ARCHITECTURAL ENGINEERING (AREN)

AREN 8000 ARCHITECTURAL ENGINEERING GRADUATE SEMINAR (1 credit)
Literature Review, reading and evaluation of technical publications concerned with theory and/or experimental data in various areas of Architectural Engineering, attendance at Architectural Engineering Graduate Project and Team Design presentations, preparation of the Master of Architectural Engineering graduate project proposal, assignments related to improving written and oral communication skills.

AREN 8010 GRADUATE DESIGN PROJECT I (3 credits)
Requires a professionally written report and oral presentation that demonstrates both mastery of the subject and a high level of writing and oral communication skills. Perform a detailed investigation in the option area of the master of architectural engineering degree. Students are permitted to enroll in this course twice. Those who fail to earn a passing grade after enrolling in this course a second time will be referred to the AE Graduate Committee, and may result in termination of their program of graduate studies.
Prerequisite(s)/Corequisite(s): AREN 8000 or AE 8000; AREN 1010, AE 4010, AREN 4020, AE 4020 or CIVE 314; permission. Not open to non-degree graduate students.

AREN 8020 GRADUATE DESIGN PROJECT II (1 credit)
Second of two-course capstone design project for the MAE degree. Requires a professionally written report and oral presentation that demonstrates both mastery of the subject and a high level of writing and oral communication skills.
Prerequisite(s)/Corequisite(s): AREN 8010 or AE 8010; permission. Not open to non-degree graduate students.

AREN 8030 INTERDISCIPLINARY TEAM DESIGN PROJECT I (5 credits)
This course is the first semester of the capstone design sequence in architectural engineering. Develop and design the electrical, lighting, mechanical, and structural systems for a building, from programming through design development phase, as an interdisciplinary team effort.
Prerequisite(s)/Corequisite(s): AREN 8010 or AE 8010. (Acoustics/Mechanical option:) AREN 4150 or AE 4150, AREN 4300 or AE 4300; (Electrical/Lighting option:) AREN 4250 or AE 4250, AREN 8220 or AE 8220; (Structural option:) CIVE 444. Not open to non-degree graduate students.

AREN 8040 INTERDISCIPLINARY TEAM DESIGN 2 (3 credits)
Is the second semester of the capstone design sequence in architectural engineering. Develop and design the electrical, lighting, mechanical, and structural systems for a building, from the design development phase through construction documents, as an interdisciplinary team effort. This course is intended to be taken the semester following AREN 8030/ARE 8030.
Prerequisite(s)/Corequisite(s): AREN 8030 or AE 8030. Not open to non-degree graduate students.

AREN 8050 INTERNSHIP IN ARCHITECTURAL ENGINEERING (3 credits)
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, Contacts, Legal issues and professionalism.
Prerequisite(s)/Corequisite(s): Not open to non-degree graduate students.

AREN 8060 ARCHITECTURAL ENGINEERING PROFESSIONAL PRACTICE I (3 credits)
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.
Prerequisite(s)/Corequisite(s): ISMG 2060 or CONE 2060.

AREN 8070 ARCHITECTURAL ENGINEERING PROFESSIONAL PRACTICE II (3 credits)
Continuation of investigation of issues related to the integration of building design processes with professional architectural engineering design practice. Building design specifications, estimating, bidding, building construction contract negotiations, building design project management, project team personnel management, project risk, and key regulatory measures.
Prerequisite(s)/Corequisite(s): ISMG 2060; AREN 8060 or AE 8060

AREN 8080 APPLIED EXPERIMENTAL DESIGN AND STATISTICAL ANALYSIS (3 credits)
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.
Prerequisite(s)/Corequisite(s): STAT 3800

AREN 8090 SUSTAINABLE BUILDING DESIGN (3 credits)
Integrates building design with the principles of minimum resource use, energy conservation, and healthy indoor environments.
Prerequisite(s)/Corequisite(s): AREN 3100 or AE 3100, AREN 8110, AE 8410. Not open to non-degree graduate students.

AREN 8110 INDOOR AIR QUALITY ENGINEERING (3 credits)
Indoor air quality, codes, standards, HVAC equipment, commissioning, operation, maintenance, investigation, and remediation.
Prerequisite(s)/Corequisite(s): AREN 3100 or AE 3100

AREN 8120 BUILDING CONTROL AND AUTOMATION SYSTEMS (3 credits)
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.

AREN 8140 BUILDING ENERGY III: ADVANCED BUILDING ENERGY SYSTEM MODELING (3 credits)
Advanced Analysis, Modeling, Dynamics 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.
Prerequisite(s)/Corequisite(s): AREN 4120 or AE 4120; or instructor permission.

AREN 8150 BUILDING ENERGY SIMULATION AND PERFORMANCE CONTRACTING (3 credits)
Integrated approach to deliver energy improvement retrofit projects that provide economical and ecological benefits. Proficiency in EnergyPlus and 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.
AREN 8170  THEORY AND APPLICATION OF THERMAL SYSTEMS MEASUREMENT (3 credits)
Analysis, theory, and methods of instrumentation for thermal system energy consumption measurement and scientific research testing. Emphasis placed on sensors, transducers, and error analysis.
Prerequisite(s)/Corequisite(s): STAT 8805 or equivalent.
AREN 8180  INDOOR AIR QUALITY DESIGN (3 credits)
Engineering approach to indoor air quality design. Topics include modeling and calculation methods to predict and design for acceptable indoor air quality.
Prerequisite(s)/Corequisite(s): (AREN 3120 or AE 3120) and (AREN 4110, AE 4110, AREN 8110 or AE 8110)
AREN 8206  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 4200).
Prerequisite(s)/Corequisite(s): AREN 3200 or AE 3200
AREN 8210  LIGHTING III: ADVANCED DESIGN PRACTICE (3 credits)
Design and analysis of lighting for outdoor sports, floodlighting and interior applications; economic analysis; modeling algorithms; advanced photometrics.
Prerequisite(s)/Corequisite(s): AREN 8206 or AE 8206.
AREN 8220  ELECTRICAL SYSTEMS FOR BUILDINGS II (3 credits)
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, Complete power system design.
Prerequisite(s)/Corequisite(s): AREN 3220 or AE 3220
AREN 8230  LIGHT SOURCES (3 credits)
Fundamental science and principles of light generation in modern electric light sources; characteristics that influence applications of light sources.
Prerequisite(s)/Corequisite(s): AREN 8206 or AE 8206.
AREN 8240  LIGHTING METRICS (3 credits)
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.
Prerequisite(s)/Corequisite(s): AREN 4200, AE 4200, AREN 8206 or AE 8206
AREN 8260  BUILDING COMMUNICATION SYSTEMS (3 credits)
Integration of voice, data and video systems into overall building design. Topics include: scalability, wireless systems; interference; project management; current industry standards and protocols.
Prerequisite(s)/Corequisite(s): AREN 3220 or AE 3220. Not open to non-degree graduate students.
AREN 8306  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 4300).
Prerequisite(s)/Corequisite(s): AREN 3300 or AE 3300
AREN 8330  ADVANCED ARCHITECTURAL ACOUSTICS (3 credits)
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.
Prerequisite(s)/Corequisite(s): AREN 3300 or AE 3300
AREN 8350  ELECTROACOUSTICS (3 credits)
Electrical-mechanical-acoustical circuit analogies; transducers, loudspeakers, microphones, and accelerometers; directivity; calibration techniques; and sound reinforcement systems in rooms.
AREN 8510  MASONRY AND TIMBER DESIGN (3 credits)
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.
Prerequisite(s)/Corequisite(s): CIVE 440 and CIVE 441 or equivalents
AREN 9160 BUILDING ENERGY SYSTEMS MODELING, CONTROL, AND OPTIMIZATION (3 credits)
Modeling, control and optimization of the secondary building energy systems; building envelope, room comfort zones, air handling units, cooling and heating water loops.
Prerequisite(s)/Corequisite(s): AREN 4100, AE 4100, AREN 8120 or AE 8120

AREN 9180 COMPUTATIONAL FLUID DYNAMICS MODELING OF INDOOR ENVIRONMENTS (3 credits)
Application of computational fluid dynamics software to modeling of indoor environments. Topics include turbulence modeling, boundary conditions, natural and forced convection flows, species transport, and fire modeling.
Prerequisite(s)/Corequisite(s): AREN 4110, AE 4110, AREN 8116 or AE 8116

AREN 9200 COLOR THEORY (3 credits)
Theories of color vision; theoretical and mathematical basis for chromaticity, color temperature, color rendering metrics, color matching functions, and color spaces; spectral weighting functions; measurement of color.
Prerequisite(s)/Corequisite(s): AREN 4200, AE 4200, AREN 8206 or AE 8206

AREN 9210 CURRENT RESEARCH IN ILLUMINATING ENGINEERING (3 credits)
Examination of the most current research in illuminating engineering. Study of experimental methodologies and research practices. Analysis of technical papers from current lighting journals.
Prerequisite(s)/Corequisite(s): Graduate standing and permission of instructor.

AREN 9220 BEHAVIORAL SCIENCES FOR LIGHTING RESEARCH (3 credits)
Overview of experimental design methods and statistical analysis techniques, specifically as these are applied to the planning, execution, analysis and description of lighting experiments.

AREN 9300 CURRENT TOPICS IN ARCHITECTURAL ACOUSTICS (3 credits)
A review of current topics in architectural acoustics. Subjects may include objective versus subjective measures in performance spaces, electronic enhancement of rooms, advanced computational modeling techniques, and auralization.
Prerequisite(s)/Corequisite(s): AREN 8330 or AE 8330

AREN 9970 RESEARCH OTHER THAN THESIS (1-6 credits)
Supervised non-thesis research and independent study.

AREN 9980 SPECIAL TOPICS (1-3 credits)
Advanced topics in architectural engineering not covered in other 9000 level courses.

AREN 9990 DOCTORAL DISSERTATION (1-24 credits)
(1-24 credits, max 55)
Prerequisite(s)/Corequisite(s): Admission to doctoral degree program and permission of supervisory committee chair