



# Civil, Environmental and Architectural Engineering

UNIVERSITY OF COLORADO **BOULDER**

## OVERVIEW ARCHITECTURAL ENGINEERING GRADUATE STUDENTS **PROFESSIONAL MS DEGREE**

### Academic Year 2020-2021

Welcome to the Architectural Engineering Graduate Program! This document contains an outline of the curriculum requirements for the Architectural Engineering Professional MS program. You are also suggested to refer to the following recourses:

- Graduate School Rules: <https://www.colorado.edu/graduateschool/policies>.
- All procedures, deadlines, and requirements by Graduate Schools:  
<https://www.colorado.edu/graduateschool/academic-resources/graduation-requirements>
- Pertinent forms for CEAE graduate students: <https://www.colorado.edu/ceae/current-students/graduate-studies/forms-graduate-students>

## 1. ARRIVING

### 1.1 Meet the Faculty

The first thing that you need to do upon arriving at the University is to meet (1) the CEAE Graduate Program Advisor and (2) the faculty member you will be working with (or the temporary advisor on your admission letter). Drop by their offices (or call/email to make an appointment) and get acquainted. Specific backgrounds and areas of expertise for each faculty member can also be found at: <http://www.colorado.edu/ceae/faculty-staff/faculty>

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You are **required** to meet with your advisor (or your temporary academic advisor) to work out a course plan of study, which is an outline of all the courses that you plan to take for your degree. You will need to obtain an official course plan sheet from Graduate Program Advisor and fill out the contents, and get a signature from your advisor before Graduate Program Advisor can lift the flag for course registration. Your course of study can be revised; you should meet with your advisor before each semester starts to review your course of study and revise it as necessary. Please feel free to discuss your proposed course plan with any of the faculty members; however, your primary advisor must formally approve your course plan.

## ***1.2 To Do Right Away***

### **Establish Colorado Residency**

If you are a US citizen or permanent resident and have come from out of state, you should, as soon as possible, take steps to establish Colorado residency. This includes obtaining a Colorado driver's license, registering your car in Colorado, and registering to vote in Colorado. Establishing residency qualifies you for much lower in-state tuition after 12 months.

### **Activate IdentiKey**

There are many computer resources on campus and in the department and you should immediately sign-up for a computing account. An IdentiKey is created when you are admitted to the University of Colorado Boulder by the university's student information system. After being accepted, you may activate your IdentiKey. Details can be found at: <http://www.colorado.edu/oit/services/identity-access-management/identikkey>. You need your IdentiKey for various campus accounts and resources.

### **Obtain Lab Access**

The Office of Information Technology also manages some computer resources through the Bechtel Lab in the Civil Engineering wing of the Engineering Center (ECCE). The Lab is used for upper division and graduate coursework and you can use your IdentiKey to login. It is also valuable to establish an account in the Integrated Teaching and Learning Laboratory (ITLL), which is across the enclosed bridge at the end of the ECCE wing. Account arrangements can be made through the ITLL main office.

You can access the Bechtel Lab via a card reader which reads your BuffOne card. To obtain the access, send a picture of your BuffOne card to CEAE office [CEAEOffice@colorado.edu](mailto:CEAEOffice@colorado.edu). Please send the email from your Colorado.edu address and indicate reasons for your request (courses, etc.).

### **Join AREN Listserv**

We have established a listserv for Architectural Engineering (AREN) colleagues. This list is used for various announcements (including job, internship, and TA/RA positions). It is very important that you subscribe to this email list by sending an email to [sympa@lists.colorado.edu](mailto:sympa@lists.colorado.edu) with the following line in the message body (where Your Name is your real name):

subscribe ceae-bsp Your Name

## 2. PROGRAM OF STUDY

Your overall course of study must be discussed with and approved by your academic advisor within the first week of the first semester. You are also strongly encouraged to review the course plan with your advisor at the beginning of every following semester. This will avoid any surprises during the semester that you are trying to graduate. Your program of study may be modified at any time (in consultation with your advisor); however, you should always have an overall plan on file.

### 2.1 Program Pre-requisites

It is expected that AREN graduate students will have a solid background in Engineering. Students with an MS degree in Engineering are considered to meet our prerequisites. Students without an MS degree in Engineering should meet the following **undergraduate pre-requisite courses**:

1. Ordinary Differential Equations
2. Physics I or Physics II
3. Thermodynamics
4. Any other pre-requisite courses identified by the academic advisor

All deficiencies must be completed before a graduate degree is awarded.

The make-up courses taken at CU to address deficiencies **will not count** toward the credit requirement for your MS degree. **Up to two courses (6 credit hours) at the 3000 level** and above can be taken for graduate credit by doing extra work and by enrolling in them as independent studies. However, this can only be done with the agreement of the course instructor. Note that you are allowed a **maximum of 6 credit hours of "independent study"** in your degree.

### 2.2. Program Requirements

The AREN Professional MS program focuses on three disciplinary areas (subplans): building systems engineering (BSE), intelligent building systems (IBS), and construction engineering and management (CEM). Students are expected to complete 30 credit hours to meet the requirements of the MS degree. Specifically, The AREN Professional MS curriculum comprises of a common core of required courses plus a set of elective courses that can be selected from three different subplans. Finally, a two-semester cooperative/internship is required to interact with professionals and gain real experience.

#### 2.2.1. Core Courses

Students enrolled in the Professional MS program are required to take the following core course:

- *AREN 5001 Building Energy Systems*: All AREN MS students are expected to have a fundamental understanding of building energy systems, construction engineering, and sustainable building design. Students who lack sufficient exposure to the engineering of building mechanical and electrical systems, including lighting engineering, will be required to take a leveling course Building Energy Systems, which is a prerequisite course for several AREN courses (and thus often suggested for the first semester).

#### 2.2.2. Electives Courses

In addition to the core courses, students enrolled in the Professional MS program are required to take elective courses in each of the three subplans:

### **Building Systems Engineering Subplan:**

In this subplan, students can take elective courses related to designing and operating sustainable building systems. In particular, students can learn to design and evaluate energy systems, including construction materials, and mechanical, lighting, and electrical systems for the built environment. There are a range of elective courses that students can select from depending on their interest and career plan.

Courses with a focus on **building energy engineering** include:

- AREN 5110 HVAC System Design
- AREN 5010 HVAC System Modeling and Control
- AREN 5080 Computer Simulation of Building Energy Systems
- AREN 4570 Electrical Systems
- AREN 5060 Electrical Distribution Generation
- AREN 5020 Building Energy Audits
- AREN 5030 Data Science for Energy and Buildings
- AREN 5830 Applied Data Analysis and Modeling
- AREN 5830 CFD of Buildings and Environment
- AREN 5830 Modeling and Simulation of Community Energy Systems
- AREN 5830 Grid Connected Systems
- ECEN 5007 Power Systems Planning and Optimizations
- ECEN 5007 Renewable Energy: Future of Power Grid
- ECEN 5007 Data Analytics and Decision Making for Power Systems

Courses with a focus on **illumination engineering** include:

- AREN 4550 Illumination II\*
  - AREN 5130 Optical Design
  - AREN 5830 Luminous Radiative Transfer
  - AREN 5830 Daylighting
  - AREN 5830 Advanced Lighting Design
  - AREN 5830 Lighting Controls
- \*Must enroll in CVEN 5849: Independent Study to receive graduate credit for this course.

Courses with a focus on **materials and resources** include:

- AREN 5830 Forensic Engineering
  - CVEN 4565 Timber Design / Design of Wood Structures\*
  - AREN 4315 Reinforced Masonry Design\*
  - AREN 5830 Sustainable Materials and Structures
  - CVEN 5831 Construction Materials
  - CVEN 5565 Lifecycle Engineering
- \*Must enroll in this class as an Independent Study to receive graduate credit for this course

### **Intelligent Building Systems Subplan:**

In this subplan, students take required and elective courses related to designing and managing **information and operational technologies for intelligent building systems**. Students will learn the broad range of concepts including HVAC system design and control, building automation systems and protocols, data communication fundamentals, data science for building operations, fundamentals of

cybersecurity, integration and functionality of diverse building systems, and the application of Building Internet of Things (BloT) technologies.

There are a range of elective courses that students can select from depending on their interest and career plan, with a subset of recommended courses indicated by \*\*.

Courses with a focus on **building systems engineering and operations** include:

- AREN 5110 HVAC System Design\*\*
- AREN 5010 HVAC System Modeling and Control\*\*
- AREN 5020 Building Energy Audits\*\*
- AREN 5080 Computer Simulation of Building Energy Systems
- AREN 4570 Electrical Systems
- AREN 5060 Electrical Distribution and Generation

Courses with a focus on **data science** include

- AREN 5030 Data Science for Energy and Buildings\*\*
- CVEN 6833 Advanced Data Analysis Techniques

Courses with a focus on **information technology architecture and cybersecurity** include:

- TLEN 5000 Fundamentals of Cybersecurity for Leaders and Innovators\*\*
- AREN 5830 Emerging Trends in the Building Internet of Things (new)
- TLEN 5530 Applied Network Security

### **Construction Engineering and Management Subplan:**

This subplan is for those students interested in specializing in building Construction Engineering and Management (CEM). The CEM courses include:

- CVEN 5836 CEM Fundamentals
- CVEN 5246 Legal Aspects of Construction
- CVEN 5276 Engineering Risk and Decision Analysis
- CVEN 5226 Safety and Quality
- CVEN 5286 Design of Construction Operations
- CVEN 5836 Building Information Modeling (BIM) for Construction
- CVEN 5346 Managing Engineering Organizations

**PLEASE NOTE:** Many of these courses are not offered every year. In fact, depending on faculty availability, these courses could even be offered in the opposite semester. The college policy for teaching by research-active faculty is three courses per year. For many faculty members who are required to offer undergraduate courses each year, the main implication of this policy is that graduate courses will be offered with less regularity. However, since most students take two years to complete their studies, all courses should be available to you with good planning.

### **2.2.3. Professional Experience**

Central to the Professional MS degree requirement is a two-semester structured cooperative or internship to gain real-life experience related to building systems. The cooperative should be taken during the second year after the student has completed the core courses and some of the electives courses and should be organized with the assistance of the student's academic advisor. The cooperative involves close interaction between the student and professionals. For instance, the cooperative can be performed

with the campus facilities management personnel for the purpose of gaining real-life and hands-on experience in the challenges encountered in managing a university campus.

### ***2.3. Certificate for Engineering for Developing Communities***

Students admitted to AREN MS Professional programs can apply for the Engineering for Developing Communities (EDC) certificate program. Once admitted, the students must fulfill the coursework and practicum requirements of that program to receive the EDC certificate in addition to their AREN MS degree. For AREN students, up to 6 units of the required EDC coursework can count as coursework needed for the MS Professional degree.

### **Degree Requirements**

For Professional Master of Science (MS) degree in Architectural Engineering, the student has to take 30 credit hours of course work. In particular, the student cannot take any credit-hours for a thesis or a project. Typically, students can successfully complete the degree requirements within 12 - 18 months. Non-CEAE courses at the 4000 level may be used for graduate credits up to a maximum of 6 credit hours, with the approval of the advisor. Moreover, up to 6 credit hours of "independent study" may be taken where an individual course of study is worked out between the student and a faculty member. Up to 9 credit hours of graduate courses can be transferred from another institution. Students are allowed to take up to 6 credit hours of non-technical coursework for the Professional MS degree.