GUIDE FOR ARCHITECTURAL ENGINEERING GRADUATE STUDENTS

Academic Year 2025-2026

Welcome to the Architectural Engineering Graduate Program! This document contains an outline of things you need to know about the program. It is by no means exhaustive, but it should help you get started. 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 Advisors 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. If you have not formalized your research topics/ideas, you may want to talk with all faculty members to find out about the courses they teach, their research interests, and their roles in the program; at the same time, this allows them a chance to find out about your background and your interests. 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 **academic advisor** (or your assigned 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. Options are discussed in the next section. You will need to obtain an official course plan sheet from the Graduate Program Advisor and fill out the contents and get a signature from your advisor before the 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.

Eventually you will select a faculty member to act as the **research supervisor** for your MS report, MS thesis, or PhD dissertation. If you are pursuing PMP, you do not need a research supervisor. Your research supervisor need not necessarily be the same individual as your academic advisor; choice of a research supervisor can be made later. At this later time, you and your research advisor will also select a graduate committee for your degree examination.

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/identikey. 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 log in. 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. 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 registering to https://groups.google.com/ and add your name to the ceae-bsp@colorado.edu.

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 course of study may be wide or narrow; it will depend on your personal career plans. People who are thinking of a future in research work may take a different approach than those who see themselves working in industry for a design or consulting engineering firm. However, your advisor will ensure that you do end up with a good grounding in all aspects of architectural engineering. 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.

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 a BS 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 graduate 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.

Program Requirements

The AREN graduate curricula will comprise typically of core required courses combined with a set of required and elective courses specific to a track within each discipline. Students must select an area of specialization or a subplan related to their graduate degree.

- All AREN graduates are expected to have a fundamental understanding of building 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 leveling courses such as AREN 5001, AREN 5002, or others.
- In addition to these required courses, PhD students may also be required by their advisors to take at least one course in applied mathematics or numerical methods

There are also courses in other departments that will be of value, for example undergraduate-level courses offered in some of the architectural engineering areas that may be useful for you to take prior to, or instead of, the graduate-level courses. If you wish to gain registration as a Professional Engineer but do not have a BS in engineering from an ABET-accredited engineering program, please consult the Colorado Board of Registration (http://cdn.colorado.gov/cs/Satellite/DORA-Reg/CBON/DORA/1251632130538) for more details about the current rules.

3. ARCHITECTURAL ENGINEERING PROGRAM DEGREES

There are three graduate degrees in the AREN program, including Professional Master's Program (PMP), regular Master of Science (MS), and Doctor of Philosophy (PhD). The specific subplans, course requirements, and graduation procedures are outlined in the following sections.

3.1 Professional Master Program (PMP) Degree in Architectural Engineering

The AREN PMP degree consists of coursework only (30 credit hours). Currently, there are seven subplans for PMP depending on the area of specialization to be selected by the students when admitted to the AREN program. The course requirements for the seven AREN PMP subplans, approved by the Graduate School on October 30, 2023, are:

3.1.1 Building Energy

Required Courses: 15 Units

AREN 5001 Building Science and Engineering I
AREN 5002 Building Science and Engineering II
EMEN 5010 Introduction to Engineering Management
or EMEN 5020 Finance for Engineering Managers
or CVEN 5006 CEM Fundamentals
Select Two of the Following:
AREN 5010 Energy System Modeling and Controls
AREN 5080 Computer Simulation of Building Systems
AREN 5990 CFD of Buildings and Environment
AREN 5830 Building Systems Simulation and Modeling
AREN 5830 Grid Connected Systems

Elective Courses: 15 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.2 Data Science for Buildings

Required Courses: 18 Units

AREN 5001 Building Science and Engineering I
AREN 5002 Building Science and Engineering II
EMEN 5010 Introduction to Engineering Management
or EMEN 5020 Finance for Engineering Managers
or CVEN 5006 CEM Fundamentals
AREN 5030 Data Science for Energy and Buildings
CVEN 6833 Advanced Data Analysis Techniques
CVEN 5836 AI/ML in Built Environment

Elective Courses: 12 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.3 Building Decarbonization

Required Courses: 15 Units

AREN 5001	Building Science and Engineering I
AREN 5002	Building Science and Engineering II
EMEN 5010	Introduction to Engineering Management
or	EMEN 5020 Finance for Engineering Managers
or	CVEN 5006 CEM Fundamentals
AREN 5660	Embodied Carbon in Buildings
AREN 5890	Sustainable Building Design

Elective Courses: 15 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.4 Lighting and Daylighting

Required Courses: 15 Units

AREN 5001	Building Science and Engineering I
EMEN 5010	Introduction to Engineering Management
or	EMEN 5020 Finance for Engineering Managers
or	CVEN 5006 CEM Fundamentals
AREN 5550	Illumination II
AREN 5580	Daylighting
AREN 5540	Landscape Lighting Design

Elective Courses: 15 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.5 Indoor Environmental Quality for Buildings

Required Courses: 15 Units

AREN 5001	Building Science and Engineering I
AREN 5002	Building Science and Engineering II
EMEN 5010	Introduction to Engineering Management
or	EMEN 5020 Finance for Engineering Managers
or	CVEN 5006 CEM Fundamentals
AREN 5990	CFD for Built and Natural Environment
AREN 5620	Adaptive Lighting Systems
MCEN 5141	Indoor Air Pollution

Elective Courses: 15 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.6 Structural Engineering

Required Courses:

CVEN 5111 Structural Dynamics
CVEN 5525 Computational Structural Analysis 1
CVEN 6595 Earthquake Engineering
AREN 5660 Embodied Carbon in Buildings
Select One of the Following:
CVEN 5575 Advanced Topics in Steel Design
CVEN 5585 Advanced Topics in Reinforced Concrete Design
CVEN 5838 Design of Masonry Structures
CVEN 5565 Design of Wood Structures

Elective Courses: 15 Units

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.1.7 Construction Engineering & Management

Required Courses: 18 Units

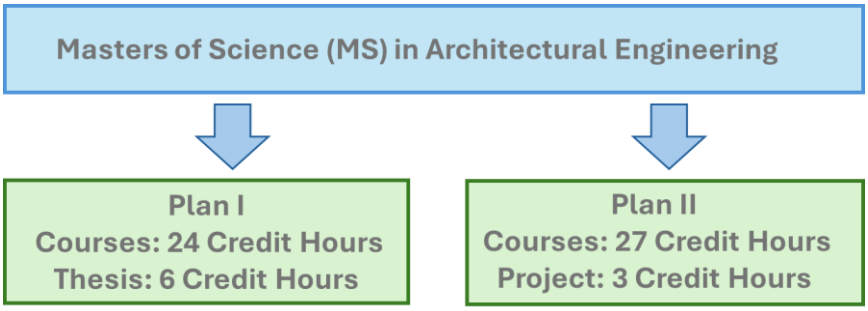
AREN 5001 Building Science and Engineering I
CVEN 5006 CEM Fundamentals
CVEN 5836 Building Information Modeling (BIM) for Construction
Select Three of the Following:
CVEN 5226 Safety and Quality
CVEN 5346 Managing Engineering Organizations
CVEN 5446 Infrastructure Asset Management
CVEN 5836 AI/ML in Built Environment
CVEN 5246 Legal Aspects of Construction

Elective Courses: 12 Credits

Students can select any set of graduate-level elective courses in architectural engineering, civil engineering, or another science or engineering field with advisor approval, depending on the desired focus area and professional skills.

3.2 Master of Science (MS) Degree in Architectural Engineering

For a regular Master of Science (MS) degree in Architectural Engineering, the student may undertake: "Plan I" with a thesis; "Plan II" with a project. Plan I requires 24 credit hours of course work plus 6 credit hours of MS Thesis work, Plan II requires 27 credit hours of course work plus 3 credit hours of MS Project work. MS students with no background in AREN are required to take both AREN 5001 Building Science and Engineering I and AREN 5002 Building Science and Engineering II. Other courses should be selected after approval from the advisor. The MS Thesis is a formal research document that discusses a research topic with a significant amount of novelty and scientific exploration. Experience has shown that it takes a typical student from 24 to 30 months to complete Plan I. Financial support is generally limited to exceptionally well-qualified students selecting Plan I. Students pursuing Plan II will prepare an MS Report, which tackles a more well-defined research question with more structure and less exploration relative to the MS Thesis option. Experience has shown that it takes a typical student around 24 months to complete Plan II. AREN faculty believes that independent research constitutes a central part of a graduate university degree and a unique opportunity for strengthening engineering skills as well as providing a lasting contribution to the field.



Note that one half of the course work must be taken in the CEAE Department (an exception may be made if the relevant courses were taken as part of an undergraduate degree). 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(s).

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 up to 6 credit hours in total of non-technical coursework for the MS/PhD degree.

Students may transfer from the PMP to MS Plan I or Plan II during the semester that they are enrolled in the thesis or credit hours.

3.3 Doctor of Philosophy (PhD) Degree in Architectural Engineering

For a Doctor of Philosophy degree (PhD) in Architectural Engineering, you need at least 30 credit hours of graduate-level coursework plus a dissertation. For students with a MS degree from another university, up to 21 hours of acceptable graduate courses may be transferred leaving at least 9 credit hours of coursework to be done at the University of Colorado, if approved by their advisor(s). The transfer credits are transferrable at the discretion of the research advisor and students may be asked to take additional courses towards the completion of their degree. Work already applied toward a graduate degree received from CU or another institution cannot be accepted for transfer toward another graduate degree of the same level at CU. All courses accepted for transfer must be graduate-level courses. A course in which a grade of B- or lower was received will not be accepted for transfer. Please consult the CEAE Graduate Advisor for the procedure and most updated rules.

For students already in the MS program in the CEAE department, 30 credit hours of graduate coursework performed at CU is applicable towards the PhD degree upon the approval of their advisors. The PhD also requires that 30 hours of dissertation credit be taken with a **minimum residency** of 2 years. After passing the Comprehensive Exam, PhD candidates are required to maintain continuous registration. Candidates must register for at least 5 hours of dissertation credits each semester.

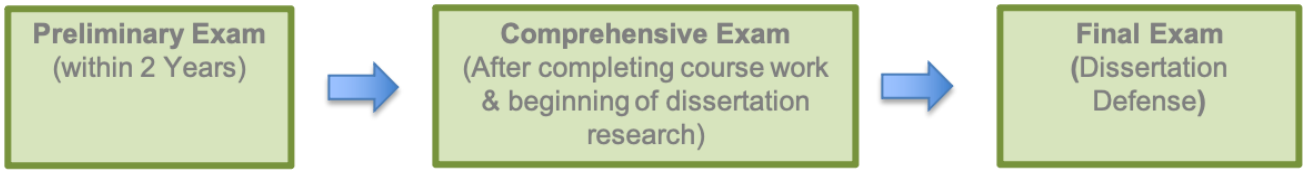
4. SIGNIFICANT MS/PHD MILESTONES

Significant milestones along the pathway toward your MS or PhD degree are:

(1) For a Professional Master Program, you need to complete all the required and elective courses listed in each of the PMP subplans (refer to Section 4.1). The required cumulative GPA for all courses must be at least 3.0 to satisfy the degree requirements. An AREN faculty, typically the member within the Graduate Committee, must review and approve all the completed coursework.

(2) For a Master of Science degree, you will take a **Final Exam** at the end of your studies. If you choose the thesis or report option, your final exam is, in part, an oral defense of your thesis or report.

(3) For a PhD you will have a **Preliminary Exam**, taken in the first two years of your studies. This exam is given to test your background knowledge and diagnose areas for further study. You will also have a **Comprehensive Exam**, taken after coursework is completed and at the beginning of research work on the dissertation. Candidacy requires passing the comprehensive exam. Your **Final Exam** is the defense of your dissertation.



4.1 Master's Degree Final Exam

The MS **Final Exam** is taken after completing all the requirements for Plan I (i.e., thesis option) or Plan II (i.e., report option). The exam is an oral exam with a committee made up of at least three committee members, approved by the Graduate School. It is your responsibility to arrange the schedule for the exam and to complete the Departmental and Graduate School forms associated with it. The first part of the exam is open to the public and starts with a 45-minute presentation of the work undertaken for the report or thesis. The remainder of the first part includes a discussion of this work, including questions from the committee members and the public.

For Plan I, the students are required to submit to all members of their committee at least one week before the final examination date, a thesis formatted according to the University of Colorado Graduate School specifications and a technical paper suitable for publication in a refereed journal.

For Plan II, the students are required to submit to all members of their committee at least one week before the final examination date, a project report and a technical paper suitable for publication in peer-reviewed conference proceedings.

The meeting is then closed to the public. The committee examines the candidate on any appropriate engineering topic. This examination will be based on, but not limited to, graduate coursework and the research quality and quantity.

The thesis or report is prepared in consultation with the student's research advisor(s). The candidate is expected to supply to the committee members, at least one week before the exam, a complete copy of the final draft of the report or thesis and a draft of a technical paper suitable for publication in a peer-reviewed conference proceedings for the report option or a peer-reviewed journal for the MS thesis option. Incomplete or late drafts will result in cancellation of the exam.

4.2 PhD Preliminary Exam

The PhD Preliminary Exam should be scheduled in the first two years following admission to the PhD program. The exam is designed to test the candidate's general background knowledge. It is also partly a diagnostic exam to identify areas of weakness. The exam will usually be given during the first weekend of the Fall semester. Students must register for the exam with the AREN Graduate Officer before taking the exam. Students must select the AREN-related topics during the registration. An example of the preliminary exam as well as syllabi of courses that cover various topics of the exam are available to the students upon request.

The exam will be a day-long written exam in which the candidate may be questioned on the following engineering topic. **Students must receive an overall score of 75% to pass the exam**. A student who fails the Preliminary Exam is suspended from the program and will be eligible for *one* make-up exam on the topics with scores less than 75% in the first exam. The cumulative score of these topics combined with the initial topics (not retaken) must be 75% or higher for the student to pass the make-up exam.

Fundamental Topics (60%):

Required (20%)

- Mathematics (20%): within the scope of *APPM 2360 Introduction to Linear Algebra and Differential Equations*

Selective (40%): Select 2 topics from the list of topics

- Thermodynamics (20%): within the scope of AREN 2110 Thermodynamics
- Heat Transfer (20%): within the scope of *AREN 2120 Fluid Mechanics and Heat Transfer*
- Fluid Mechanics (20%): within the scope of *AREN 2120 Fluid Mechanics and Heat Transfer*
- Statics (20%): within the scope of *CVEN 2121 Analytical Mechanics*

AREN-related Topics (40%):

Select only 2 topics from the list of topics:

- HVAC Fundamentals (20%): within the scope of *AREN 5002 Building Science and Engineering II.*
- Electrical Fundamentals for Buildings (20%): within the scope of *AREN 5001 Building Science and Engineering I.*
- Illumination Fundamentals (20%): within the scope of *AREN 5001 Building Science and Engineering I.*
- Materials and Structures (20%): within the scope of *AREN 5001 Building Science and Engineering II.*

Sample problems for the prelim PhD exam can be made available to the students upon request.

4.3 PhD Comprehensive Exam

The **Comprehensive Exam** is an oral exam taken by a PhD candidate after coursework is completed and at the beginning of substantial dissertation work. The oral exam usually lasts approximately two hours, covering both a presentation and discussion of your research plan as well as an examination of the underlying engineering foundations. It is your responsibility to arrange the schedule for the exam and to complete the Departmental and Graduate School forms associated with it. The exam committee needs to include at least five members approved by the Graduate School. One of the five members of the ema committee needs to be external to the CEAE department. During the oral exam, the candidate is expected to present a proposal to the PhD dissertation committee and answer specific questions about fundamental analysis methods and the proposed evaluation approach. A written proposal should be provided to each committee member at least one week prior to the oral exam. The proposal typically includes a statement of the problem and research objectives, a review of the literature, a description of preliminary work and results, and a planned research agenda. The proposal will need to be reviewed and finalized by the advisor. The committee may approve the proposal at the time of the presentation or ask that the proposal be developed more fully.

4.4 PhD Final Exam

Like the MS degree, the PhD **Final Exam** is taken after the dissertation has been completed. The exam is an oral exam of at least two hours in duration. It is your responsibility to arrange the schedule for the

exam and to complete the Departmental and Graduate School forms associated with it. The first part of the exam is open to the public and starts with a 45-minute presentation of the work undertaken for the dissertation. The remainder of the first part is taken up with discussion of this work including questions from the committee and the public. The meeting is then closed to the public. The committee examines the candidate on any appropriate engineering topic. This examination will be mostly based on the quality and quantity of the research work.

PhD students are required to submit to all members of their committee at least two weeks before the final examination date, a dissertation report formatted according to the University of Colorado Graduate School specifications. They are also required to have at least one technical paper be submitted and accepted for publication in a refereed journal.

4.5 Fundamental Expectations of AREN Graduates

Upon graduation, you will hold an advanced degree in architectural engineering, which carries with it fundamental expectations about your assimilated knowledge. During the MS Degree Final Examination or the PhD Comprehensive Examination, you should be able to correctly answer fundamental questions on the following topics (as they pertain to your particular course of study): Thermodynamics, Heat Transfer, Construction Materials, Structural Engineering, HVAC Systems, Electrical Systems, Illumination Fundamentals, Mathematics (Calculus, Differential Equations, Numerical Methods), Construction Engineering, and Project Management.