ARCHITECTURAL ENGINEERING,
BACHELOR OF SCIENCE

The architectural engineering (BSAE) undergraduate program is a four-year program requiring 129 credit hours. A one-year Master of Architectural Engineering (MAE) program of 36 credits is also offered. The MAE degree is accredited by the Engineering Accreditation Commission (EAC) of 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 either the design of:

1. building structural systems;
2. building mechanical systems and acoustics; or
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 the students 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 a 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 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 the student 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.

Career Opportunities
Architectural engineering graduates normally enter the building design industry and become registered professional engineers. There are 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. The students must have a minimum of 3.0 GPA over a pre-determined set of 43 credit hour freshman and sophomore level courses to be professionally admitted to the AE program and continue to take 300-level AREN courses. A spreadsheet for calculation of AE professional admittance GPA is provided on The Durham School AE website. 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 accepted 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 EAC for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Architectural Engineering.

Program Controls
Because of rapid technical developments, the AE curriculum is continually reviewed and upgraded. Currently enrolled students 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 reentry.
**Grade Rule**

**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.

The AE program follows the UNL ACE general education requirements. Because of the specific needs of the program, most of these courses are specified in the curriculum.

Please contact Melissa Hoffman at melissa.hoffman@unl.edu or 402.554.4482 if you are interested in more information about this program.

**Requirements**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>AREN 1010</td>
<td>INTRODUCTION TO ARCHITECTURAL ENGINEERING</td>
<td>1</td>
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<tr>
<td>CMST 1110</td>
<td>PUBLIC SPEAKING FUNDS</td>
<td>3</td>
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<tr>
<td>MATH 1950</td>
<td>CALCULUS I</td>
<td>5</td>
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<tr>
<td>CHEM 1180</td>
<td>GENERAL CHEMISTRY I</td>
<td>3</td>
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<tr>
<td>CHEM 1184</td>
<td>GENERAL CHEMISTRY I LABORATORY</td>
<td>1</td>
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<tr>
<td>ACE ELECTIVE (SLO 9)</td>
<td></td>
<td>3</td>
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<tr>
<td>AREN 1000</td>
<td>DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR</td>
<td>0</td>
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<tr>
<td><strong>Credits</strong></td>
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<td><strong>16</strong></td>
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**Second Semester**

| MATH 1960  | CALCULUS II                                               | 5       |
| PHYS 2110  | GENERAL PHYSICS I - CALCULUS LEVEL                        | 4       |
| PHYS 1154  | GENERAL PHYSICS LABORATORY I                              | 1       |
| AREN 1030  | AE DESIGN & SIMULATION STUDIO I                           | 3       |
| CIST 1400  | INTRODUCTION TO COMPUTER SCIENCE I                        | 3       |
| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **16**  |

**Third Semester**

| ECEN 2110  | 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 2230  | ENGINEERING STATICS                                       | 3       |
| AREN 2030  | DESIGN AND SIMULATION STUDIO II                           | 3       |
| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **16**  |

**Fourth Semester**

| MECH 2000  | ENGINEERING THERMODYNAMICS                                | 3       |
| MATH 2350  | DIFFERENTIAL EQUATIONS                                    | 3       |
| MECH 3250  | MECHANICS OF ELASTIC BODIES                               | 3       |
| MECH 3730  | ENGINEERING DYNAMICS                                     | 3       |
| AREN 3070  | MECHANICS OF MATERIALS LAB                                | 1       |
| CONE 2110  | CONSTRUCTION BUSINESS METHODS                             | 3       |

| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **16**  |

**Fifth Semester**

| 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/MECH 3100 | FLUID MECHANICS                                           | 3       |
| CIVE 319   | HYDRAULICS LAB                                            | 1       |
| CIVE 341   | INTRODUCTION TO STRUCTURAL ENGINEERING                   | 4       |
| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **17**  |

**Sixth Semester**

| 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 & SIMULATION STUDIO III (NOTE: LISTED AS AREN 4940 FOR REGISTRATION) | 3       |
| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **18**  |

**Seventh Semester**

**All options:**

| AREN 4030  | AE DESIGN & SIMULATION STUDIO IV (NOTE: LISTED AS REEN 4940 FOR REGISTRATION) | 3       |
| CONE 2060  | ENGINEERING ECONOMICS                                    | 3       |
| ENGL 3980  | TECHNICAL WRITING ACROSS THE DISCIPLINES                 | 3       |
| AREN 1000  | DURHAM SCHOOL OF ARCHITECTURAL ENGINEERING AND CONSTRUCTION SEMINAR | 0       |
| **Credits**|                                                            | **18**  |

Select one of the following three options

**Lighting and Electrical Option**

| AREN 4200  | LIGHTING II: THEORY, DESIGN & APPLICATION                | 3       |
| AREN 4120  | BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS        | 3       |
| PSYC 1010  | INTRODUCTION TO PSYCHOLOGY I (satisfies ACE SLO 6)        | 3       |

**Mechanical and Acoustics Option**

| AREN 4120  | BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS        | 3       |
| ACE ELECTIVE (SLO 6) | ELECTIVE MUST BE APPROVED BY ADVISOR               |         |

**Structural Option**

| CIVE 443   | ADVANCED STRUCTURAL ANALYSIS                             |         |
| CIVE 440   | REINFORCED CONCRETE DESIGN I                             |         |
ACE ELECTIVE (SLO 6)  
Credits 18

Eighth Semester
All options:
ACE ELECTIVE (SLO 5 OR 7) ONE OF ACE 5 OR 7 MUST INCLUDE ART 3770 (5 OR 7) 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

Lighting and Electrical Option
AREN 4250 LIGHTING DESIGN 4
PSYC 4210 SENSATION AND PERCEPTION 3

Mechanical and Acoustics Option
AREN 4150 HVAC DESIGN 4
AREN 4300 ADVANCED NOISE CONTROL 3

Structural Option
CIVE 334 INTRODUCTION TO GEOTECHNICAL ENGINEERING 4
CIVE 444 STRUCTURAL DESIGN AND PLANNING 3

Credits 10

Total Credits 129

1 ENGR 3000 is an accepted equivalent for ENGL 3980.
2 ACE Elective: Satisfies ACE SLO 9.
3 ART 3770: Satisfies ACE SLO 5.
4 ART 3770: AREN 3770 is an accepted substitute for ART 3770.
5 ART 3780: Satisfies ACE SLO 7.

Seventh Semester Options

Lighting and Electrical Options
Code Title Credits
AREN 4200 LIGHTING II: THEORY, DESIGN & APPLICATION 3
AREN 4120 BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS 3
PSYC 1010 INTRODUCTION TO PSYCHOLOGY I 1 1

Total Credits 9

1 PSYC 1010 Satisfies ACE SLO 6.

Mechanical and Acoustics Options
Code Title Credits
AREN 4120 BUILDING ENERGY II: PRIMARY AND SECONDARY SYSTEMS 3
ACE Elective 1 3

General Elective 2 3

Total Credits 9

1 ACE electives: Satisfies ACE SLO 6.
2 General elective: Should be approved by your advisor.

Structural Option
Code Title Credits
CIVE 443 ADVANCED STRUCTURAL ANALYSIS 3
ACE Elective 1 3

Total Credits 9

1 ACE electives: Satisfies ACE SLO 6.
2 General elective: Should be approved by your advisor.

Eighth Semester Options

Lighting and Electrical Options
Code Title Credits
AREN 4250 LIGHTING DESIGN 4
PSYC 4210 SENSATION AND PERCEPTION 3

Total Credits 7

Mechanical and Acoustics Options
Code Title Credits
AREN 4150 HVAC DESIGN 4
AREN 4300 ADVANCED NOISE CONTROL 3

Total Credits 7

Structural Option
Code Title Credits
CIVE 334 INTRODUCTION TO GEOTECHNICAL ENGINEERING 4
CIVE 444 STRUCTURAL DESIGN AND PLANNING 3

Total Credits 7

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)

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)/Corequisite(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)/Corequisite(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)/Corequisite(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 CAD 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)/Corequisite(s): AREN 2250 or AE 2250

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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(s): AREN 3220 or AE 3220; AREN 4200 or AE 4200

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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(s): AREN 3300 or AE 3300

AREN 4600 BUILDING SENSORS (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)/Corequisite(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)/Corequisite(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)/Corequisite(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)/Corequisite(s): Permission of instructor.