**ARCHITECTURAL ENGINEERING (AE)**

**AE 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.

**AE 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): AE 8000, and AE 4010 or AE 4020 or CIVE 314, and permission. Not open to non-degree graduate students.

**AE 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): AE 8010 and permission. Not open to non-degree graduate students.

**AE 8030** INTERDISCIPLINARY TEAM DESIGN PROJECT I (4 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): (Acoustics/Mechanical option) AE 4150 and AE 4300 or; (Electrical/Lighting option) AE 4250 and AE 8220 or; (Structural option) CIVE 444. Not open to non-degree graduate students.

**AE 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 AE 8030.

Prerequisite(s)/Corequisite(s): AE 8030. Not open to non-degree graduate students.

**AE 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.

**AE 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.

**AE 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): ISMG2060 and AE 8060

**AE 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): STAT3800

**AE 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): CIVE341 and (AE 3100 or AE 8410). Not open to non-degree graduate students.

**AE 8110** INDOOR AIR QUALITY ENGINEERING (3 credits)
Indoor air quality, codes, standards, HVAC equipment, commissioning, operation, maintenance, investigation, and remediation.

Prerequisite(s)/Corequisite(s): AE 3100

**AE 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.

**AE 8140** SPECIAL TOPICS IN ARCHITECTURAL ENGINEERING - BUILDING ENERGY III (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): MENG 3000, MENG 4200, AE 3100, AE 4120, or permission.

**AE 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 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.
AE 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.

AE 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): AE 3120 and (AE 4110 or AE 8116)

AE 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 AE 4200)
Prerequisite(s)/Corequisite(s): AE 3200

AE 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): AE 8206.

AE 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): AE 3220

AE 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): AE 8206.

AE 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): AE 8206.

AE 8250 DAYLIGHTING (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): AE 3220. Not open to non-degree graduate students.

AE 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 AE 4300)
Prerequisite(s)/Corequisite(s): AE 3300

AE 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): AE 3300

AE 8350 ELECTROACOUSTICS (3 credits)
Electrical-mechanical-acoustical circuit analogies; transducers, loudspeakers, microphones, and accelerometers; directivity; calibration techniques; and sound reinforcement systems in rooms.

AE 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): AE 4400 and AE 441 or equivalents

AE 8800 GRADUATE SEMINAR IN ARCHITECTURAL ENGINEERING AND CONSTRUCTION (1 credit)
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.
Prerequisite(s)/Corequisite(s): Not open to non-degree graduate students.

AE 8920 INDIVIDUAL INSTRUCTION IN ARCHITECTURAL ENGINEERING (1-3 credits)
Individual instruction in Architectural Engineering at the graduate level in a selected area, under the supervision and guidance of an Architectural Engineering faculty member.

AE 8940 SPECIAL TOPICS IN ARCHITECTURAL ENGINEERING (3 credits)
Special topics in Architectural Engineering at the graduate level that are not yet covered in other courses in the Architectural Engineering curriculum.
Prerequisite(s)/Corequisite(s): Permission.

AE 8950 INDIVIDUAL INSTRUCTION IN ARCHITECTURAL ENGINEERING (1-3 credits)
Individual instruction in Architectural Engineering at the graduate level in a selected area, under the supervision and guidance of an Architectural Engineering faculty member.

AE 8990 MASTER'S THESIS (1-10 credits)
Masters Thesis.
Prerequisite(s)/Corequisite(s): Admission to Architectural Engineering masters degree program and permission of major advisor. Not open to nondegree students.

AE 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): AE 4100 or AE 8120

AE 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): AE 4110 or AE 8116

AE 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): AE 4200 or AE 8206

AE 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.
AE 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.

AE 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): AE 8330

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

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

AE 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