

# ARCHITECTURAL ENGINEERING (AREN)

## Architectural Engineering Undergraduate Courses

### **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 211

### **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 211

### **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 200 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 and analysis of data from different types of building sensors. Overview of current sensing technology and control in buildings. (Cross-listed with AREN 8600).

**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.