared with CCAA for review.

*Table 2. Proposed Earth Science electives for the new Environmental Engineering curriculum.*

| Course Number | Course Title |
|---|---|
| ATMOSSC 2940 | Basic Meteorology |
| EARTHSC 2203 | Environmental Geoscience[#] |
| EARTHSC 2210 | Energy, Mineral Resources, and Society[#] |
| EARTHSC 2911 | The Climate Crisis: Mechanisms, Impacts, and Mitigation[#] |
| ENR 3000 | Soil Science |
| GEOG 2960 | Introduction to Physical Geography |

[*] Equivalent alternatives include PHYSICS 1250H (Honors Physics: Mechanics and Conservation Laws; Special Relativity), PHYSICS 1260 (FEH Physics: Mechanics, Thermal Physics, Waves), and PHYSICS 1270 (Classical Mechanics, Conservation Laws, and Special Relativity for Majors)

### 3.1.5. Microbiology

In the old curriculum, Environmental Engineering students took MICRBIO 4000.0x to meet the ABET requirement for biological science. In the new curriculum, we propose to replace MICRBIO 4000.0x with ENVENG 5110. ENVENG 5110 has been redeveloped, and in its most recent offering, the course reviews microbiology and introduces both bioprocesses and wastewater treatment design. In this redeveloped state, MICRBIO 4000.0x is still required. Thus, to maintain the ABET requirement for a biological science, the next iteration of ENVENG 5110 will provide deeper microbiology content and introduce only bioprocesses; there would then be an opportunity to develop a new course in wastewater treatment design as a technical elective. A laboratory experiment focused on microbiology is under consideration for the redesign of ENVENG 4200.

### 3.1.6. Probability and Statistics

The new curriculum includes a change in the required course covering probability and statistics. We propose to require STAT 3470.0x (Introduction to Probability and Statistics for Engineers), which is currently an alternative to CIVILEN 2050 (Probabilistic Applications and Data Interpretation in Civil and Environmental Engineering). This differs from the recent change to the Civil Engineering curriculum, which replaced CIVILEN 2050 with STAT 3450.0x (Basic Statistics for Engineers). As a committee, we felt that the additional topics of regression and Bayesian statistics in STAT 3470 aligns with our emphasis on data analysis (see Section 2).

The department will sunset CIVILEN 2050 as the result of these changes to the two curricula.

## 3.2. Engineering Fundamentals

### 3.2.1. College Requirements

The College of Engineering requires students to take MATH 1151; PHYSICS 1250 or equivalent; ENGR 1181 (Fundamentals of Engineering I; or equivalent for Honors or transfer students); and ENGR 1182 (Fundamentals of Engineering II; or equivalent for Honors or transfer students). Our students also take ENGR 1100.15 (Introduction to Ohio State and Engineering)[†]. Some of these college requirements overlap with the math and basic science courses (MATH 1151; PHYSICS 1250).

### 3.2.2. Programming

We propose to maintain the requirement of ENGR 1221 (Introduction to Computer Programming in MATLAB for Engineers and Scientists), with CSE 1222 (Introduction to Computer Programming in C++ for Engineers and Scientists), CSE 1223 (Introduction to Computer Programming in Java), and CSE 1224 (Introduction to Computer Programming in Python) as acceptable alternatives. We would like our students to gain the skill of programming, but we do not want to prescribe a specific language. Further, including additional options may facilitate the pursuit of, e.g., a minor in Computer Science that complements the Environmental Engineering degree.

ENGR 1221 is a 2 credit-hour course, while the others are 3 credit hours. Thus, the minimum requirement is 2 credit hours of programming.

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[†] We are aware that the Department of Engineering Education is considering the inclusion of ENGR 1100.15 within the first-year sequence, but it is our understanding that this will not change the total number of credits across the Fundamentals of Engineering sequence + "Engineering Survey".

### 3.2.3. Engineering Mechanics

We propose to change the requirement of MECHENG 2040 (Statics and Introduction to Mechanics of Materials) to MECHENG 2010 (Statics). The need for every Environmental Engineering graduate to understand concepts related to mechanics of materials (e.g., stress/strain; Mohr's circle; and beam deflections) is unclear to the committee. However, this change will impact an Environmental Engineering student's ability to take certain Civil Engineering courses as electives (e.g., CIVILEN 3540 – Geotechnical Engineering). Therefore, we propose to include MECHENG 2020 (Mechanics of Materials) as a Foundational Elective (see Section 3.3.1.5) to enable access to these courses. Moreover, MECHENG 2040 will be an acceptable alternative to MECHENG 2010 with this proposed change.

MECHENG 2030 (Dynamics) was removed as a required course from the Environmental Engineering curriculum via faculty vote in Autumn 2023, and the committee proposes to uphold this decision. Students will still have the option to take MECHENG 2030 as a Foundational Elective (see Section 3.3.1.5).

## 3.3. Major Courses

For context, in the new Civil Engineering curriculum, major courses were categorized into required courses, core courses, laboratory courses, design courses, and Capstone. Herein, we propose a different categorization of courses within the Environmental Engineering curriculum. Our rationale for these differences is that these are two different degree programs within our department that are subject to two different sets of ABET Program Criteria. Specifically, the ABET Program Criterion relevant to Environmental Engineering states that "the curriculum must include material and energy balances; fate and transport of substances in and between air, water, and soil phases; and advanced principles and practices relevant to program objectives."

Thus, the course categories for the proposed Environmental Engineering curriculum include Foundational courses; Fundamental courses; and Advanced Core courses, each of which builds towards addressing at least one of the NASEM Grand Challenges for Environmental Engineering in the 21st Century. Within these categories, we include a Foundational Elective (see Section 3.3.1.5) and a Design Elective (see Section 3.3.5). We also propose a set of Elective courses (both "Technical" and "Breadth") to complement these major courses (see Section 3.4).

We propose the outright cancellation of three courses herein: CIVILEN 2050; CIVILEN 2090 (Professional Aspects of Civil and Environmental Engineering); and ENVENG 2100 (Environmental Engineering Analytical Methods). CIVILEN 2050 will be replaced by STAT 3470 (see Section 3.1.6). We propose that content from the 1-credit CIVILEN 2090 course be distributed across CIVILEN 2001 (Section 3.3.1.1), CIVILEN 3080 (Section 3.3.1.2), ENVENG 3200 (Section 3.3.2.1), and ENVENG 4090.0x (Section 3.5), and efforts are already underway to implement this. For discussion of ENVENG 2100, see Sections 3.3.2 and 3.3.4. In addition to fitting with the new vision for the Environmental Engineering curriculum, these proposed cancellations will enable additional teaching flexibility, enabling both teaching relief for other courses, as needed, and the potential development of new courses to serve the curriculum.

We propose that CIVILEN 2060 (Numerical Analysis Methods for Civil and Environmental Engineering Applications) will become an Elective course for students, identical to the recommendation for the Civil Engineering curriculum. We suggest that it be reduced to 3 credit hours and be re-branded to a title similar to "Software and Simulation for Civil and Environmental Engineering". The existing pre-requisite chain does not demonstrate a dependency on this course in our current curriculum. Thus, we recommend that any required skills from CIVILEN 2060 be taught within the appropriate context of the course where those skills are needed, e.g., specific numerical methods for use in support of computational tools in Design

courses (see Section 3.3.5). Where appropriate, CIVILEN 2060 could be included in guidance documentation for students interested in certain technical areas within the department.

### 3.3.1. Foundational Courses

Foundational courses are required courses, which provide content upon which the Environmental Engineering curriculum will build. These courses meet some combination of CEGE curricular proficiencies and ABET Program Criteria. Each Foundational course is described below. The proficiencies met by each is included in Appendix A.

#### 3.3.1.1. CIVILEN 2001: Introduction to Infrastructure

This course was developed during the curriculum renewal process by Drs. Lisa Burris, Daniel Gingerich, Anthony Massari, Andy May, and Daniel Pradel and was subsequently built upon by Drs. Burris and May with Drs. Andre Carrel and Allison MacKay. Dr. May, along with Drs. Natassia Brenkus and Rabi Mishalani, delivered this course during Spring 2025, and it has continued to be offered during AY25-26. It directly addresses concerns raised by the CEGE faculty related to Environmental Engineering graduates' "Professional Identity"; as such, it covers many proficiencies within that educational goal.

Briefly, the course considers the role of both Civil and Environmental Engineers in infrastructure projects. It provides an overview of different technical areas within the programs; an introduction to analysis, design, and engineering drawings within the context of the programs; and an introduction to environmental, social, and economic factors that influence infrastructure projects. The course embeds professionalism and professional development, including the importance of licensure, both written and oral communication, and engineering ethics.

This course will include a foundational writing objective that will be defined as part of broader departmental efforts.

This course requirement was approved for the current Environmental Engineering by the CEGE faculty in Autumn 2023 and by CAA in Spring 2024.

#### 3.3.1.2. CIVILEN 3080: Engineering Economics and Optimization

This course provides foundational content related to engineering economics and operations research. Moreover, there is an opportunity to modify this course to more broadly cover "engineering decision-making" content, which would include more sustainability, societal, and ethical considerations within the context of this course, all of which are related to other ABET Program Criteria and ABET Student Outcomes. Adding more ethics context to this course facilitates the cancellation of CIVILEN 2090 (see above under Section 3.3). This course directly addresses NASEM Grand Challenge #5 (see Section 2).

#### 3.3.1.3. CIVILEN 3130

Fluid mechanics is specifically listed as a requirement in the ABET Program Criteria for Environmental Engineering.

#### 3.3.1.4. ENVENG 5110

ENVENG 5110 has been redeveloped to provide not only content on bioprocesses but microbiology relevant to Environmental Engineering (see Section 3.1.5). Hence, this course will fill the role of a biological science course in the ABET Program Criteria. It currently contains content related to wastewater treatment design; some of this content will be moved into ENVENG 3210 (Environmental Engineering Unit Operations), but we emphasize the need for a standalone wastewater treatment design course.

3.3.1.5. Foundational Elective

In the current Environmental Engineering curriculum, students are required to take either CHEM 2310 (Introductory Organic Chemistry) or CHEM 2510 (Organic Chemistry I). An organic chemistry course can serve as foundational knowledge for subsequent courses related to chemical fate, transport, treatment, or remediation; however, not all students entering the major will pursue a career path related to these areas.

Therefore, we propose to replace the organic chemistry requirement with Foundational Elective courses, which will span a breadth of topics relevant to Environmental Engineering. Students will be required to take two of these courses to provide this breadth in foundational knowledge. Our initial proposed list of these Foundational Elective courses, which does include the two organic chemistry courses as options, is provided in Table 3. This list will be maintained by the departmental Undergraduate Studies Committee, and any updates to the list will be shared with CCAA for review.

*Table 3. Proposed Foundational Electives for the new Environmental Engineering curriculum.*

| Course Number | Course Title |
|---|---|
| CHEM 2310<br>CHEM 2510 | Introductory Organic Chemistry OR<br>Organic Chemistry I |
| MECHENG 3500<br>FABENG 3120 | Engineering Thermal Sciences OR<br>Thermodynamics in FABENG |
| ECE 2300*<br>ECE 2360* | Electrical Circuits and Electronic Devices OR<br>Electronics for CSE Majors |
| MECHENG 2020[#] | Mechanics of Materials |
| MECHENG 2030 | Dynamics |
| PHYSICS 1251 | E&M, Waves, Optics, Modern Physics |
| MICRBIO 5155 | Environmental Microbiology[$] |

*Final details to be worked out with the Department of Electrical and Computer Engineering, but a conditional agreement is in place.

[#]A student who completes MECHENG 2040 as an alternative to MECHENG 2010 will be unable to take MECHENG 2020. Further, completing MECHENG 2040 will not satisfy both the Statics requirement and the Foundational Elective requirement via substitution.

[$]We are discussing the inclusion of this course with its instructor from the Department of Microbiology, specifically related to a waiver of the pre-requisite of MICRBIO 4000. That department had previously waived the pre-requisite of a "3 credit hours in Biology" for MICRBIO 4000.0x in our current curriculum.

### 3.3.2. Fundamental Courses

ABET Program Criterion 1b for Environmental Engineering highlights three key elements that are central to an Environmental Engineering degree. The Fundamental courses will introduce two critical elements of this criterion, namely "material and energy balances"; and "fate and transport of substances in and between air, water, and soil phases". The third element will be addressed in the Advanced Core Courses.

3.3.2.1. ENVENG 3200

We recommend that ENVENG 3200 remains as a required course for the Environmental Engineering program. This course will introduce the concepts related to "material and energy balances" from the ABET Program Criterion, which will be built upon in subsequent courses within the program. However, we propose that the course is modified in the following ways:

1. It is updated to meet the criteria outlined for a "Core course" in the Civil Engineering degree, namely:
    a. An explicit connection to both engineering licensure and engineering ethics to emphasize these topics within the context of the course's technical area.
    b. An explicit connection between the course and other options within the curriculum. This could be as simple as discussing the courses that come next and how they relate to the core course during both the first and last lectures of the semester, or it could manifest as a thread throughout the semester. Regarding the latter, this could include highlighting limitations in the core course and how those limitations will be addressed in subsequent courses.
2. It is partially re-designed to co-optimize the needs of both Civil Engineering and Environmental Engineering students.
    a. For example, a Civil Engineer should understand things like the National Environmental Policy Act (NEPA) and stormwater pollution prevention plans (SWPPP), as well as concepts related to material and energy balances, which are relevant for a general understanding of environmental pollution. These topics would also support an Environmental Engineering student, who will later go on to apply material and energy balances to more sophisticated problems later in the undergraduate curriculum.
    b. To enable additional emphasis on certain topics, we propose moving some content to other courses, as appropriate.

The Environmental Engineering Curriculum Renewal Committee is currently working to develop a more detailed proposal to share with the ENVENG 3200 instructors for further discussion about these course modifications. We plan to submit a course change request to CCAA after approval of this curriculum proposal.

3.3.2.2. ENVENG 4400

ENVENG 4400 is currently an elective course for Environmental Engineering students. We propose to convert this into a required course as it addresses the ABET Program Criterion "fate and transport of substances in and between air, water, and soil phases". Further, it will reinforce concepts related to "material and energy balances".

The chemical fate and transport concepts within this course facilitate:

- The removal, or at least de-emphasis, of course content in other courses. For example, ENVENG 3200 currently introduces students to the concepts of Gaussian plumes for atmospheric transport modeling. However, ENVENG 4400 currently includes a full module on dispersion modeling in the environment, considering dispersion in one, two, and three dimensions in space and including treatment of dispersion that varies in time.
- The cancellation of ENVENG 2100. The lecture portion of ENVENG 2100 includes many concepts related to water chemistry, including carbonate chemistry, acid-base titration, and mineral dissolution. ENVENG 4400 currently contains a review of these environmental chemistry processes, but there is space to expand upon this to ensure that these chemistry topics are sufficiently covered within ENVENG 4400 to ensure that students are adequately prepared for ENVENG 4200.

The committee is working to develop a more complete plan to redesign this course, ensuring that all necessary material from other courses will be covered. We plan to submit a course change request to CCAA after approval of this curriculum proposal.

### 3.3.3. Advanced Core Courses

Advanced Core Courses represent the final set of required courses within the curriculum. These courses begin to explore the "advanced principles and practices relevant to the program objectives" in the ABET Program Criteria, and they directly build upon content from the Foundational and Fundamental Courses. Additionally, some provide experiences with "hands-on laboratory experiments, and analysis and interpretation of the resulting data in more than one major environmental engineering focus area, e.g., air, water, land, environmental health" or "design of environmental engineering systems that includes considerations of risk, uncertainty, sustainability, life-cycle principles, and environmental impacts", which are two additional ABET Program Criteria.

#### 3.3.3.1. CIVILEN 3160

CIVILEN 3610 (Water Resources Engineering) serves multiple functions in the proposed Environmental Engineering curriculum. It builds upon the formulation of material and energy balances, especially those introduced in CIVILEN 3130. Further, it advances student knowledge related to environmental physics.

Within the revised Civil Engineering curriculum, CIVILEN 3160 has been converted into a laboratory course, providing students with experiences in laboratory, field, and numerical settings. Thus, this course is subject to additional criteria (see Section 3.3.4).

#### 3.3.3.2. ENVENG 3210

ENVENG 3210 introduces concepts related to pollution treatment technologies. Historically, there has been a large emphasis on water treatment, although this has evolved over time. Within the new curriculum, there is an opportunity to modify this course to provide additional breadth – many of the physical, chemical, and/or biological processes follow the same underlying principles regardless of the environmental medium. We propose to update this course to provide an emphasis on not only water treatment but also wastewater treatment, and consequently, we may consider retitling the course. The committee is discussing a plan to facilitate this redesign. We plan to submit a course change request to CCAA after approval of this curriculum proposal.

This course will also provide an initial design experience to Environmental Engineering students, and it will serve as a pre-requisite to subsequent design courses related to treatment approaches (e.g., advanced water treatment, advanced wastewater treatment, air pollution control). All design courses, including ENVENG 3210, are subject to additional criteria (see Section 3.3.5).

#### 3.3.3.3. ENVENG 4200

We propose that ENVENG 4200 be modified in several ways:

1. It will increase from a 1 credit hour course to a 3 credit hour course. This will facilitate the expansion of lecture content to provide students with additional guidance on data analysis and interpretation (including uncertainties and error propagation) and presentation of data in figures and tables.
2. It will retain its inclusion of experiments in multiple environmental media (e.g., air, water), but new experiments in other media (e.g., land, environmental health) should be explored to account for the removal of the requirements of other lab courses (i.e., MICRBIO 4000, ENR 3000/3001).

These modifications, in combination with the proposed changes to ENVENG 4400, facilitate the cancellation of ENVENG 2100. As with other courses, the committee is working to develop a plan to aid

in the redesign. We plan to submit a course change request to CCAA after approval of this curriculum proposal.

#### 3.3.3.4. ENVENG 5170

ENVENG 5170 (Sustainability and the Circular Economy) builds upon concepts introduced in CIVILEN 2001 and CIVILEN 3080, namely life-cycle thinking and engineering decision-making. Thus, this course supports students' ability to design systems that consider sustainability, life-cycle principles, and environmental impacts, all of which are explicitly required in the ABET Program Criteria.

### 3.3.4. Laboratory Courses

In our revision of the Civil Engineering curriculum, we identified a subset of our curricular proficiencies that should be met by any laboratory course; these are noted in Appendix A. Per the ABET requirements, Environmental Engineering students are required to conduct laboratory experiments in "more than one major environmental engineering focus area, e.g., air, water, land, environmental health". This requirement does not need to be met in multiple courses, and the modifications of ENVENG 4200 will continue to satisfy this requirement.

The laboratory experience should include the following (adopted from the more-comprehensive American Society of Civil Engineering (ASCE) commentary on ABET for Civil Engineering):

1) Understand the objectives and procedures associated with an experiment
2) Conduct an experiment, including setup, measurement and data collection
3) Observe and document error and uncertainties in data collection procedures
4) Analyze data
5) Interpret experimental results, with appropriate conclusions and recommendations, and
6) Apply experimental procedures and analysis of results consistent with real-world Environmental Engineering problems or situations

Context for the item 6) is provided within the AAEES commentary; experiments may be related to characterization, monitoring, process analysis, or pilot plant studies that are relevant to Environmental Engineers.

Within the Civil Engineering curriculum revisions, we proposed an additional list of criteria that laboratory courses should meet, and we propose that these criteria are applied to the Environmental Engineering curriculum as well:

1) A direct connection to a technical area will provide students with the proper context in their experiences. This criterion will be applied to the proposed Environmental Engineering curriculum in the context of addressing the requirement of laboratory experiences in more than one major environmental engineering focus area.
2) The laboratory experiences should have a "hands-on" component. Two examples include a) physical experiments in which the students set up the experiments and conduct measurements to collect data; and b) numerical experiments in which the students configure the inputs to a software package and conduct simulations to obtain data (i.e., not just "clicking buttons")[‡].

[‡] Virtual lab experiences are only permissible under extreme circumstances (e.g., pandemic) per the AAEES commentary. In this context, a virtual lab would entail watching a video on how the data were collected and solely conducting data analysis on results provided to students.

3) The minimum amount of time devoted to the laboratory aspects of the course should be equivalent to 1 credit hour (i.e., 3 hours of student work per week). Within this 1 credit hour, the balance between "hands-on" experimentation (including both physical and computational), and subsequent data analysis, data interpretation, uncertainty analysis, and other supporting activities related to the hands-on experience will depend on the instructor and/or nature of the course content. To achieve this 1 credit hour requirement, we recommend a minimum of 36 hours to be spent over the semester associated with laboratory content.
4) The laboratory experiences should meet a consistent writing objective across all lab courses to build technical literacy skills. This will be defined through a departmental ad hoc committee.

### 3.3.5. Design Courses

Students will take a minimum of two design courses. Unlike the ABET Civil Engineering criterion related to design, the Environmental Engineering criterion does not require design in two different contexts, but the AAEES Commentary states that "the breadth of the design experiences across the curriculum should reflect the breadth of the environmental engineering discipline". All students will take ENVENG 3210, and they will be required to take at least one additional design course; an example listing based on current courses is provided in Table 4. As indicated in the table footnotes, some of these courses may require course change requests, which we will submit to CCAA after approval of this curriculum proposal if we decide to convert any such that the satisfy the requirements for a design class outlined below.

*Table 4. Proposed design electives for the new Environmental Engineering curriculum.*

| Course Number | Course Title |
|---|---|
| CIVILEN 5220 | Open Channel Hydraulics |
| ENVENG 5760 | Design of Urban Stormwater Control Measures |
| ENVENG 5410 | Hazardous Waste Management and Remediation |
| ENVENG 5210 | Advanced Physical Chemical Treatment Processes |
| ENVENG 5195 | Engineering Design for Environmental Health* |
| CBE 5771 | Air Pollution[#] |
| CIVILEN 4210 | Physics of Sustainable Buildings* |
| ENVENG 5xxx | Advanced Wastewater Treatment Processes[$] |
| ENVENG 4090.0x | Environmental Engineering Capstone Design[%] |

*Indicates a course that would need to be redesigned to satisfy design criteria

[#]Indicates a course that would need to be revived

[$]Indicates a course that would need to be developed

[%]Indicates that students would have the opportunity to complete both Capstone courses. One would satisfy ABET requirements to complete a Capstone course, while the other would satisfy the design course requirements – however, a student could not double-count a single Capstone course in both categories.

We identified a subset of our curricular proficiencies that should be met by any design course; these are noted in Appendix A. Design courses beyond the minimum requirement will be options as elective courses.

The ABET criterion related to design requires the curriculum to include "constraints [including] a minimum of the following five considerations: risk, uncertainty, sustainability, life-cycle principles, and environmental impacts…" The design experience should meet the following criteria (adopted from the more-comprehensive ASCE commentary on ABET):

1) Include both analysis (the application of engineering tools and principles to predict performance) and synthesis (the creation of something new)

2) Include iterations
3) Require solutions to ill-defined and/or open-ended problems
4) Apply engineering standards and realistic constraints
5) Involve multi-disciplinary teams

Items 1) – 4) should be met by any design course, but item 5) is only required for Capstone courses.

As a committee, we propose an additional list of criteria that design courses should meet:

1) A design course should include content related to risk and uncertainty.
2) A design course should include the use of appropriate computational tools. We unanimously agree that computer-based calculations are an important aspect of student learning for the design process. The choice of these tools is up to the instructor and may include:
    a. Design software (e.g., HydroCAD); or
    b. Parametric-based design in Excel, Matlab, or similar
3) The inclusion of visualization in the design. While this could be, e.g., AutoCAD or SolidWorks, it could take the form of hand sketches or GIS-based efforts. 4000-level and above courses should use some computer-aided visualization approaches.
4) Design courses should include an individual project deliverable with a written component.
    a. This written component should meet a consistent writing objective across all design courses. This will be defined through a departmental ad hoc committee.
    b. The written component should include discussion of at least:
        i. Standards that were incorporated into the design.
        ii. Constraints related to risk, uncertainty, sustainability, life-cycle principles, and environmental impacts.
        iii. Sequencing, specifications, and/or tolerances.

We advise against team projects in these courses, because not all students will be responsible for all aspects of the projects. While oral communication is important, we should cover this elsewhere (e.g., with presentation deliverables in other courses).

## 3.4. Elective Courses

The proposed elective structure is designed to provide students with flexibility, allowing for the opportunity to pursue additional courses within the department and elsewhere. There are three categories of electives presented here (excluding the earth science electives, foundational electives, and design electives discussed previously): technical electives (Section 3.4.1), which provide technical depth or breadth within different areas of environmental engineering or environmental science; breadth electives (Section 3.4.2), which provide complementary technical or professional training to environmental engineering; and data analysis electives, which support our emphasis on data analysis within the curriculum (Section 3.4.3). There are no curricular proficiency requirements for elective courses.

There are six elective courses included in the proposed Environmental Engineering curriculum. Of these, students are required take between 1-2 breadth electives along with 1 data analysis elective. The balance (3-4 courses) must be technical electives. All earth science, foundational, and data analysis electives will be included in the list of breadth electives to provide additional opportunities to take these courses. Students will be required to take at least one elective course in an Engineering discipline.

A full preliminary list of technical and breadth electives are provided in Appendix C; these are thematically grouped in the table within this appendix to aid in student decision-making, but there is no requirement to take courses across the groupings. The preliminary data science elective list is provided in Section 3.4.3.

This list will be maintained by the departmental Undergraduate Studies Committee, and any updates to the list will be shared with CCAA for review.

### 3.4.1. Technical Electives

Technical electives provide depth or breadth in the field of environmental engineering or environmental science. Many of the technical electives are either CIVILEN or ENVENG courses (including those not taken to satisfy requirements above), but we also include courses from other engineering disciplines (e.g., FABENG), natural sciences (e.g., ATMOSSC, EARTHSC, ENR), and life sciences (e.g., MICRBIO). Undergraduate research (e.g., ENVENG 4998) will be considered as a technical elective, because this experience will require students to apply their technical knowledge to address a research question. The list of relevant courses will be maintained by the departmental Undergraduate Studies Committee.

### 3.4.2. Breadth Electives

Breadth electives complement environmental engineering and science, and they may be technical or non-technical courses. As such, the proposed list includes courses related to (construction) management, planning, policy, and public health. Some of these breadth courses may overlap with General Education requirements (Section 3.6) and may facilitate the completion of undergraduate minors. Internships (e.g., CIVILEN 4191) will be considered to be a breadth elective; while students will apply some of their technical knowledge during this experience, they will gain professional skills that advance their career development. A list of breadth electives will be provided upon its completion; as with other lists, this will be maintained by the departmental Undergraduate Studies Committee.

### 3.4.3. Data Science Elective

An elective related to data science supports our emphasis on data analysis within the proposed curriculum. We have not identified any specific learning outcomes for this elective, but the listed courses focus on applications (e.g., geospatial analysis, remote sensing, machine learning). We acknowledge that this list may expand within the near future, as additional data-science-related courses, which are accessible to our students, are likely to become available.

*Table 5. Initial proposed Data Science electives for the new Environmental Engineering curriculum.*

| Course Number | Course Title |
|---|---|
| CIVILEN 5400<br>GEOG 5210 | Introduction to GIS OR<br>Fundamentals of Geographic Information Systems |
| CIVILEN 5420<br>EARTHSC 5310<br>GEOG 5225 | Remote Sensing of Environment OR<br>Remote Sensing in the Earth Sciences OR<br>Geographic Applications of Remote Sensing |
| EARTHSC 5641 | Geostatistics |
| EARTHSC 5757 | Artificial Intelligence in Earth Sciences |
| CSE 5052 | Survey of Artificial Intelligence for Non-Majors |
| GEOG 4103<br>GEOG 5103 | Introductory Spatial Data Analysis OR<br>Intermediate Spatial Data Analysis |

## 3.5. Capstone

ENVENG 4090 (Environmental Engineering Capstone Design) satisfies the ABET Program Criterion for a “culminating major engineering design experience”. A change is currently in process to create two sections of this course, with different pre-requisites, based on the focus of each course; this update will

occur independently from this curriculum proposal. Traditionally, the Autumn offering has projects within the area of water resources, while the Spring offering has projects within the area of water treatment.

## 3.6. General Education

All our students must complete the University's general education requirements.

### 3.6.1. Bookends

Students are required to take two seminars as part of the general education requirements. The launch seminar (GENED 1201) enables students to define academic and career goals and provides guidance through the general education requirements. The reflection seminar is a culminating experience that enables students to demonstrate their growth across their academic career. This is embedded within the Environmental Engineering Capstone course.

### 3.6.2. Foundations

Students must take courses in seven Foundation categories. These include the following, along with pathways to meet each category:

1) Historical or cultural studies: student choice
2) Literary, visual, and performing arts: student choice
3) Mathematical and quantitative reasoning or data analysis: MATH 1151
4) Natural sciences: PHYSICS 1250
5) Race, ethnicity, and gender diversity: student choice
6) Social and behavioral sciences: student choice
7) Writing and information literacy: ENGR 1300

MATH 1151 and PHYSICS 1250 are requirements for both ABET and the College of Engineering. We propose that ENGR 1300 (Introduction to Writing for STEM) be added as a "major-foundational" course to provide our students with training on writing within an appropriate context.[§] This requirement of ENGR 1300 was already approved in the current Environmental Engineering curriculum by CAA in Spring 2024.

### 3.6.3. Themes

Students must take 4 – 6 credit hours in two thematic areas:

1) Citizenship for a Diverse and Just World
2) One additional theme:
    a. Health and Well-Being
    b. Lived Environments
    c. Migration, Mobility, Immobility
    d. Number, Nature, Mind
    e. Origins and Evolution
    f. Sustainability
    g. Traditions, Cultures, and Transformations

[§] Incoming students with course credit for ENGL 1110: First-Year English Composition are excluded from taking ENGR 1300. In the new Civil Engineering curriculum, we have approved ENGR 2301: Exploring Citizenship in Engineering: Integrative Designation. However, this substitution has led to its own issues, and we have identified ENGLISH 3305: Technical Writing as another option. We are still exploring other options for potential *technical writing* course substitutions.

Some earth science electives (Section 3.1.4) and some breadth electives (Section 3.4.2) are classified as Theme courses; thus, if a student opts to take one of these courses, it may count towards both requirements.

### 3.6.4. Embedded Literacies

There are three additional requirements for the general education program that are outside of the Bookends, Foundations, and Themes: data analysis; advanced writing; and technology. These competencies must be embedded within the major programs.

#### *3.6.4.1. Data Analysis*

Our students will meet all data analysis embedded literacies through the combination of STAT 3470, laboratory courses (e.g., CIVILEN 3160, ENVENG 4200), and the requirement to complete a Data Science elective.

#### *3.6.4.2. Advanced Writing*

Our students will meet all advanced writing embedded literacies through the technical writing content embedded within the proposed curriculum. This includes ENGR 1300, CIVILEN 2001, laboratory courses, design courses, and Capstone.

#### *3.6.4.3. Technology and Society*

Our students will meet all technology and society embedded literacies through a sequence of required courses: CIVILEN 2001, CIVILEN 3080, and ENVENG 5170, as well as design courses and Capstone.

## 3.7. Artificial Intelligence (AI) Fluency

Similar to the General Education program, our students will achieve the AI Fluency Learning Outcomes put forth by the Provost's Office. While we have submitted our responses through the AI Fluency Roadmap Templates, the exact plan is largely incomplete as we have limited AI content within our current curriculum. Further, we require additional time to have conversations both with the department's External Advisory Board and with our broader alumni base to understand how AI is emerging within Environmental Engineering practice.

# 4. Example Curriculum Sheet

The figure below provides a visual example of how the proposed structure fits together. We have been intentional to avoid overloading a single semester with 18 credit hours of STEM coursework in this guide. We anticipate that this example curriculum sheet represents a "generic" pathway through the major; student interests will drive different pathways.

Further, the various electives within the proposed curriculum (e.g., Foundational, Earth Science, Data Science) enable flexibility with regards to when a student may take these courses. However, some of these courses are pre-requisites for Technical or Breadth Electives, so we will work with our departmental academic advisors to remind students to pay attention to necessary pre-requisite chains.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Total hours: | 130 | |
| | Autumn | | | | Spring | | | Categories |
| | Number | Name | Hours | | Number | Name | Hours | ABET M/S |
| 1 | ENGR 1100 | Engineering Survey | 1 | | CIVILEN 2001 | Introduction to Infrastructure | 3 | Foundational |
| | ENGR 1181 | Fundamentals of Engineering 1 | 2 | | ENGR 1182 | Fundamentals of Engineering 2 | 2 | Fundamental |
| | ENGR 1300 | Intro. to STEM writing | 3 | | MATH 1172 | Engineering Math A | 5 | Advanced core |
| | MATH 1151 | Calculus I | 5 | | CHEM 1210 | General Chemistry I | 5 | Gen. Ed. |
| | PHYSICS 1250 | Mechanics, Work, and Energy | 5 | | MECHENG 2010 | Statics | 2 | |
| | | Gen Ed - Opening Bookend | 1 | | | | | |
| | | Semester hours: | 17 | | | Semester hours: | 17 | |
| 2 | CHEM 1220 | General Chemistry II | 5 | | CIVILEN 3080 | Engineering Decision-Making | 3 | |
| | MATH 2173 | Engineering Math B | 3 | | ENGR 1221 | Programming in MATLAB | 2 | |
| | CIVILEN 3130 | Fluid Mechanics | 3 | | ENVENG 3200 | Fund. Env. Eng. | 3 | |
| | STAT 3470.0x | Intro. Prob. Stat. for Engineers | 3 | | MATH 2174 | Lin. Alg. and Diff. Eq. | 3 | |
| | | Gen Ed - Foundation | 3 | | | Gen Ed - Foundation | 3 | |
| | | | | | | Foundational Elective | 3 | |
| | | Semester hours: | 17 | | | Semester hours: | 17 | |
| 3 | CIVILEN 3160 | Water Resources Engineering | 3 | | ENVENG 3210 | Unit Operations | 3 | |
| | ENVENG 4400 | Fate and Transport | 3 | | ENVENG 5170 | Sustainability Circ. Econ. | 3 | |
| | ENVENG 5110 | Bioprocesses | 3 | | | Earth Science Elective | 3 | |
| | | Gen Ed - Foundation | 3 | | | Gen Ed - Foundation | 3 | |
| | | Data Science Elective | 3 | | | Foundational Elective | 3 | |
| | | | | | | | | |
| | | Semester hours: | 15 | | | Semester hours: | 15 | |
| 4 | ENVENG 4200 | Environmental Engineering Lab | 3 | | ENVENG 4090.0x | ENVENG Capstone | 3 | |
| | | Gen Ed - Theme | 4 | | | Gen Ed - Theme | 4 | |
| | | ENVENG Design Elective | 3 | | | Technical Elective | 3 | |
| | | Technical Elective | 3 | | | Technical Elective | 3 | |
| | | Breadth Elective | 3 | | | Breadth Elective | 3 | |
| | | | | | | | | |
| | | Semester hours: | 16 | | | Semester hours: | 16 | |

*Figure 1. Sample sequence of courses for the proposed curriculum.*

## 5. Next Steps

If the proposed structure is approved, the next steps are as follows:

1. Present the proposed lists of the Technical, Breadth, and Data Science Electives to the full faculty for discussion and a vote, following the protocol applied to the current curriculum.
2. Develop implementation strategies for proficiency assessment.
3. Discuss course-specific modifications with the instructor(s) beyond the course change proposals appended to this curriculum change proposal, if needed.

## 6. Thematic Threads through the Curriculum

Throughout the curriculum, we have identified the following cross-cutting threads spanning different themes. These threads will satisfy some combination of ABET Program Criteria, ABET Student Outcomes, and the vision of the Department Chair and/or Undergraduate Curriculum Renewal Committee – each are important for the Civil Engineering of the future.

*Table 6. Summary of cross-cutting thematic threads across the proposed curriculum.*

| **Writing** | **Licensure** | **Ethics** | **Sustainability, Risk, Uncertainty, Resilience** | **Societal Implications** |
|---|---|---|---|---|
| ENGR 1300 | CIVILEN 2001 | CIVILEN 2001 | CIVILEN 2001 | Gen. Ed. |
| CIVILEN 2001 | ENVENG 3200 | CIVILEN 3080 | CIVILEN 3080 | CIVILEN 2001 |
| Lab courses | Design courses | ENVENG 3200 | ENVENG 3200 | CIVILEN 3080 |
| Design courses | Capstone | Design courses | ENVENG 5170 | ENVENG 5170 |
| Capstone | | Capstone | Design courses | Capstone |
| | | | Capstone | |

## Appendix A: Proficiency Mapping

The following table summarizes the curricular Goals, Outcomes, and Proficiencies and the courses within the Environmental Engineering curriculum that will be used in assessment. We have not yet populated this list, as a current undertaking of the departmental Undergraduate Studies Committee is to review and reassess these proficiencies through the lens of curriculum implementation in the context of the new Civil Engineering program. These proficiencies are internal to the department, directly as a metric to assess our curricula.

This list of courses differs from the new Civil Engineering curriculum as we do not have categories in which students can make a choice; rather, we specify a common set of courses for all students. We have yet to map proficiencies to these courses, as several will undergo redesign as part of the proposed curricular revision process.

Courses to be used in proficiency assessment include:

- CIVILEN 2001
- CIVILEN 3080
- CIVILEN 3130
- CIVILEN 3160
- ENVENG 3200
- ENVENG 4200
- ENVENG 4400
- ENVENG 5110
- ENVENG 5170
- Design (ENVENG 3210 + Design Elective)
- Capstone (ENVENG 4090)

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. Civil and Environmental Engineering Tools and Techniques** | | | | | | | | | | | |
| Goal: Students will be familiar and approaching proficiency with state-of-the-art protocols, modeling/simulation platforms, data analysis, numerical methods and physical experimentation used in civil and environmental engineering analysis and design. | | | | | | | | | | | |
| *1. Apply branch-specific tools and techniques to address engineering concerns* | | | | | | | | | | | |
| (a) Explain the underlying theory, operating principle and proper application of a particular tool | | | | X | | | | | | X | |
| (b) Define the conditions under which a certain tool will apply and the limits of its applicability | | | | X | | | | | | X | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (c) Recognize the differences between controlled lab or desktop experiments and real-world measurements | | | X | X | | | | X | | | |
| (d) Utilize appropriate data collection and preparation techniques | | | | X | | X | | | | | |
| (e) Utilize appropriate analytical and computational methods | | | X | | | | X | X | | X | |
| (f) Analyze and interpret experimental and/or computational results | | | | X | | X | X | | | | X |
| (g) Apply experimental or computational output to satisfy design and compliance criteria | | | | | | | | | | X | X |
| *2. Combine multiple tools or techniques in analysis and design* | | | | | | | | | | | |
| (a) Apply a combination of tools and techniques to a particular design problem | | | | | | | | X | | X | X |
| (b) Synthesize the output of multiple tools/techniques to solve a design problem | | | | | | | | X | | | X |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **B. Application of Knowledge and Skills to Problem Solving in Civil and Environmental Engineering** | | | | | | | | | | | |
| *1. Identify and locate information necessary to set up engineering problems* | | | | | | | | | | | |
| (a) List applicable governing codes, standards, zoning and/or legal/ethical framework | | | | | X | | | | | X | X |
| (b) Identify boundary conditions, loads, inputs, data, assumptions and/or design criteria | | | X | | X | | X | | | X | |
| (c) Identify the context surrounding a problem (e.g., information from other disciplines, team members, and stakeholders) | | X | | | X | | | | X | | X |
| *2. Solve and analyze solutions to engineering problems* | | | | | | | | | | | |
| (a) Apply codes, regulations, standards or protocols | | | | | | X | | | | X | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (b) Check solution satisfies constraints and client needs, troubleshoot problems, and iterate as necessary | | X | X | | | | | X | | X | |
| (c) Incorporate risk, reliability, and uncertainty analyses as needed | | | | X | | X | | | X | X | |
| **C. Professionalism and Professional Development in Civil and Environmental Engineering** | | | | | | | | | | | |
| Goal: Students will be resilient, skilled in collaboration, and exhibit professionalism necessary for success in their careers. | | | | | | | | | | | |
| *1. Successfully execute a project as a member of a team.* | | | | | | | | | | | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) As an individual, contribute to the success of a team (e.g., communicate effectively with team members; demonstrate leadership when appropriate; identify individual strengths and growth areas) | X | | | | | X | | | | | X |
| (b) As a team, conduct work cohesively (e.g., accept/adjust to feedback; demonstrate willingness to consider everyone's ideas; identify the distribution of tasks, knowledge, and skills; maintain organization) | X | | | X | | | | X | | | X |
| (c) Explain the value of having diverse teams, comprised of individuals with different backgrounds and perspectives | X | | | | | | | | | | |
| *2. Describe how engineers contribute to the acquisition, budgeting and follow-through of engineering contracts.* | | | | | | | | | | | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Provide proper estimates of fees and time required for engineering services they will perform | | | | | | | | | | | X |
| (b) Develop and understand the proposal process in obtaining work | | | | | | | | | | | X |
| *3. Recognize the importance of staying current with professional practice, obtaining licensure or other credentials, and finding resources to continue life-long learning.* | | | | | | | | | | | |
| (a) Identify the importance, benefits, and limitations of professional licensure or certifications in civil and environmental engineering | X | | | | X | | | | | | |
| (b) List the requirements for maintaining technical knowledge required for professional licensure | | | | | | | | | | X | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (c) Identify opportunities, and the need for, participation in post-graduate engineering training (e.g., ASCE Short Courses) | | | | | | | | | | X | |
| (d) Identify the need and limitation of engineering certifications and licensure for specific tasks and roles in civil and environmental works and projects | | | | | | | | | | X | |
| *4. Understand the broader social, economic, ethical, and political context in which engineering decisions are made.* | | | | | | | | | | | |
| (a) Identify how societal context may impact project goals and outcomes | X | X | | | | | | X | X | | |
| (b) Explain the sustainability consequences of engineering designs | X | X | | | | | | X | X | | |
| (c) Describe the importance of ethics in engineering | X | | | | X | | | | X | | X |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D. Communication in Civil and Environmental Engineering:** | | | | | | | | | | | |
| Goal: Students will be able to communicate civil and environmental engineering concepts effectively, both orally, visually, and in writing, to a range of audiences. | | | | | | | | | | | |
| *1. Effectively utilize a variety of communication modes* | | | | | | | | | | | |
| (a) Present data and information in plots and figures effectively | | X | | X | | X | X | | X | | |
| (b) Create a visually effective presentation to accompany an oral presentation | X | | | | | | X | | | | X |
| (c) Speak effectively in public | | | | | | | | | X | | X |
| (d) Document, present and discuss technical content in written format | | X | | X | | X | | | | X | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (e) Develop personal professional documents, such as resumes and cover letters | X | | | | | | | | | | |
| (f) Communicate through informal communication media (email, verbally in meetings, communication with colleagues and co-workers, "elevator" pitch) | X | | | | | | | | | | |
| (g) Communicate as a team, with a unified vision and goal | X | | | X | | X | | | | | X |
| *2. Tailor communication to a variety of audiences* | | | | | | | | | | | |
| (a) Discuss civil (environmental) engineering concepts, tools, and processes with other professionals | | | | | | | | | X | | X |
| (b) Explain civil (environmental) engineering concepts and tools with an audience of non-experts | X | | | | | | | | X | | X |
| *3. Provide, receive, and respond to feedback* | | | | | | | | | | | |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Provide helpful feedback in a professional manner | | | | | | | | | | | X |
| (b) React appropriately to, and integrate feedback from, various sources | | | | X | | | X | | X | | |
| **E. Civil and Environmental Engineering Professional Identity:** | | | | | | | | | | | |
| Goal: Students will develop an identity within the fields of civil and environmental engineering. | | | | | | | | | | | |
| *1. Articulate the roles that civil and environmental engineers play in society* | | | | | | | | | | | |
| (a) Explain the role of infrastructure in the public and private domain | X | | | | X | | | | X | | |
| (b) Develop an understanding of the career paths and job market trends for Civil and Environmental Engineers | X | | | | X | | | | | | X |

| **Goal** / *Outcome* / Proficiency | CIVILEN 2001 | CIVILEN 3080 | CIVILEN 3130 | CIVILEN 3160 | ENVENG 3200 | ENVENG 4200 | ENVENG 4400 | ENVENG 5110 | ENVENG 5170 | Design | Capstone |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (c) Describe the consequence on public safety and trust of civil and environmental engineering success and failure | X | | | | X | | | | | X | |
| *2. Discern among the technical specialties within Civil and Environmental Engineering* | | | | | | | | | | | |
| (a) Identify types of problems specific to the field of civil and environmental engineering | X | | | | X | | | | | | |
| (b) Identify the specialties needed for specific projects within the fields of civil and environmental engineering | X | | | | | | | | | X | |
| (c) Discern the roles and responsibilities of civil or environmental engineers from those of other project contributors | X | | | | | | | | X | | |

## Appendix B: ABET Program Criteria

The following table demonstrates how the new curriculum will satisfy ABET Program Criteria. We subdivide the program criterion related to "advanced principles and practices relevant to the program objectives" into categories related to the five NASEM Grand Challenges. This does not include the large number of elective courses, most of which would satisfy at least one NASEM Grand Challenge.

| ABET Program Criterion | Foundational | Fundamental | Advanced Core |
|---|---|---|---|
| Formulate material and energy balances | CIVILEN 3130 | ENVENG 3200<br>ENVENG 4400 | CIVILEN 3160<br>ENVENG 3210<br>ENVENG 5170 |
| Fate and transport in and between air, water, and soil | | ENVENG 4400 | |
| *Interactions with biota in these media** | ENVENG 5110 | | |
| Lab experiments, data analysis, and interpretation | | | |
| *Water* | | | CIVILEN 3160[$]<br>ENVENG 4200[$] |
| *Land* | | | @ |
| *Air* | | | ENVENG 4200 |
| *Environmental health* | | | |
| Design of environmental engineering systems with consideration of: | | | ENVENG 3210<br>Design elective<br>ENVENG 4090^ |
| *Risk, uncertainty* | | | ENVENG 3210<br>Design elective<br>ENVENG 4090^<br>ENVENG 5170[#] |
| *Sustainability and life-cycle thinking* | | | ENVENG 3210<br>Design elective<br>ENVENG 4090^<br>ENVENG 5170[#] |
| *Environmental impacts* | | | ENVENG 3210<br>Design elective<br>ENVENG 4090^<br>ENVENG 5170[#] |
| Use of computational tools in design* | | | ENVENG 3210<br>Design elective<br>ENVENG 4090 |
| Advanced principles and practices | | | |
| *Sustainably supply food, water, and energy* | ENVENG 5110 | ENVENG 3200<br>ENVENG 4400 | CIVILEN 3160<br>ENVENG 3210<br>ENVENG 5170 |
| *Curb climate change and adapt to its impacts* | | ENVENG 3200<br>ENVENG 4400 | CIVILEN 3160 |

| ABET Program Criterion | Foundational | Fundamental | Advanced Core |
|---|---|---|---|
| *Design a future without pollution or waste* | ENVENG 5110 | ENVENG 3200<br>ENVENG 4400 | ENVENG 3210<br>ENVENG 5170 |
| *Create efficient, healthy, resilient cities* | | ENVENG 3200 | ENVENG 3210<br>ENVENG 5170 |
| *Foster informed decisions and actions* | CIVILEN 2001<br>CIVILEN 3080 | ENVENG 3200 | ENVENG 5170 |
| Professional practice and project management | CIVILEN 2001 | | ENVENG 4090^<br>ENVENG 4200 |
| Environmental policy and regulations (protection and improvement of the environment*) | CIVILEN 2001 | ENVENG 3200 | ENVENG 4090^ |
| Application of economics and ethics in environmental engineering* | CIVILEN 2001<br>CIVILEN 3080 | ENVENG 3200 | ENVENG 5170 |

*We acknowledge this as a proposed change to the ABET Program Criteria for Environmental Engineering (see https://www.abet.org/accreditation/accreditation-criteria/proposed-changes/). We will ensure that, if approved, ENVENG 5110 will address the criterion related to interactions with biota in air, water, and soil. The use of some computational tool within a design course is one of the criteria outlined for a Design Course (see Section 3.3.5). We currently address the proposed change of "roles and responsibilities of public institutions and private organizations pertaining to the protection and improvement of the environment, and applications of economics and ethics in environmental engineering" in existing courses.

$CIVILEN 3160 contains laboratory experiments related to water transport (e.g., open channel flow, hydrology), while ENVENG 4200 contains laboratory experiments related to water treatment (e.g., coagulation/flocculation, disinfection).

@In our redesign of ENVENG 4200, we may add laboratory experiments related to soil. The ABET requirement is for students to conduct laboratory experiments in "more than one major environmental engineering focus area, e.g., air, water, land, environmental health", so even if we do not include an experiment in this context, we will still satisfy the ABET requirement through the other media.

^For formatting purposes, we include ENVENG 4090 in the category of Advanced Core courses within this table.

#While not a design course, ENVENG 5170 supports students' ability to consider risk, uncertain, sustainability, life-cycle thinking, and environmental impacts.

## Appendix C: Preliminary Elective Lists

Our initial list of elective courses is provided below. The categories are intended to indicate thematic groupings to guide students, but they may be subject to change. There is no requirement to take courses across different categories. This list also includes an indication of whether a course is grouped as a technical elective (TE) or breadth elective (BE).

When communicating these options to students, we will include a statement similar to "Note that not all courses may be offered in any given academic year. Further, courses offered outside of CEGE may be subject to discontinuation without the department's notice. Finally, courses on this list may have pre-requisites that must be satisfied, so students should plan accordingly."

| Course Number | **Category** / Course Title | Tech. Elective (TE) / Breadth Elective (BE) |
|---|---|---|
| | **Water Resources and Hydrology** | |
| CIVILEN 5220 | Open Channel Hydraulics | TE |
| CIVILEN 5230 | Transp. Phenom. for Water Res. | TE |
| EARTHSC 5206 | Advanced Oceanography | BE |
| EARTHSC 5651 | Hydrogeology | TE |
| EARTHSC 5655 | Land Surface Hydrology | TE |
| ENR 4285 | Watershed Hydrology | BE |
| ENVENG 5760 | Urban Stormwater Control Meas. | TE |
| FABENG 5750 | Stream Geomorphology and Watershed Hydrology | TE |
| | | |
| | **Air Quality and Atmospheric Processes** | |
| ATMOSSC 5950 | Atmospheric Thermodynamics | BE |
| ENVENG 5140 | Air Quality Engineering | TE |
| PUBHEHS 5340 | Air Contaminants and Public Health | BE |
| ATMOSSC 5901 | Climate System Modeling: Basics and Applications | BE |
| GEOG 5900 | Weather, Climate, and Global Warming | BE |
| | | |
| | **Environmental Chemistry and Contaminant Fate** | |
| CBE 3610 | Kinetics and Reactor Design | TE |
| ENR 5262 | Environmental Soil Chemistry and Remediation | TE |
| ENR 5273 | Env. Fate and Impact of Contam. in Soil and Water | TE |
| ENVENG 5210 | Adv. Phys. Chem. Treatment Processes | TE |
| ENVENG 5718 | Aquatic Geochemistry | TE |
| ENVENG 5410 | Hazardous Waste Management and Remediation | TE |
| EARTHSC 5621 | Introduction to Geochemistry | BE |
| | | |
| | **Biological and Ecological Systems** | |
| EEOB 3410 | Ecology | BE |
| FABENG 5310 | Ecological Engineering | TE |
| MICRBIO 4010 | Foundations of Microbio. and Human Health | BE |

| Course Number | **Category** / Course Title | Tech. Elective (TE) / Breadth Elective (BE) |
|---|---|---|
| BIOCHEM 4511 | Intro. To Biological Chemistry | TE |
| EARTHSC 5160 | Geomicrobiology | BE |
| | | |
| | **Public Health and Toxicology** | |
| EARTHSC 5203 | Geo-environment and Human Health | BE |
| ENVENG 5195 | Eng. Des. For Public Health | TE |
| PUBHEHS 3320 | Fundamentals of Environ. Health Risk Assessment | BE |
| PUBHEHS 4340 | Mol. Tech. for Environ. Health Sciences | BE |
| PUBHEHS 5315 | Principles of Toxicology | BE |
| PUBHEPI 2410 | Epidemiology in Public Health | BE |
| PUBHEHS 4325 | Climate Change and Public Health | BE |
| PUBHEHS 3310 | Current Issues in Global Environmental Health | BE |
| | | |
| | **Earth Systems** | |
| EARTHSC 4450 | Water, Ice, and Energy in the Earth System | BE |
| EARTHSC 4911 | Earth's Climate: Past and Future | BE |
| EARTHSC 5268 | Soils and Climate Change | BE |
| EARTHSC 5656 | Ecohydrology in a Changing Climate | BE |
| EARTHSC 5663 | Global Change and Sust. in the Earth System | BE |
| ENVENG 5218 | Meas. and Mod. of Climate Change | TE |
| CIVILEN 3540 | Geotechnical Engineering | TE |
| EARTHSC 5751 | Quantitative Reservoir Modeling | BE |
| ENR 3001 | Soil Science Laboratory* | TE |
| ENR 5261 | Environmental Soil Physics | TE |
| FABENG 5550 | Sustainable Waste Management | TE |
| CIVILEN 5240 | Groundwater and Geoenergy Engineering | TE |
| | | |
| | **Building Systems and Green Infrastructure** | |
| ARCH 5810<br>CONSYSM 2345 | Intro. to Environ., Mech., and Elec. Syst. in Arch. OR<br>Mechanical Systems for Buildings | BE |
| CIVILEN 4210 | Physics of Sustainable Buildings | TE |
| CONSYSM 5670 | Green Building and Sustainable Construction | BE |
| | | |
| | **Energy Systems** | |
| FABENG 3150 | System Dynamics and Electricity | BE |
| MECHENG 5535 | Advanced Topics in Solar Energy Systems | BE |
| MECHENG 4505 | Intro. To Nuclear Science and Engineering | BE |
| CBE 5200 | Intro. To Petroleum Engineering | BE |
| MECHENG 5500 | Sustainable Energy Science and Technology | BE |
| CRPLAN 5500 | Energy Planning | BE |

| Course Number | **Category** / Course Title | Tech. Elective (TE) / Breadth Elective (BE) |
|---|---|---|
| AEDECON 4320 | Energy, the Environment, and the Economy | BE |
| | | |
| | **Policy, Planning, and Communication** | |
| CRPLAN 3210 | Sust. Urban. Planning Policy and Practice | BE |
| ENR 3200 | Env. and Nat. Resources Policy | BE |
| ENR 4450 | Climate Change Policy | BE |
| ENR 5210 | US Env. Impact Assess. | BE |
| ENR 5211 | Int. Env. Impact Assess. | BE |
| PUBAFRS 2620 | Sci., Eng., and Tech. for Policy and … | BE |
| PUBAFRS 3000 | Public Policy Analysis | BE |
| PUBAFRS 3500 | Public Management | BE |
| PUBAFRS 5610 | Innovation, Policy, and the Global Economy | BE |
| PUBAFRS 5770 | Risk Management and Policy | BE |
| ENVENG 5600 | Science, Engineering, and Public Policy | BE |
| PUBAFRS 5770 | Risk and Decision Analysis | BE |
| COMM 4240 | Science Communication | BE |
| COMPSTD 2341 | Technology, Science, and Society | BE |
| AEDECON 2500 | Intro. To Sustainability | BE |
| BUSMHR 2210 | Personal Leadership and Team Effectiveness | BE |
| BUSMHR 3211 | Leadership and Character | BE |
| | | |
| | **Humanitarian and Social Dimensions** | |
| FABE 3200S | Engineering for Food Justice | BE |
| CIVILEN 5610.01 | WaSH Infrast. for Developing Rural Communities | TE |
| CIVILEN 5610.02 | Safe Water on Tap | TE |
| FABENG 3210 | Introduction to Humanitarian Engineering | BE |
| | | |
| | | |
| | **Other Areas** | |
| CIVILEN 2060 | Numerical Analysis for Civil and Environ. Engineers | TE |
| CIVILEN 5168 | Introduction to the Finite Element Method | TE |
| MECHENG 5139 | Applied Finite Element Method | TE |
| CIVILEN 2405<br>CONSYSM 2210 | Com. Graphics for Civil Engineers OR<br>Graphic Presentation | BE |
| CIVILEN 2410<br>CONSYSM 2440 | Intro. to Surveying OR<br>Const. Surveying and Site Development | BE |
| | | |
| | **Earth Science Electives** | |
| ATMOSSC 2940 | Basic Meteorology | BE |
| EARTHSC 2203 | Environmental Geoscience | BE |

| Course Number | **Category** / Course Title | Tech. Elective (TE) / Breadth Elective (BE) |
|---|---|---|
| EARTHSC 2210 | Energy, Mineral Resources, and Society | BE |
| EARTHSC 2911 | The Climate Crisis: Mechanisms, Impacts, and Mitigation | BE |
| ENR 3000 | Soil Science (with or without ENR 3001) | BE |
| GEOG 2960 | Introduction to Physical Geography | BE |
| | | |
| | **Foundational Electives** | |
| CHEM 2310<br>CHEM 2510 | Introductory Organic Chemistry OR<br>Organic Chemistry I | BE |
| MECHENG 3500 | Engineering Thermal Sciences OR<br>Thermodynamics in FABENG | BE |
| ECE 2300<br>ECE 2360 | Electrical Circuits and Electronic Devices OR<br>Electronics for CSE Majors | BE |
| MECHENG 2020 | Mechanics of Materials | BE |
| MECHENG 2030 | Dynamics | BE |
| PHYSICS 1251 | E&M, Waves, Optics, Modern Physics | BE |
| MICRBIO 5155 | Environmental Microbiology | BE |
| | | |
| | **Data Science Electives** | |
| CIVILEN 5400<br>GEOG 5210 | Introduction to GIS OR<br>Fundamentals of Geographic Information Systems | BE |
| CIVILEN 5420<br>EARTHSC 5310<br>GEOG 5225 | Remote Sensing of Environment OR<br>Remote Sensing in the Earth Sciences OR<br>Geographic Applications of Remote Sensing | BE |
| EARTHSC 5641 | Geostatistics | BE |
| EARTHSC 5757 | Artificial Intelligence in Earth Sciences | BE |
| CSE 5052 | Survey of Artificial Intelligence for Non-Majors | BE |
| GEOG 5103 | Intermediate Spatial Data Analysis | BE |

*Course must be taken concurrently with ENR 3000 Soil Science, which serves as an Earth Science elective within the proposed curriculum.