

# ARCHITECTURAL ENGINEERING, BACHELOR OF SCIENCE

The architectural engineering (BSAE) undergraduate program is a four-year program requiring 128 credit hours. A one-year master of architectural engineering (MAE) program of 30 credits is also offered. The MAE degree is accredited by ABET, and almost all of our BSAE graduates continue to complete the MAE degree.

## Educational Objectives

The following are the BSAE/MAE program educational objectives (PEOs):

1. **Professional Accomplishment:** The AE program will prepare graduates to become licensed professional engineers a few years after graduation.
2. **Career Accomplishment:** The AE program will prepare graduates to contribute to society by working in an occupation related to the built environment a few years after graduation.

Architectural engineering (AE) is the engineering design of buildings. Students have the option to specialize in the design of one of the following:

1. Building structural systems
2. Building mechanical systems and acoustics
3. Building lighting and electrical systems

The first three years are common to all three fields of specialization and include the math and science courses common to all engineering programs. Students take an introductory course in AE in their first semester where they learn about the materials and systems that comprise a building, visit a construction site, and interact with their industry mentors. It provides a preview of the work they can expect to perform after graduation. This introductory course helps students decide if AE is the career path they wish to pursue.

In the second semester, the AE student begins the first of a four-course sequence of courses in AE Design and Simulation Studio. These courses familiarize the engineering student with building information technology (BIM), building systems, and how they support the design process of architects. The AE degree is keenly focused on integrating engineering concepts with architectural features to deliver aesthetic and high performing buildings. Exposure to construction is an important part of the AE student's education. It develops creativity and constructability where AE graduates enjoy a special ability to work effectively with all professionals on the design and construction team.

The AE program develops breadth and depth by requiring a good understanding of all the systems that comprise a building while also providing specialized education in one of the areas listed above. Breadth is provided in the fifth and sixth semesters, where all students take courses in each of the three areas of specialization. Depth is provided in the seventh and eighth semesters where courses are taken primarily in one of the three specialization tracks.

A one-year master of architectural engineering (MAE) degree follows the four-year undergraduate program. This fifth year continues the specialized education in each of the three option areas and provides the professional practice topics that architectural engineers need later in their careers.

The MAE year features a major interdisciplinary design project. The project requires students to practice the design skills and understanding of building systems previously developed. Student teams complete a significant building design in a manner that closely simulates professional practice. Industry and faculty members serve as consultants to the students. Typically, students enter this design into the national Architectural

Engineering Institute competition. Traditionally, our students do very well at this competition. Additionally, students complete an individual mastery project in a topic of their choice.

## Career Opportunities

Architectural engineering graduates normally enter the building design industry and become registered professional engineers. There are only about 20 accredited architectural engineering programs in the country, so there is a large unfulfilled demand for engineers educated in building design. In Nebraska, the home of several large architectural and engineering design firms, this is especially true.

Architectural engineering is accredited by the EAC-ABET, Inc. The accreditation is attached to the one-year master of architectural engineering degree.

## Major Department Admission

Students must complete at least 43 credit hours in the AE program before applying for professional admission to the degree program in AE. Transfer students must have all transfer hours accepted before applying for professional admission. Professional admission in the BSAE program requires a minimum of 3.0 GPA and allows students to continue to take 300-level AREN courses. The number of admitted students will depend on the availability of space, faculty, and other academic resources. Students are not permitted to register for more than 61 credit hours of courses listed in the AE curriculum until they have been professionally admitted into the degree program.

## Learning Outcomes

Graduates of architectural engineering will develop:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The above student outcomes have been approved by the ABET Engineering Area Delegation for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Architectural Engineering.

## Additional Major Requirements

### AREN 1000 DSAEC Seminar Requirement

Undergraduate Architectural Engineering majors are required to complete this zero-credit-hour course every semester they are in the major.

### Grade Rules

#### C- and D grades

Architectural engineering students must earn a grade of C or better in math, science, computer programming, and engineering courses to obtain credit for that course toward graduation. Additionally, all courses that are

prerequisites for engineering courses must be passed with a grade of C or better.

### Catalog to Use

Because of rapid technical developments, the AE curriculum is continually reviewed and upgraded. Students currently enrolled are expected to modify their programs to take advantage of such revisions. Students who do not maintain continuous progress toward the degree through enrollment in applicable coursework will be considered as new students upon re-entering the program and will be subject to the requirements of the undergraduate catalog current at the time of their re-entry.

### ACE Requirements

The AE program follows the University of Nebraska–Lincoln Achievement Centered Education (ACE) requirements. Because of the specific needs of the program, most of these courses are specified in the curriculum.

Please contact DurhamSchool@unl.edu (durhamschool@unl.edu), if you are interested in more information about this program.

### Requirements

Course	Title	Credits
<b>First Semester</b>		
AREN 1010	INTRODUCTION TO ARCHITECTURAL ENGINEERING	1
CMST 1110	PUBLIC SPEAKING FUNDS	3
MATH 1950	CALCULUS I	5
CHEM 1180	GENERAL CHEMISTRY I	3
CHEM 1184	GENERAL CHEMISTRY I LABORATORY	1
ACE ELECTIVE (SLO 9)		3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
ENGR 10	FRESHMAN ENGINEERING SEMINAR	0
<b>Credits</b>		<b>16</b>
<b>Second Semester</b>		
MATH 1960	CALCULUS II	4
PHYS 2110	GENERAL PHYSICS I - CALCULUS LEVEL	4
PHYS 1154	GENERAL PHYSICS LABORATORY I	1
AREN 1030	DESIGN AND SIMULATION STUDIO I	3
CIST 1600	INTRODUCTION TO PROGRAMMING USING PRACTICAL SCRIPTING	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
<b>Credits</b>		<b>15</b>
<b>Third Semester</b>		
ECEN 211	ELEMENTS OF ELECTRICAL ENGINEERING	3
MATH 1970	CALCULUS III	4
PHYS 2120	GENERAL PHYSICS-CALCULUS LEVEL	4
PHYS 1164	GENERAL PHYSICS LABORATORY II	1
MECH 223	ENGINEERING STATICS	3
AREN 2030	DESIGN AND SIMULATION STUDIO II	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
<b>Credits</b>		<b>18</b>
<b>Fourth Semester</b>		
MECH 200	ENGINEERING THERMODYNAMICS	3
MATH 2350	DIFFERENTIAL EQUATIONS	3

MECH 325	MECHANICS OF ELASTIC BODIES	3
MECH 373	ENGINEERING DYNAMICS	3
AREN 3070	MECHANICS OF MATERIALS LAB	1
CONE 211	CONSTRUCTION BUSINESS METHODS	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
<b>Credits</b>		<b>16</b>
<b>Fifth Semester</b>		
AREN 3200	LIGHTING I: FUND FOR DESIGN	3
AREN 3300	BUILDING ACOUSTICS FUNDAMENTALS	3
ACE ELECTIVE (SLO 5 or 7)	ONE OF ACE 5 OR 7 MUST INCLUDE ART 3770 (7 ONLY) OR ART 3780 (5 ONLY)	3
CIVE 310	FLUID MECHANICS	3
CIVE 319		1
CIVE 341	STRUCTURAL ANALYSIS FUNDAMENTALS	3
CIVE 342	STRUCTURAL DESIGN FUNDAMENTALS	1
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
<b>Credits</b>		<b>17</b>
<b>Sixth Semester</b>		
AREN 3220	ELECTRICAL SYSTEMS FOR BUILDINGS I	3
AREN 3100	HVAC FUNDAMENTALS	3
CIVE 441	STEEL DESIGN I	3
AREN 4040	BUILDING ENVELOPES	3
STAT 3800	APPLIED ENGINEERING PROBABILITY AND STATISTICS	3
AREN 3030	AE DESIGN AND SIMULATION STUDIO III (Note: Listed as AREN 4940 for Registration)	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
<b>Credits</b>		<b>18</b>
<b>Seventh Semester</b>		
All options:		
AREN 4030	AE DESIGN AND SIMULATION STUDIO IV (Note: Listed as AREN 4940 for Registration)	3
CONE 206	ENGINEERING ECONOMICS	3
ENGL 3980	TECHNICAL WRITING ACROSS THE DISCIPLINES	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
Select one of the following three options		9
<b>Lighting and Electrical Option</b>		
AREN 4200	LIGHTING II: THEORY, DESIGN & APPLICATION	
AREN 4120	BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS	
PSYC 1010	INTRODUCTION TO PSYCHOLOGY I (satisfies ACE SLO 6)	
<b>Mechanical and Acoustics Option</b>		
AREN 4120	BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS	
ACE ELECTIVE (SLO 6)		

GENERAL ELECTIVE	ELECTIVE MUST BE APPROVED BY ADVISOR	
<b>Structural Option</b>		
CIVE 440	REINFORCED CONCRETE DESIGN I	
CIVE 443	ADVANCED STRUCTURAL ANALYSIS	
ACE ELECTIVE (SLO 6)		
<b>Credits</b>		<b>18</b>
<b>Eighth Semester</b>		
<b>All options</b>		
ACE ELECTIVE (SLO 5 OR 7)	ONE OF ACE 5 OR 7 MUST INCLUDE ART 3770 (7 ONLY) OR ART 3780 (5 ONLY)	3
AREN 1000	DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR	0
Select one of the following three options:		7
<b>Lighting and Electrical Option</b>		
AREN 4250	LIGHTING DESIGN	
PSYC 4210	SENSATION AND PERCEPTION	
<b>Mechanical and Acoustics Option</b>		
AREN 4150	HVAC DESIGN	
AREN 4300	ADVANCED NOISE CONTROL	
<b>Structural Option</b>		
CIVE 334		
CIVE 444	STRUCTURAL DESIGN AND PLANNING	
<b>Credits</b>		<b>10</b>
<b>Total Credits</b>		<b>128</b>

#### **AREN 1000 DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR (0 credits)**

Presentation of professional problems and practices by students, faculty, and professionals associated with careers in the Durham School of Architectural Engineering and Construction

#### **AREN 1010 INTRODUCTION TO ARCHITECTURAL ENGINEERING (1 credit)**

An overview of architectural engineering. Descriptions of structural, lighting and electrical, and mechanical engineered systems in buildings. Design and measurement exercises. Field visits to buildings.

#### **AREN 1030 DESIGN AND SIMULATION STUDIO I (3 credits)**

Focus on virtual modeling in the context of conceptual design. Study of fundamentals of Building Information Modeling (BIM), iterative design processes, early design analysis techniques, and technical problem-solving processes. Development of modeling skills in various software programs including Autodesk Revit, Formit, Dynamo, and Trimble Sketchup.

#### **AREN 2010 ARCHITECTURAL ENGINEERING SEMINAR (1 credit)**

This course will inform students about careers in Architectural Engineering and about non-technical issues of engineering practice. It will include visits to offices and job sites, and talks by practicing professionals. Professional, ethical, social, and environmental issues will be addressed. Students will gain experience in teamwork, and in presentation of information.

**Prerequisite(s):** AREN 1010 or AE 1010; 30 credit hours completed

#### **AREN 2030 DESIGN AND SIMULATION STUDIO II (3 credits)**

Focus on building systems as integral elements in architecture, building and construction assemblies, materials and methods, fabrication, and tectonic exploration using building information modeling (BIM) processes. Exposure to building construction systems, stereotomic and tectonic construction assemblies, and fundamentals of the architectural design process.

**Prerequisite(s):** AREN 1030 or AE 1030 Design and Simulation Studio I

#### **AREN 2110 THERMODYNAMICS FOR ARCHITECTURAL ENGINEERING (3 credits)**

First and Second Laws of Thermodynamics, properties of gases and vapors. Sources of energy and its conversion to work. Applications on Architectural Engineering and Construction.

**Prerequisite(s):** MATH 1960, PHYS 2110. Not open to non-degree graduate students.

#### **AREN 2250 CONSTRUCTION GRAPHICS AND DESIGN PROCESS (3 credits)**

Introduction to typical computer-graphics and calculation applications used in a contemporary architectural engineering design office. Extensive use of CADD and electronic spreadsheet software to solve typical analysis and design problems. Fundamentals of descriptive geometry and two and three-dimensional drawing systems. Use of drawing conventions common to construction design. Basics of personal computer applications. Conceptual review of engineering design and technical problem solving processes.

#### **AREN 2400 BUILDING SYSTEMS (3 credits)**

Building systems as integral elements in architecture; building assemblies and materials; building system relationships; communication of ideas between design professionals, clients, contractors and manufacturers; construction drawings and specifications.

**Prerequisite(s):** AREN 2250 or AE 2250

#### **AREN 3030 AE DESIGN AND SIMULATION STUDIO III (3 credits)**

A comprehensive focus on building design and construction through integrating program, structure, site, and enclosure aligned with architectural engineering. Topics include structure and construction assemblies; envelope performance; and whole building organization and space-making using BIM processes.

**Prerequisite(s):** AREN 2030 or permission of instructor

#### **AREN 3070 MECHANICS OF MATERIALS LAB (1 credit)**

Introduction to the behavior and testing of various building materials. The concepts of axial stress and strain, flexural stress and strain, beam deflections and column buckling.

**Prerequisite(s):** Coreq: MECH 3250.

#### **AREN 3100 HVAC FUNDAMENTALS (3 credits)**

Topics will include an introduction to the types of air conditioning systems; the properties of moist air, psychometric processes in HVAC equipment; indoor air quality; thermal comfort; heat transmission in buildings; solar radiation; and the calculation of building infiltration rates, space heating loads and space cooling loads.

**Prerequisite(s):** MECH 2000 or MENG 2000; corequisite AREN 4040

#### **AREN 3120 MECHANICAL SYSTEMS FOR BUILDINGS (3 credits)**

Fluid flow, pumps, and piping design; space air diffusion; fans, ducts, and building air distribution; refrigeration equipment.

**Prerequisite(s):** AREN 3100 or AE 3100 and CIVE 310 and CIVE 319

#### **AREN 3130 HVAC LAB (1 credit)**

Conduct experiments and prepare written reports involving fluid flow, pumps, fans, ducts, piping; basic heat transfer and thermodynamic principles.

**Prerequisite(s):** AREN 3100 or AE 3100 and CIVE 310 and CIVE 319

#### **AREN 3200 LIGHTING I: FUND FOR DESIGN (3 credits)**

Introduction to illumination engineering for building interiors. Topics include the fundamentals of light and vision, lighting equipment, requirements for building lighting, and basic illuminating engineering design methods.

**Prerequisite(s):** ECEN 2110

#### **AREN 3220 ELECTRICAL SYSTEMS FOR BUILDINGS I (3 credits)**

Study of basic design of building electrical systems including circuit design, power distribution and service equipment, communications systems, and special electrical systems.

**Prerequisite(s):** ECEN 2110

**AREN 3230 LIGHTING AND ELECTRICAL SYSTEMS LAB (1 credit)**

General introduction to lighting and electrical systems in building interiors, through hands-on exercises using a range of currently available lighting and electrical technologies. Topics include: principles of object modeling, lamp and luminaire workshops, field measurements of lighting and electrical systems, motor workshop, power consumption and power factor workshops.  
**Prerequisite(s):** AREN 3200 or AE 3200; coreq AREN 3220

**AREN 3300 BUILDING ACOUSTICS FUNDAMENTALS (3 credits)**

An introduction to the acoustics of buildings. Topics include the fundamentals of sound generation, propagation, and measurement; human hearing; acoustic properties of materials and constructions; basic room acoustics; and noise control.  
**Prerequisite(s):** PHYS 2120

**AREN 3770 GLOBAL EXPERIENCES IN ARCHITECTURAL ENGINEERING (1-3 credits)**

Individual or group educational experience in Architectural Engineering that combine classrooms, lectures, discussions, and/or seminars with field and/or classroom studies in a foreign country. Choice of subject matter and coordination of on- and off-campus activities are at the discretion of the instructor.

**AREN 3920 INDIVIDUAL INSTRUCTION IN ARCHITECTURAL ENGINEERING III (1-3 credits)**

Individual instruction in Architectural Engineering at the junior level in a selected area, under the supervision and guidance of an Architectural Engineering faculty member.

**AREN 3940 SPECIAL TOPICS IN ARCHITECTURAL ENGINEERING III (3 credits)**

Special topics in Architectural Engineering at the junior level that are not yet covered in other courses in the Architectural Engineering curriculum.  
**Prerequisite(s):** Permission of instructor.

**AREN 4020 ARCHITECTURAL ENGINEERING SENIOR DESIGN PROJECT IN LIGHTING (4 credits)**

Senior design project that integrates lighting design and illuminating engineering through a semester long design problem. A self-directed execution of the lighting design process culminating with a professional design solution.

**Prerequisite(s):** AREN 3220 or AE 3220; AREN 4200 or AE 4200

**AREN 4030 AE DESIGN AND SIMULATION STUDIO IV (3 credits)**

Advanced topics in Building Information Modeling (BIM) are presented including modeling tools and processes for building engineers, designers, contractors, and operators. BIM management throughout the building lifecycle, technical engineering use cases, and specific topics in virtual reality, simulation, augmented reality, and graphical programming environments are covered. Advanced topics relevant to all AE fields include collaborative design and interoperability.

**Prerequisite(s):** AREN 3030

**AREN 4040 BUILDING ENVELOPES (3 credits)**

Design and analysis of building envelopes is an important and interdisciplinary topic within the Architectural Engineering field that relates to all AE subdisciplines (lighting, electrical systems, structures, mechanical systems, and acoustics). This introductory Building Envelopes course is created to supplement the sub-discipline specific introductory courses as well as combine some of these topics under the umbrella of building envelopes. It aims to fill an important gap in the BSAE curriculum and cover a comprehensive introduction to the processes of Building Energy Modeling.  
**Prerequisite(s):** MECH 2000 or MENG 2000; junior standing; corequisite: AREN 3100

**AREN 4120 BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS (3 credits)**

Analysis and design of building air distribution systems, fans, pumps, piping, space air diffusion and heat exchangers.  
**Prerequisite(s):** AREN 3100 or AE 3100; CIVE 310

**AREN 4150 HVAC DESIGN (4 credits)**

Develop and design the mechanical system for an actual building, from the programming phase to the final construction documents.  
**Prerequisite(s):** AREN 4120 or AE 4120. Not open to non-degree graduate students.

**AREN 4200 LIGHTING II: THEORY, DESIGN & APPLICATION (3 credits)**

Design and analysis of lighting systems; the emphasis is on the integration between the lighting design process and the technical foundations for building lighting; topics include design criteria; lighting design procedures, lighting modes and subjective effects; calculation tools. Lab sessions include photometric measurements and computer applications. (Cross-listed with AREN 8206).

**Prerequisite(s):** AREN 3200 or AE 3200

**AREN 4250 LIGHTING DESIGN (4 credits)**

Advanced design and analysis of lighting systems. Application of the lighting design process for advanced interior applications such as multimedia facilities, and outdoor applications such as sports lighting. (Requires the initiation of the design process, proceeding in a self-directed manner through intermediate steps, and producing professional lighting design solutions.)

**Prerequisite(s):** AREN 4200 or AE 4200. Not open to non-degree graduate students.

**AREN 4300 ADVANCED NOISE CONTROL (3 credits)**

Characterization of acoustic sources; use and measurement of sound power and intensity; sound-structure interaction; acoustic enclosures and barriers; muffling devices; vibration control; and active noise control. (Cross-listed with AREN 8306).

**Prerequisite(s):** AREN 3300 or AE 3300

**AREN 4420 HEALTHCARE DESIGN AND CONSTRUCTION (3 credits)**

Introduction to the design and construction of healthcare facilities. Healthcare regulations and standards, infection control, interim life safety measures, code requirements, medical equipment selection and coordination, healthcare design and construction techniques, and best practices will be addressed. Provides guidance in preparation for the Certified Healthcare Constructor credential offered by the American Healthcare Association. (Cross-listed with AREN 8426, CNST 842, CNST 442).

**Prerequisite(s):** Senior or graduate standing

**AREN 4600 SMART BUILDING SENSORS AND PROGRAMMING (3 credits)**

Principles of modeling, interfacing, and signal conditioning of sample building sensors, and acquisition and analysis of data utilizing engineering programming language such as LabVIEW. Overview of current sensing technology and control in buildings.

**Prerequisite(s):** CIST 1400

**AREN 4620 MEMS SENSORS DYNAMICS (3 credits)**

Study of the dynamics of Microelectromechanical system (MEMS) beam-structures. Modeling principles and data analysis from different types of MEMS will be explained along with deep theoretical and experimental investigation of nonlinear MEMS dynamics. Learn to conduct experiments using state-of-the-art MEMS characterization tools. (Cross-listed with AREN 8626).

**Prerequisite(s):** Instructor Permission

**AREN 4920 INDIVIDUAL INSTRUCTION IN ARCHITECTURAL ENGINEERING IV (1-3 credits)**

Individual instruction in Architectural Engineering at the senior level in a selected area, under the supervision and guidance of an Architectural Engineering faculty member.

**Prerequisite(s):** Instructor Permission

**AREN 4940 SPECIAL TOPICS IN ARCHITECTURAL ENGINEERING IV  
(3 credits)**

Special topics in Architectural Engineering at the senior level that are not yet covered in other courses in the Architectural Engineering curriculum.

**Prerequisite(s):** Permission of instructor.