

# ARCHITECTURAL ENGINEERING (AREN)

## AREN 800 MAE Graduate Seminar

**Prerequisites:** Co-requisites: AREN 425 or AREN 415 or CIVE 334

**Description:** Intended specifically for the 1-year UNL Master of Architectural Engineering (MAE) program to prepare for the MAE Graduate Project and the MAE Interdisciplinary Team Design sequences. Focus on further developing competencies within the UNL College of Engineering's Complete Engineer framework including self-management and leadership, teamwork, communication skills, inclusive excellence, professionalism and ethics, and civic responsibility.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 801

## AREN 801 Graduate Individual Mastery Project I

**Prerequisites:** AREN 800

**Notes:** Students are permitted to enroll in this course twice. If a passing grade is not achieved after two attempts, the AE graduate committee will consider termination of the master's program for that student.

**Description:** This is the first of the Graduate Individual Mastery Project two-course sequence, which requires a self-directed project that results in a professionally written report and oral presentation. Successful completion of this sequence will demonstrate a high-level of written and oral communication skills and show individual student mastery of a topic related to architectural engineering.

**Credit Hours:** 2

**Max credits per semester:** 2

**Max credits per degree:** 2

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 802

## AREN 802 Graduate Individual Mastery Project II

**Prerequisites:** AREN 801

**Notes:** Students are permitted to enroll in this course twice. If a passing grade is not achieved after two attempts, the AE graduate committee will consider termination of the master's program for that student.

**Description:** This is the second of the Graduate Individual Mastery Project two-course sequence, which requires a self-directed project that results in a professionally written report and oral presentation. Successful completion of this sequence will demonstrate a high-level of written and oral communication skills and show individual student mastery of a topic related to architectural engineering.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Grading Option:** Grade Pass/No Pass Option

## AREN 803 Interdisciplinary Team Design Project I

**Prerequisites:** (Acoustics/Mechanical option) AREN 415 and AREN 430 or; (Electrical/Lighting option) AREN 425 and AREN 822 or; (Structural option) CIVE 444.

**Notes:** Not open to non-degree graduate students. This course is the 1st semester of the capstone design sequence in architectural engineering.

**Description:** Develop and design the electrical, lighting, mechanical, and structural systems for a building, from programming through design development phase, as an interdisciplinary team effort.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 804

## AREN 804 Interdisciplinary Team Design Project II

**Prerequisites:** AREN 803

**Notes:** This course is intended to be taken the semester following AREN 803. AREN 804 is the 2nd semester of the capstone design sequence in architectural engineering.

**Description:** Develop and design the electrical/lighting, mechanical/acoustical, and structural systems for a building, through the design development phase, as an interdisciplinary team effort.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Grading Option:** Graded

**Offered:** SPRING

## AREN 805 Internship in Architectural Engineering

**Description:** This course requires participation in a full time summer internship associated with an Architectural Engineering related entity.

The course includes weekly assignments and a final presentation designed to create interaction between the AE entity and the intern associated with the business side of the entity. General Topics include Business Plans, Marketing, Finance and Budgets, Contracts, Legal issues and professionalism.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Grading Option:** Grade Pass/No Pass Option

## AREN 806 Professional Practice and Ethics

**Prerequisites:** CONE 2060

**Description:** Investigation of issues related to the integration of building design processes with professional architectural engineering practice. Aspects of building design project finance, budgets, contracts, legal issues, professional licensure and professional responsibility. The perspective of life-cycle costing. Professional ethics will be thoroughly integrated with all course topics.

**Credit Hours:** 2

**Max credits per semester:** 2

**Max credits per degree:** 2

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 807

**AREN 807 Architectural Engineering Professional Practice II**

**Prerequisites:** IMSE 206/(UNO) IMSE 2060; and AREN 806/(UNO) AE 8060

**Notes:** Continuation of investigation of issues related to the integration of building design processes with professional architectural engineering design practice.

**Description:** Building design specifications, estimating, bidding, building construction contract negotiations, building design project management, project team personnel management, project risk, and key regulatory measures.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 808 Applied Experimental Design and Statistical Analysis**

**Prerequisites:** STAT 380/(UNO) 3800

**Description:** Overview of advanced experimental design methods and statistical analysis techniques. Application of these to the planning, execution, analysis, and description of research in architectural engineering.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 809 Sustainable Building Design**

**Prerequisites:** CIVE 341 or ARCH 332; AREN 310 (AE 3100) or AREN 841 or ARCH 333

**Description:** Integrates building design with the principles of minimum resource use, energy conservation and healthy indoor environments.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 810 Solar Energy Systems**

**Prerequisites:** MECH 820 or permission

**Description:** Fundamentals of solar energy system modeling analysis and design. Solar radiation modeling, surface properties of opaque and glazing materials, flat-plate collector design, solar energy storage, solar system thermal calculation, system application and design.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 811 Indoor Air Quality Engineering**

**Prerequisites:** AREN 310.

**Description:** Indoor air quality. Codes, standards, HVAC equipment, commissioning, operation, maintenance, investigation, and remediation.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 818; AREN 918

**AREN 812 Building Control and Automation Systems**

**Prerequisites:** MATH 3350 ; AE 3100, AE 4120, AE 4120

**Description:** Fundamental concepts of building control theory and automation. Building control: state-variable plant and closed-loop system representation, time and frequency response, stability, root-locus methods and design of building control systems. Automation: thermostats, dampers, valves, direct digital control, control of air handling units, terminal units, primary building systems, supervisory control and system optimization, communication systems, BACnet, and DDC system design and implementation.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 913; AREN 915; AREN 916; AREN 917

**AREN 814 Building Energy III: Advanced Building Energy System Modeling**

**Prerequisites:** AREN 310, AREN 412, or instructor permission.

**Description:** Advanced Analysis, Modeling, Diagnostics and Optimization of Building Energy Systems. Be familiar with Engineering Equation Solver (EES) Programming; Be able to build models for Air Handling Unit Systems and Vapor Compression Cycle Equipment; Be able to analyze building operating efficiency and identify faulty operating conditions; Be able to conduct retrofit energy efficiency analysis and feasibility study.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 917

**AREN 815 Building Energy Simulation and Performance Contracting**

**Prerequisites:** AE 3100, AE 4120, AE 4140, and AE 4400 (UNO)

**Description:** Integrated approach to deliver energy improvement retrofit projects that provide economical and ecological benefits. Proficiency in EnergyPlus or DOE-2 and in retrofit cost estimation will be attained and integrated into an engineering economic analysis. Partnering configurations, contracts, financing, and measurement and verification. Concepts applied to a practical class project.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 817 Theory and Application of Thermal Systems Measurement**

**Prerequisites:** STAT 8805 or equivalent

**Description:** Analysis, theory, and methods of instrumentation for thermal system energy consumption measurement and scientific research testing. Emphasis on sensors, transducers, and error analysis.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 818 Indoor Air Quality Design**

**Prerequisites:** AREN 811 or permission

**Description:** Fundamentals of project management within the mechanical and electrical contracting industry. Emphasis on codes, contract documents, productivity, coordination, project control and administration, scheduling, safety, and project closeout, all from a speciality contracting perspective.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 820 Lighting II: Theory, Design and Application**

**Crosslisted with:** AREN 420

**Prerequisites:** (UNO) AE 3200

**Notes:** Lab sessions include photometric measurements and computer applications.

**Description:** Design and analysis of lighting systems; the integration between the lighting design process and the technical foundations for building lighting; design criteria; lighting design procedures lighting modes and subjective effects; and calculation tools.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 425; AREN 823; AREN 825; AREN 920

**AREN 821 Lighting II: Advanced Design Practice**

**Prerequisites:** AREN 820

**Description:** Design and analysis of lighting for outdoor sports, floodlighting and interior applications; economic analysis; modeling algorithms; advanced photometrics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 822 Electrical Systems for Buildings II**

**Prerequisites:** AE 3220

**Description:** Power systems analysis and design, integration of electrical system components into functional, safe and reliable power distribution systems for commercial and industrial facilities. Per unit analysis, fault analysis, power quality, grounding, overcurrent protection coordination and complete power system design.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**Prerequisite for:** AREN 828

**AREN 823 Light Sources**

**Prerequisites:** AREN 820

**Description:** Fundamental science and principles of light generation in modern electric light sources; characteristics that influence applications of light sources.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 824 Lighting Metrics**

**Prerequisites:** AE 3200 or equivalent

**Description:** Critical survey and application of measures developed to characterize the effects of lighting systems on human perception and performance. Contrast, visibility, visual performance (Relative Visual Performance, Visibility Level); visual comfort probability; discomfort glare rating system; and unified glare rating system.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 825 Daylighting**

**Prerequisites:** AREN 420 or AREN 820

**Description:** Use of natural light in building design. Solar position, sky luminance, distribution models, daylighting equipment, calculation methods, and psychological concepts. Extensive use of computer modeling and scale models.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 826 Building Communication Systems**

**Prerequisites:** AREN 322 (AE 3220)

**Description:** Integration of voice, data and video systems into overall building design. Scalability; wireless systems; interference; project management; current industry standards and protocols.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 828 Applied Photovoltaic and Renewable Energy Sources**

**Prerequisites:** AREN 822 or AREN 8220 (UNO)

**Description:** Introduction to integration of renewable energy sources in the electric grid and built environment. Study of various renewable energy sources with a focus on photovoltaic (PV) systems detailing theory of operation, design methodologies, system components, NEC requirements and simulation software for stand-alone, utility-interactive and multi-mode systems.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded

**AREN 830 ADV NOISE CONTROL**

**Crosslisted with:** AREN 430

**Prerequisites:** AE 3300 or equivalent

**Description:** 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.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 833 ADV ARCH ACOUSTICS****Prerequisites:** AE 3300 or equivalent**Description:** Advanced study of the behavior of sound in rooms. Design of acoustical spaces; physical and computational modeling; measurement techniques; and introduction to sound reinforcement in rooms.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Prerequisite for:** AREN 930**AREN 835 ELECTROACOUSTICS****Prerequisites:** AE 3300 or equivalent**Description:** Electrical-mechanical-acoustical circuit analogies; transducers, loudspeakers, microphones, and accelerometers; directivity; calibration techniques; and sound reinforcement systems in rooms.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**AREN 841 BLDG ENERGY&ACOUSTIC****Prerequisites:** Admission to MEng program or permission**Description:** Building energy and acoustical systems: energy systems, including psychometric processes and applications; load calculations; distribution systems; acoustic fundamentals; room acoustics; and noise control.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**AREN 842 Healthcare Design and Construction****Crosslisted with:** AREN 442, CNST 442, CNST 842**Prerequisites:** Senior or graduate standing**Description:** 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.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**AREN 851 Masonry and Timber Design****Prerequisites:** CIVE 440 (Reinforced Concrete Design) or equivalent; CIVE 441 (Steel Design) or equivalent.**Description:** Masonry as a structural material, Unreinforced Masonry Design, Reinforced Masonry Design, State-of-the-art Assessment methods for Existing Masonry Structures, Timber as a structural material, Timber Design.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**AREN 860 Smart Building Sensors and Programming****Crosslisted with:** AREN 460**Prerequisites:** CSCE 155A**Description:** Principles of modeling, interfacing and signal conditioning of sample building sensors, and acquisition of sensor data utilizing an 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.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**AREN 862 Intelligent Sensors****Prerequisites:** Instructor permission**Description:** 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.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded**AREN 880 Graduate Seminar in Architectural Engineering and Construction****Description:** The objectives of this course are to broaden student knowledge on engineering topics, improve presentation and professional skills, as well as learn about professional development resources available on campus. To pass the course, a student must attend a minimum of 15 Durham School Graduate Student Seminars, MAE project presentations, and/or MS/PhD thesis presentations in the College of Engineering. The student must also present one seminar within the Durham School Graduate Student Seminar series, prior to the final oral examination. All MS and PhD graduate students in architectural engineering must enroll within their first 3 semesters of matriculation.**Credit Hours:** 1**Max credits per semester:** 1**Max credits per degree:** 1**Grading Option:** Pass No-Pass**AREN 892 Individual Instruction in Architectural Engineering****Prerequisites:** Permission**Description:** Individual instruction in Architectural Engineering at the graduate level in a selected area, under the supervision and guidance of an Architectural Engineering faculty member.**Credit Hours:** 1-3**Min credits per semester:** 1**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**AREN 894 SPECIAL TOPICS****Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 9**Grading Option:** Grade Pass/No Pass Option

**AREN 899 MASTERS THESIS**

**Prerequisites:** Admission to AREN/AE (UNO) masters degree program and permission of major adviser

**Credit Hours:** 1-10

**Min credits per semester:** 1

**Max credits per semester:** 10

**Max credits per degree:** 99

**Grading Option:** Grade Pass/No Pass Option

**AREN 913 DYNAMIC PROGRAMMING**

**Prerequisites:** AE 3100, AE 4120, AE 4140 ; AREN 812

**Description:** Concepts and implementation of dynamic programming for building optimal and adaptive control. Deterministic shortest-path applications and continuous-time optimal control, inventory control, perfect and imperfect state information, suboptimal and adaptive control, discounted infinite horizon and stochastic shortest-path problems including Q-Learning.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 915 MOD BLDG CONTROL APP**

**Prerequisites:** AE 3100, AE 4120, AE 4140 ; AREN 812

**Description:** Neuro-dynamic programming/reinforcement learning methodology, fuzzy logic methods, and evolutionary/genetic algorithms (GA) to building control problems. Concepts applied to case studies from problem areas.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 916 BLDG ENRGY SYS MDLNG**

**Prerequisites:** AE 420 and AREN 812; or permission

**Description:** Modeling, control, and optimization of the secondary building energy systems: building envelope, room comfort zones, air handling units, cooling and heating water loops.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 917 PRIMARY ENERGY SYS**

**Prerequisites:** AREN 812, AREN 814 or permission

**Description:** Modeling, control, and optimization of the primary building energy systems: central distribution systems, chiller systems, boiler systems, central cooling plants, central heating plants, and thermal storage systems.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 918 FLUID DYNAMC MODELNG**

**Prerequisites:** AREN 811, MECH 810, or permission

**Description:** Application of computational fluid dynamics software to modeling of indoor environments. Turbulence modeling, boundary conditions, natural and forced convection flows, species transport, and fire modeling.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 920 COLOR THEORY**

**Prerequisites:** AREN 820

**Description:** Theories of color vision; theoretical and mathematical basis for chromaticity, color temperature, color rendering metrics, color matching functions, and color spaces; spectral weighing functions; and measurement of color.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 921 RSH: ILLUMINATN THRY**

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 922 BEHVR SCI LIGHT RSH**

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 923 PSYCH OF LIGHTING**

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 930 TOPC: ARCH ACOUSTICS**

**Prerequisites:** AREN 833

**Description:** Current topics in architectural acoustics. Objective versus subjective measures in performance spaces, electronic enhancement of rooms, advanced computational modeling techniques, and auralization.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Grade Pass/No Pass Option

**AREN 997 RSH OTHER THAN THESI**

**Prerequisites:** Permission

**Description:** Supervised non-thesis research and independent study.

**Credit Hours:** 1-6

**Min credits per semester:** 1

**Max credits per semester:** 6

**Max credits per degree:** 36

**Grading Option:** Grade Pass/No Pass Option

**AREN 998 SPECIAL TOPICS**

**Prerequisites:** Permission

**Description:** Advanced topics in architectural engineering.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 1

**Grading Option:** Grade Pass/No Pass Option

**AREN 999 DOCTORAL DISSERTATN**

**Prerequisites:** Admission to doctoral degree program and permission of supervisory committee chair

**Credit Hours:** 1-24

**Min credits per semester:** 1

**Max credits per semester:** 24

**Max credits per degree:** 99

**Grading Option:** Grade Pass/No Pass Option