Civil Systems Engineering Graduate Studies Guide

2024-2025

University of Colorado **Boulder**

DEPARTMENT OF CIVIL, ENVIRONMENTAL, AND ARCHITECTURAL ENGINEERING (CEAE)
UNIVERSITY OF COLORADO

Boulder, CO

Updated 11/09/2024

Welcome to the Civil Systems program!

The Civil Systems graduate program introduces engineering students to the tools necessary to analyze the uncertainty and complexity inherent in the 21st century. Civil systems students learn to adopt systems analysis approaches to the development, management, and monitoring of civil infrastructure systems, applying engineering, social science, economic, and public policy approaches.

The following introductory information should be useful to you in familiarizing yourself with the program.

Advising

You will be assigned a temporary academic advisor from among the faculty. The first thing to do upon arriving at the University of Colorado Boulder is schedule an appointment and meet with this advisor to work out a course of study. This will be an outline of all the courses you plan to take for your degree.

Get acquainted, learn about courses they teach, learn what research they are doing, and inform them of your interests. Feel free to discuss your proposed plan with any member of the faculty; however, be aware that only your academic advisor can formally approve your courses. The academic advising form is included at the end of this guide and can also be accessed online (see the "Forms" link provided at end of guide).

All students conducting research will also select a faculty member to act as research advisor for your report, thesis, or dissertation. Again, as soon as you arrive you should schedule a meeting with this faculty member. They do not necessarily have to be your academic advisor, but we recommend that the same person serve as both research and academic advisors, particularly if you have already determined a specific research topic.

If will be working as Teaching Assistant (TA) and already know whom you will be working with, schedule a meeting with this faculty member as soon as you arrive as well. If you will be TA and do not yet know whom you will be working with, this information will be provided to you before the beginning of the semester.

Faculty & Staff

When you arrive on campus, you should introduce yourself to the following Civil Systems faculty members and staff:

Faculty

Kyri Baker, Assistant Professor, Ph.D., Carnegie Mellon University. Power system optimization and control, renewable energy, energy storage, smart buildings. (303-735-4802, kyri.baker@colorado.edu)

Angela Bielefeldt, Professor, P.E., Ph.D., University of Washington. Engineering Education, Sustainability, Environmental Engineering for Developing Communities (303-492-8433, Angela.Bielefeldt@colorado.edu)

Sherri Cook, Assistant Professor, Ph.D., University of Michigan. Sustainable water system design and implementation; resource recovery from waste; environmental biotechnology, sustainability-based decision making. (303-735-7288, sherri.cook@colorado.edu)

Gregor P. Henze, Professor, Ph.D., P.E., University of Colorado Boulder. Building-to-grid integration, human presence detection, uncertainty quantification of occupant behavior and its impact, energy analytics and decision analysis, model predictive control and reinforcement learning control for grid-interactive efficient buildings. (303-492-1094, gregor.henze@colorado.edu)

Amy Javernick-Will, Associate Professor, Ph.D., Stanford University. Disaster recovery, resilience and sustainability of infrastructure and social systems in resource-limited communities, knowledge mobilization, organizational management. (720-220-7220, amy.javernick@colorado.edu)

Joseph Kasprzyk, Assistant Professor, Ph.D., Penn State University. Water resources planning and management, decision making under uncertainty, high performance computing, creation of 'usable science' to aid decision making. (303-492-1818, joseph.kasprzyk@colorado.edu)

Abbie Liel, Associate Professor, Ph.D., Stanford University. Seismic collapse performance prediction of structures and structural systems; life safety risks and economic losses; earthquake performance of housing and schools internationally. (303-492-1050, abbie.liel@colorado.edu)

Karl Linden, Professor, Ph.D. UC Davis, Water Treatment, Wastewater Treatment, Disinfection, Advanced Oxidation (303-492-4798, karl.linden@colorado.edu)

Evan Thomas, Professor, Ph.D., University of Colorado Boulder, Mortenson Center Director (303-550-4671, ethomas@colorado.edu).

Cristina Torres-Machi, Assistant Professor, Ph.D. Universitat Politecnica de Valencia. Transportation asset management, pavement management systems, sustainable and long-term analysis of transportation infrastructure. (303-735-4609, cristina.torresmachi@colorado.edu)

Edith Zagona, Research Professor, P.E., Ph.D., University of Colorado. Water resources systems and modeling, hydropower, decision support, adaptation for climate change. (303-492-2189, zagona@colorado.edu)

Staff

For Current Students: Jenna Rodriguez, Graduate Program Coordinator

For Prospective Students: Deanne Sylvester, Senior Graduate Program Advisor

If you have questions, please contact our graduate program advisors at:
ceaegrad.advising@colorado.edu

Curriculum Requirements

Students may pursue their graduate studies in Civil Systems through Civil Engineering. The degree requirements for both are detailed in the following sections.

Master of Science Degree in Civil Engineering

You must obtain your advisor's concurrence and complete the attached graduate academic advising sheet before you register for any classes.

The **M.S. degree in Civil Engineering** may be obtained by completing one of three plans:

M.S. Degree Plans

Degree Plan	Core	Emphasis	Electives	Research
MS Plan I (Thesis)	9	9	6	Thesis- 6
MS Plan IIA	9	9	9	Report- 3
MS Plan IIB	9	9	12	N/A

Note: numbers listed are credit hours. Research credits need to be advised by a faculty mentor in the Civil Systems program (see Faculty listed above).

Course Offerings

There are three required courses in addition to 9 credit hours in an area of emphasis. The number of elective requirements depends on your particular plan (see above).

Required Core Courses

Course ID	Term	Course Name
CVEN 5454	Spring	Statistical Methods for Natural and Engineered Systems (or equivalent[1])
Varies	F/S	Two courses from the following list: CVEN 5147: Civil Engineering Systems and Planning CVEN 5157: A Systems Approach to Global Engineering CVEN 5393: Water Resource Systems and Management CVEN 5836: Infrastructure Asset Management CVEN 5830: Grid Connected Systems AREN 5660: Embodied Carbon in Buildings CVEN 5834: Sustainable Engineering Design Note that not all courses may be offered every academic year.
Area of Emphasis		Complete 9 hours in an area of emphasis. An area of emphasis can be from a traditional CEAE area, or an interdisciplinary area (interdisciplinary grouping of classes) with advisory committee approval (the student must assemble an advisory committee that consists of three faculty members, at least two of whom are Civil Systems faculty).

For approval of courses not listed, student must submit a syllabus and obtain signatures from 3 Civil Systems faculty.

Note: if you have experience in one or more of the core courses and you wish to substitute an elective course, you must petition the faculty.

Area of Emphasis Options

Disciplinary Course Groupings:

- *Construction:* In consultation with an advisor, select three courses from among the following: CVEN 5346: Managing Engineering Projects and Organizations; CVEN 5226:

[1] Options for Research Methods in Civil Systems include: **CVEN 5454 Statistical Methods for Natural and Engineered Systems, AREN 5030 Data Science for Energy and Buildings**; EMEN 5005 Introduction to Applied Statistical Methods; PSYC 5741General Statistics (Psychology sequence); PSCI 7085 (Political Science; SOCY 6121 (Qualitative Methods, Sociology); SOCY 7121 (Qualitative Analysis, Sociology); EVEN 5444: Analytical Methods, Experimental Design, and Applied Data Analysis.

Construction Safety & Quality; CVEN 5836: Infrastructure Asset Management (do not double count); CVEN 5836: Building Information Modeling for Capital Projects

- *Structures:* CVEN 5111 Structural Dynamics; CVEN 5161 Advanced Mechanics of Materials; CVEN 5525 Analysis of Framed Structures.
- *Environmental:* In consultation with an advisor, select two from among the following: CVEN 5404 Water Chemistry, CVEN 5484 Environmental Microbiology, CVEN 5464 Environmental Engineering Processes; and, select one from among the following: CVEN 5524 Drinking Water Treatment, CVEN 5534 Wastewater Treatment, CVEN 5474 Hazardous Waste Management, CVEN 5834 Small Community Water and Wastewater Systems, CVEN 5594 Water Reuse, and CVEN 5323 Applied Stream Ecology.
- *Water Resources:* CVEN 5423 Water Resources Engineering is required. CVEN 5454 Statistical Methods is the recommended quantitative methods class for this track. CVEN 5393 Water Resources Development and Management is the recommended systems thinking course for this track. A 5000-level optimization class could cover the Life Cycle Assessment class, since optimization is a key skill for water resources. Suggested courses for the remainder of the electives, to be determined in consultation with an advisor, include but are not limited to: CVEN 5363 Modeling of Hydrologic Systems, CVEN 5537 Numerical Methods, CVEN 5353 Groundwater Hydrology, CVEN 5383 Groundwater Modeling, CVEN 6833 Advanced Data Analysis, CVEN 5833 Open Channel Hydraulics, CVEN 5833 Surface Water Quality Modeling.
- *Building Systems:* In consultation with an advisor, select three of the following courses: AREN 5080 Computer Simulation of Building Energy Systems; CVEN 5830: Building Energy Systems; CVEN 5890: Sustainable Building Design; AREN 5010 HVAC System Modeling and Control; AREN 5110 HVAC System Design; AREN 4570 Electrical Systems; AREN 5830 Grid Connected Systems; CVEN 5020 Building Energy Audits.
- *Global Engineering*:* CVEN 5919: Global Development for Engineers, CVEN 5939: Global Development Practicum and, in consultation with an advisor, six additional Global Engineering credits. *Enrollment in Global Engineering Graduate Certificate required.

Interdisciplinary Course Grouping Examples:

- *Hazards and Disasters:* Three courses (with approval of advisory committee), which may include: SOC 5087: Graduate Seminar on Hazards, Disasters, and Risk; CVEN 5818: Geotechnical Earthquake Engineering; CVEN 6595: Earthquake Engineering; CVEN 5276: Engineering Risk & Decision Analysis; CVEN 5830 Spc Topics: Humanitarian Response and Disaster Management;
- Engineering Risk and Decision Analysis: EMEN 5080: Ethical Decision Making; CVEN 5276: Engineering Risk & Decision Analysis; Optimization courses
- Engineering & Policy: CSTPR recommended courses: ENVS 5100 Science and Technology Policy; ENVS 5110 Science, Technology, and Society; ENVS 5120 Quantitative Methods of Policy Analysis; ENVS 5100 Behavioral Insights for Sustainability (new course, need to check future offerings) (see: http://sciencepolicy.colorado.edu/stcert/curriculum/courses.html)

Elective Courses

A list of recommended electives is provided below and should be approved by the student's advisor.

Elective requirements may be satisfied by successfully completing any graduate-level courses offered in the Civil Engineering Department, as approved by your academic advisor. Reference the CU Graduate School Rules (link provided below) for the final course grade requirements in order to consider a course successfully completed. Identification of other electives not on the following list is encouraged but must be approved by your academic advisor.

Civil Engineering Electives

CVEN 5393	Water Resource Systems and Management

Mortenson Center in Global Engineering (MCGE) Electives

CVEN 5919	Global Development for Engineers*
CVEN 5939	Global Development Practicum*

Full listing of MCGE courses

Potential Electives Outside of Civil Systems Program (may require approval of the instructor)

SOC 5037	Graduate Seminar on Hazards, Disasters, and Risk
GEOG 5023	Quantitative Methods in Geography
GEOG 5100	GIS in the Social and Natural Sciences
GEOG 5113	Advanced GIS: Integrating Data Across Space and Time

**Note- Enrollment in the Global Engineering Graduate Certificate is required for CVEN 5919 and 5939 but not for the other MCGE courses.*

M.S. Degree Final Defense

A final defense is required for all plans. The defense is oral and typically one hour in duration. It is the student's responsibility to complete the departmental and graduate school required forms on time and to schedule the defense. Forms are available on the "Current Student" portion of the department's graduate student website (http://ceae.colorado.edu/current-students/). Frequently asked questions and answers are also posted to this website. Additional questions about the proper forms and dates of submittal should be directed to the CEAE Graduate Advisor (contact information provided in "Faculty and Staff" section above.

The final defense for Coursework Only students is a review of grades and coursework by a panel of three faculty committee members. Follow the "CEAE Forms" link at the end of this guide for further information.

A Master's level report or thesis is prepared in consultation with the student's research advisor. Failure to provide the report/thesis by the submittal date will postpone the examination to the following semester. These documents must follow the CU graduate school format requirements and be submitted in advance of the required deadlines.

An MS report allows students to pursue a topic of special interest in greater depth than provided by the offered courses. The MS report includes (at a minimum) a thorough review of relevant literature on a Civil Systems topic. In addition, some active (e.g., interviews, case studies) or passive (e.g., survey, Delphi) data collection and analysis is often conducted. A good report should be acceptable for publication at a conference and requires a minimum of 135 hours worked over the semester.

An MS thesis involves the synthesis of original knowledge that contributes to a particular domain of knowledge related to Civil Systems engineering. A thesis is strongly recommended for students that plan to pursue a Ph.D.; however, a thesis is also encouraged for students that wish to explore a specific topic in greater depth. An MS thesis includes (at a minimum) a thorough literature review on a topic related to Civil Systems; a well-defined point of departure; a clear and concise research question; a structured, justified, and rigorous research method; significant results; analyses; conclusions; and recommendations. The thesis should produce a clear advancement in knowledge. A good thesis should be acceptable for publication at a peer-reviewed journal and requires a minimum of 270 hours worked over the semester.

Doctor of Philosophy Degree in Civil Engineering

The **Ph.D. program** requires a dissertation, and may require additional coursework, in addition to a Master's degree. At the Ph.D. level, Civil Systems is an emphasis within the Civil Engineering Program.

There are three (3) examinations and a public presentation required of Ph.D. students. These include: preliminary exam, comprehensive exam, and a final Ph.D. Defense. Each is described below.

Preliminary Exam: This exam must be scheduled and completed when the majority of your coursework has been completed as a Ph.D. student. It should be noted that admission to the Ph.D. program is dependent upon successful completion of this examination. The exam is designed to determine the candidate's background knowledge in Civil Engineering and Civil Systems. It is a diagnostic exam to identify areas of weakness. An aggregate score of 80% or better is needed to pass the examination. Ph.D. students who fail their first attempt of the exam will be allowed to retake it one additional time. Students failing the exam twice will not be permitted to continue in the Ph.D. program.

The Civil Systems preliminary examination is an open-book, two-day exam. One day of the examination consists of responding to questions from four courses. The first course is

CVEN 5454, and the remaining three are from the remaining core courses taken and chosen by the student. Each subject area should take approximately 1-1.5 hours to complete. The other day, the student will respond to an essay style question from their advisor(s) that relates to their planned research topic from a systems perspective. Students with undergraduate preparation in fields other than Civil or Architectural Engineering may also be tested on fundamental Civil and Architectural Engineering subjects.

Comprehensive Exam: a Ph.D. candidate takes this exam towards the beginning of their dissertation, after coursework and the preliminary examination are completed, with *at least* one year remaining within the Ph.D. after passing the comprehensive exam. The focus of the examination is to evaluate the student's ability to conduct independent research. A comprehensive proposal (in written form) is submitted to committee members two (2) weeks prior to the examination date. The proposal should highlight the research question(s) and/or hypotheses being addressed/tested, a literature review, a plan for data collection/analysis/validation, and expected contributions. In addition, it should include a reference list, proposed timeline, and expected papers. The written proposal is followed by an oral presentation and examination where the candidate presents her/his proposed work and answers questions from committee members. During this exam the candidate may be asked to clarify or expand on the written portion. The committee may approve the proposal at the time of the presentation or ask that the proposal be developed more fully.

Ph.D. Defense: This is the final step in obtaining a Ph.D. It is a public meeting at which the candidate presents and defends the work contained in the dissertation. The candidate's committee and the public are welcome to attend.

Financial Support

Financial support is limited. Students requiring financial support should discuss this matter with his/her academic advisor and contact the appropriate faculty researchers regarding possible Research Assistantships. Also, students should contact the graduate committee representative for the Civil Systems program to inquire about a potential appointment as a Teaching Assistant. Department Teaching Assistantships are typically awarded for one year only. Teaching Assistants should seek alternate financial support for subsequent years.

Research/Teaching Assistantships

Students on RA or TA appointments are expected to take no more than 9 credit hours per semester. Students appointed as 50% TA's/RA's are required to work solely for their associated faculty. Any student working for outside departments, companies, etc. will lose their TA/RA appointment immediately.

Masters students holding either Research Assistantships or Teaching Assistantships are required to follow Plan I (Thesis Option). Students holding half-time positions shall ordinarily carry no more than 9 hours of graduate course work per semester. All students with RA or TA appointments are required to apply for Colorado residency in order to qualify for in-state tuition. See "Other Information" section below for more information.

Other Information

The general CEAE office is ECOT 441 (4th floor of the engineering office tower). Research Assistant and Teaching Assistant mailboxes are also located on the 4th floor.

Colorado Residency

If you are a US citizen or a permanent resident, but are from another state, you should establish Colorado residency by obtaining a Colorado driver's license, registering your vehicle in Colorado, registering to vote, and paying Colorado State Income tax as soon as possible. Note that if you are funded by a Teaching Assistant (TA) or Research Assistant (RA) position, **you are required** to establish Colorado residency as soon as possible. This means that you will apply for residency within your first year and establish it for your second year. More information about this process can be found here: http://www.colorado.edu/registrar/state-tuition

Desk Space

Desks are reserved for Ph.D. students working on research. When available, M.S. Thesis students may also have desk space, according to seniority and funding status. It is important that all students are respectful of students working.

Email

All students are required to get an e-mail account for CU. If you prefer to use another email account (e.g. yahoo, gmail, etc.), you are still responsible for checking your CU email for important announcements (e.g. from the Department, Graduate School).

Civil Systems Email List

Sign up for the "Civil Systems Student and Faculty" Google group to receive updates, announcements, and other important information. How to sign up:

1. Use the following URL to go to the group page: https://groups.google.com/forum/#!forum/civilsystemsstudentsandfaculty
2. Click sign up
3. Create a Google groups profile (if you do not have one) and submit your information – make sure to use the email address that you check most frequently
4. Your application will be approved by the administrator and you will have access to the page and will receive group emails

Volunteering options to consider as a student group!

- Organize a community volunteer outreach day
- Lead a seminar series for Civil Systems Students
- Plan get-togethers with other Civil Systems Faculty and Students

Useful Websites

General CU Boulder

Graduate School: http://www.colorado.edu/GraduateSchool/

Graduate School Calendar: http://www.colorado.edu/GraduateSchool/calendar/

Policies: http://www.colorado.edu/policies/

Graduate School Requirements and Forms: http://www.colorado.edu/graduateschool/academic-resources

CU Research Policies: http://www.colorado.edu/VCResearch/researchpolicies/index.html

Funding Resources: http://www.colorado.edu/graduateschool/graduate-student-funding

Civil, Environmental, and Architectural Engineering Department

CU CEAE Website: http://www.colorado.edu/ceae/current-students

CU CEAE Forms: http://www.colorado.edu/ceae/current-students/graduate-studies/forms-graduate-students

CU CEAE Advising: http://www.colorado.edu/ceae/current-students/graduate-studies/graduate-student-advising

CU CEAE Rules: http://www.colorado.edu/ceae/sites/default/files/attached-files/CEAEGraduateRules_13Dec2012.pdf

CU CEAE Graduate Student FAQ's: http://www.colorado.edu/ceae/current-students/graduate-studies/faqs

CIVIL, ENVIRONMENTAL, AND ARCHITECTURAL ENGINEERING

GRADUATE STUDENT ACADEMIC ADVISING SHEET

DATE: _____

NAME: _____

SEMESTER ADMITTED: _____

All graduate students should have a planned program before they register for the second semester.

Degree	
Coursework	_____
Master's Thesis	_____
Master's Report	_____
Ph.D.	_____

The student named above and I, as the student's academic advisor, have examined his/her academic record. The attached list of courses represents his/her planned graduate program.

_____

Faculty Academic Advisor/Date

_____

Student Signature/Date

CIVIL SYSTEMS PROGRAM

Area of Emphasis: ______________________________

COURSE	CREDIT HOURS