

Architectural Engineering (AREN)

COURSES

AREN 1105. INTRODUCTION TO ARCHITECTURAL ENGINEERING. 1 Hour.

Introduction to basic architectural engineering practice. There are several writing assignments and an oral presentation. Use of spreadsheet and word processor software in solving architectural engineering problems and presenting solutions. Professional engineering licensure and the various specializations within civil engineering are covered.

AREN 1152. INTRODUCTION TO CONSTRUCTION DRAFTING. 1 Hour.

This course will introduce students to basic concepts of construction drafting including an introduction to orthographic drawings (plans, sections, elevations), principles of scale, line weight, drawing types and drawing conventions. The course introduces students to 2-dimensional Computer Aided Design tools which they use to produce the construction drawings. Prerequisite: Grade of C or better in MATH 1421; or concurrent enrollment in MATH 1426 or HONR-SC 1426; or grade of C or better in MATH 1426 or HONR-SC 1426.

AREN 1205. INTRODUCTION TO ARCHITECTURAL ENGINEERING. 2 Hours.

This course introduces students to the education and practice of architectural engineering, a discipline of engineering that prepares engineers to work effectively on teams that are creating buildings. Course content addresses engineering ethics, professional licensure, sustainability, creative approaches to problem solving and the role of architectural engineering and other engineering disciplines on building construction projects.

AREN 1252. COMPUTER TOOLS - AUTOCAD. 2 Hours.

Introduction to computer aided design, using AutoCAD. Creation of precise two-dimensional engineering drawings and solid models. Prerequisite: Grade of C or better in MATH 1421.

AREN 2152. COMPUTER TOOLS - MATHCAD. 1 Hour.

Introduction to computer aided mathematics, using Mathcad. Solution of engineering problems involving systems of simultaneous linear and nonlinear equations and elementary calculus, use of the tools for visualization. Prerequisite: Grade of C or better in PHYS 1443.

AREN 2153. COMPUTER TOOLS - CIVIL 3D. 1 Hour.

Introduction to civil engineering construction documentation and building information modeling (BIM) using AutoCAD Civil 3D. Prerequisite: Grade of C or better in AREN 1252.

AREN 2191. PROBLEMS IN ARCHITECTURAL ENGINEERING. 1 Hour.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the department chair.

AREN 2213. BUILDING SCIENCE. 2 Hours.

This course introduces the physical phenomena that affect human comfort and building energy performance. The basic principles of thermodynamics applied to building systems are discussed to understand heat and mass transfer analysis techniques. This includes development and application of energy balance equation and psychrometric process with respect to building energy performance. Prerequisite: Grade of C or better in CHEM 1465 and PHYS 1444.

AREN 2221. DYNAMICS. 2 Hours.

Planar and spatial kinematics and kinetics of particles and rigid bodies utilizing Newton's Laws of Motion, the principle of work and energy, and the principle of impulse and momentum; introduction to single degree of freedom vibration. Prerequisite: Grade of C or better in AREN 2311; grade of C or better in MATH 2425.

AREN 2252. INTRODUCTION TO CONSTRUCTION DRAFTING. 2 Hours.

This course will introduce students to basic concepts of construction drafting including an introduction to orthographic drawings (plans, sections, elevations), principles of scale, line weight, drawing types and drawing conventions. The course introduces students to 2-dimensional Computer Aided Design tools which they use to produce the construction drawings. Prerequisite: Grade of C or better in MATH 1421; or concurrent enrollment in MATH 1426 or HONR-SC 1426; or grade of C or better in MATH 1426 or HONR-SC 1426.

AREN 2291. PROBLEMS IN ARCHITECTURAL ENGINEERING. 2 Hours.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the department chair.

AREN 2311. STATICS. 3 Hours.

Vector algebra; composition and resolution of forces; equivalence of force couple systems; equilibrium of force systems acting on particles, and force - couple systems acting on rigid bodies, and systems of rigid bodies; internal forces in rigid bodies; shear and moment diagrams; centroids and moments of inertia; frictional forces. Prerequisite: Grade of C or better in PHYS 1443.

AREN 2312. STATICS & DYNAMICS FOR AREN. 3 Hours.

Principles of forces and force systems, resultants and components of force systems, forces due to friction, condition of equilibrium, forces acting on members of trusses and frame structures, centroids and moments of inertia, review of kinematics and kinetics of particle motion, and two-dimensional motion of rigid bodies. Prerequisite: Grade of C or better in MATH 2425 (or concurrent enrollment) and PHYS 1443 (or concurrent enrollment).

AREN 2313. MECHANICS OF MATERIALS I. 3 Hours.

Concepts of stress and strain; stress-strain relationships. Behavior of members subjected to tension, compression, shear, bending, torsion, and combined loading. Deflections and elastic curves, shear and bending moment diagrams for beams, and column theory. Prerequisite: Grade of C or better in AREN 2311; Grade of C or better in MATH 2425.

AREN 2315. CONSTRUCTION MATERIALS AND METHODS. 3 Hours.

Materials, methods and sequences of the construction process; emphasis on design, specification, purchase and use of concrete, steel, masonry and wood. An understanding of the uses of construction materials. Prerequisite: Grade of C or better in AREN 1205.

AREN 2321. BUILDINGS AND THE ENVIRONMENT. 3 Hours.

A general engineering course on geological materials and processes that interact with the built environment and are critical to architectural engineering including: 1) mineral and rock formation processes; rock mechanics and deformation, weathering, erosion and soils; soil hazards, land subsidence and mass movements; groundwater geology, 2) Interactions between plate tectonics, atmosphere, oceans, and human built environment, 3) Nature and variability of weather and climate, including wind, temperature, clouds and precipitation, droughts, and flooding. Storm systems, fronts, thunderstorms, tornadoes, hurricanes. Relevant topics toward the interactions between buildings and the natural environment are included. Prerequisite: Grade of C or better in AREN 1205.

AREN 2391. PROBLEMS IN ARCHITECTURAL ENGINEERING. 3 Hours.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the chair of the department.

AREN 3110. ARCHITECTURAL ENGINEERING COMMUNICATIONS. 1 Hour.

Technical writing, oral communication, professional presentations, and other related topics. Prerequisite: Grade of C or better in COMS 2302.

AREN 3143. PROPERTIES AND BEHAVIOR OF SOILS. 1 Hour.

An introduction to determination of civil engineering properties of soil and their behavior, identification, grain size analysis, Atterberg limits, compaction, permeability, consolidation, and shear strength. Also an introduction to sampling of soil materials. Prerequisite: Concurrent enrollment in AREN 3343.

AREN 3191. PROBLEMS IN ARCHITECTURAL ENGINEERING. 1 Hour.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the department chair.

AREN 3218. ARCHITECTURAL ENGINEERING GEOMETRIC DESIGN TOOLS. 2 Hours.

This course will address principles of Euclidean and non-Euclidean Geometry in the area of architectural engineering. Topics include golden ratio, golden mean, geodesics on surfaces, conic sections, parametric equations with focus on the techniques, skills, and modern engineering tools necessary for architectural engineering practices. Prerequisite: MATH 1421 or equivalent, AREN 1205.

AREN 3291. PROBLEMS IN ARCHITECTURAL ENGINEERING. 2 Hours.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the department chair.

AREN 3301. STOCHASTIC MODELS FOR CIVIL ENGINEERING. 3 Hours.

Basic theory of probability and statistics with practical applications to civil and environmental engineering problems. Emphasis on sampling, distribution functions, tests of significance, and regression modeling. Prerequisite: Grade of C or better in MATH 2425.

AREN 3305. BASIC FLUID MECHANICS. 3 Hours.

Fundamentals of fluid statics, kinematics of fluid flow, fluid energy, fluid forces, similitude, and dimensional analysis. Related to steady flow of incompressible fluids in confined and free surface systems. Prerequisite: Grade of C or better in AREN 2311; Grade of C or better in MATH 3319 or concurrent enrollment.

AREN 3311. CONSTRUCTION ENGINEERING. 3 Hours.

Principles of construction engineering and the project management process, value engineering, specifications, different construction contracts and delivery methods, estimating and scheduling fundamentals and project control, and management of construction process. Prerequisite: Grade of C or better in IE 2308.

AREN 3315. BUILDING HYDRAULIC SERVICE SYSTEMS. 3 Hours.

This course takes a system-based approach to the analysis and design of hydraulic building systems, ensuring they meet the operational requirements of architectural spaces in compliance with the International Building Code. Topics include: 1) stormwater management & collection system design, 2) sewage management & sanitary plumbing system design, 3) domestic water distribution (cold & hot water systems and water heating system design), 4) gas distribution system design, 5) fire suppression & firefighting water distribution systems, 6) design of retention tanks, clear water storage, fire safety tanks, sump tanks, and temporary detention systems during construction. Prerequisite: Grade of C or better in AREN 3305.

AREN 3330. APPLICATIONS OF BUILDING CODES IN ARCHITECTURE. 3 Hours.

An engineering-based approach to architecture, space planning, and occupant safety focused on the technical aspects associated to engineering an architectural space per the International Building Code. Topics included are: occupant load calculations and sizing of facilities, space programming aspects (room sizing and window sizing), acoustic, noise control, & thermal considerations in space planning, circulation aspects (vertical and horizontal circulations and ADA, elevator specification and stair design), fire safety aspects (emergency egress, fire resistance of the structure & building envelope/enclosures, suppression, detection and alarm, smoke control, first responder considerations), considerations in engineering architectural finishes (smoke development, flame spread, indoor air quality & volatile organic compounds). Prerequisite: Grade of C or better in AREN 2315.

AREN 3331. MECHANICAL AND ELECTRICAL SYSTEMS. 3 Hours.

Mechanical and electrical systems with a major emphasis on estimating and installation, design and control of the electrical, heating, ventilation and cooling system, site planning and acoustical treatments. Prerequisite: Grade of C or better in PHYS 1444.

AREN 3341. STRUCTURAL ANALYSIS. 3 Hours.

Structural analysis/design process, structural forms, and basic structural elements. Analysis of statically determinate structures including beams, trusses, frames, and composite structures, shear and moment diagrams, influence lines, and moving loads. Methods to compute deflections including double integration, moment area, and virtual work. Methods of analysis for statically indeterminate structures including consistent deformation, slope deflection and moment distribution. Use of structural analysis programs. Prerequisite: Grade of C or better in AREN 2313.

AREN 3343. SOIL MECHANICS. 3 Hours.

An introduction to the significant geophysical and soil science properties and behavior of materials making up the earth's crust as they apply to civil engineering, sources of materials, classification, plasticity, permeability, stress distribution, consolidation, shear strength, and settlement. Also an introduction to basic foundation engineering concepts. Prerequisite: Grade of C or better in AREN 2313; Concurrent enrollment in AREN 3143.

AREN 3346. ELECTRICAL SYSTEMS & LIGHTING FOR ARCHITECTURAL ENGINEERS. 3 Hours.

Basic fundamentals of electrical principles and electric lighting principles; application of basic electrical science for the design and specification of electrical systems and lighting for buildings using modern techniques; safety and protection systems in buildings and national electrical code and standards. Prerequisite: Grade of C or better in MATH 2425 (or HONR-SC 2425) and PHYS 1444; Admission to the AREN Professional Program.

AREN 3391. PROBLEMS IN ARCHITECTURAL ENGINEERING. 3 Hours.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the department chair.

AREN 4300. ADVANCED TOPICS IN ARCHITECTURAL ENGINEERING. 3 Hours.

Advanced topics of current interest in any one of the various fields of architectural engineering. The subject title to be listed in the class schedule. May be repeated for credit when topic changes. Prerequisite: Consent of instructor required and Admission to the AREN Professional Program.

AREN 4301. ADVANCED TOPICS IN ARCHITECTURAL ENGINEERING WITH LAB. 3 Hours.

Advanced topics of current interest in any one of the various fields of architectural engineering. The subject title to be listed in the class schedule. May be repeated for credit when topic changes. Prerequisite: Consent of instructor required and Admission to the AREN Professional Program.

AREN 4307. CONSTRUCTION SUSTAINABILITY. 3 Hours.

Types of construction contracts, contractual relationship between general contractor and owner, contractual relationship between general contractor and subcontractors, legal issues in construction administration, insurance, and concepts in value engineering. Reading and evaluating specifications, CSI Master Format. Credit not granted for both AREN 4307 and CE 5382. Prerequisite: Grade of C or better in AREN 3311; Admission to the AREN Professional Program.

AREN 4309. THERMODYNAMICS FOR ARCHITECTURAL ENGINEERS. 3 Hours.

Basic concepts and definitions of thermodynamics, entropy, and introduction to first law of thermodynamics, second law of thermodynamics, and introduction to conductive, convective, and radiative transfer. Application of thermodynamics to building heating, cooling and ventilation (HVAC) systems; use of modern techniques for design and specifications of selected thermal and mechanical systems for buildings. Prerequisite: Grade of C or better in MATH 2425 (or HONR-SC 2425), PHYS 1444, and CHEM 1465 (or concurrent enrollment) or CHEM 1441 and CHEM 1442 (or concurrent enrollment).

AREN 4314. TECHNOLOGIES FOR HIGH PERFORMANCE BUILDINGS. 3 Hours.

Post design & construction phase, it is important to continuously monitor, operate, improve building performance for energy efficiency and occupant comfort. This course discusses various topics in high performance buildings with hands-on learning experiences using practical skills, including 1) sensing & control for building environmental systems, 2) post occupancy evaluation for occupant comfort & health, 3) sustainable building retrofits, and 4) smart building systems. Prerequisite: Grade of C or better in AREN 2213. Admission to the AREN Professional Program.

AREN 4316. BUILDING STRUCTURAL SYSTEMS. 3 Hours.

Structural system-based approach to analysis & design of steel building structural systems under gravity and lateral loads per American Institute of Steel Construction (AISC 360 & AISC 341 & ACI 318) & American Society of Civil Engineering (ASCE 7) criteria including: 1) Ordinary Concentrically Braced Frames & Tension Elements, 2) Special Concentrically Braced Frames & Compression Elements, 3) Ordinary/Intermediate Moment Frames & Bending Elements, 4) Truss Moment Frames, 5) Eccentrically Braced Frames & Shear Elements, 6) Special Moment Frames & Axial/Moment Interaction, 7) Floor Systems (Diaphragm and Composite Action), 8) Foundations Systems and Integration of Steel Elements with RC Foundation Elements. Prerequisite: Grade of C or better in AREN 3341 and admission to the AREN professional program.

AREN 4318. MACHINE LEARNING IN CIVIL ENGINEERING. 3 Hours.

Machine learning is transforming the way we approach problems across all fields of civil and environmental engineering. This course is designed for students across various concentrations to offer a broad perspective on how data science and machine learning can reshape the future of Civil and Environmental engineering. You will learn how machine learning techniques can be applied to analyze and improve a wide range of engineering systems—from smart buildings and geotechnical infrastructure to water resources and transportation networks. Whether working with big data, such as GPS tracking data for traffic flow, satellite images for environmental monitoring, and IoT sensor data in buildings, or small data, such as soil properties for construction site assessment and water distribution system restoration after disasters, machine learning can uncover patterns and insights to improve efficiency, reliability, and resilience of the components or systems. Students will learn how to select and build models for regression, classification, and clustering, and apply them to tackle real-world challenges across various engineering disciplines. Through case studies and practical exercises in Python and Jupyter Notebooks, you will also gain valuable skills in exploratory data analysis, machine learning model construction and validation, and result visualization. Credit not granted for both AREN 4318 and CE 4318. Prerequisite: Grade of A or better in AREN 3301 or consent of instructor and admission to the AREN Professional Program.

AREN 4320. SYSTEM RESILIENCE, RELIABILITY, & PERFORMANCE IN AREN. 3 Hours.

This course focuses on risk & reliability aspects of architectural engineering, applied to design & performance of various building systems. Students will explore probabilistic analysis and reliability-based design principles for hydraulic systems (storm drainage, water distribution, sewage), HVAC systems (thermal loads, system reliability), electrical systems (load factors, redundancy), and structural systems (load combinations, vertical & lateral loads, performance expectations). Emphasis is placed on how uncertainty & variability are quantified in each system to ensure resilience, reliability, and performance. Prerequisite: Grade of C or better in AREN 3301, AREN 3315, AREN 3346, AREN 4331, and AREN 4347 and admission to the AREN Professional Program.

AREN 4326. GIS/HYDROLOGIC & HYDRAULIC MODELING. 3 Hours.

Use of Geographic Information Systems (GIS) and design of GIS-developed hydrologic/hydraulic models commonly applied in the water resources field. The course will have three main areas of emphasis including: principles and operations of ArcGIS, design and implementation of standard hydrologic and hydraulic models, and the linkage of these models to engineering analysis of current water resources problems including flooding, water quality and water supply. Prerequisite: Grade of C or better in AREN 3305; Admission to the AREN Professional Program.

AREN 4331. BUILDING HVAC SYSTEMS DESIGN. 3 Hours.

This course will introduce the fundamental principles and engineering procedures for basic building science; design of heating, ventilating, and air conditioning (HVAC) systems; system and equipment selection; and duct design and layout. This course will also include energy conservation techniques and computer applications, including building energy modeling. Prerequisite: Grade of C or better in PHYS 1444; Admission to the AREN Professional Program.

AREN 4334. DRONES & ADVANCED CONSTRUCTION TECHNOLOGY. 3 Hours.

A practical course for technologies and their applications used on construction job sites. Topics include drones (also known as sUAS, or small unmanned aircraft systems), robotics, extended reality, artificial intelligence, blockchain, wearables, etc. Practical sessions are included to train students to operate drones for various construction applications. Credit not granted for both CE 4334 and AREN 4334. Prerequisite: Grade of C or better in AREN 3311; Admission to the AREN Professional Program.

AREN 4341. SUSTAINABLE BUILDING ENERGY MODELING. 3 Hours.

This course will introduce a whole process of net-zero energy building design in which students work in teams to design, analyze, and provide full documentation for a net-zero energy building. Students are expected to effectively and affordably integrate principles of building science, construction engineering and management, economic analysis, and architectural design in an integrated design process. The course projects will align with a design competition, typically the Department of Energy's Solar Decathlon Design Challenge. The course prepares the next generation of architects, engineers, and construction managers with skills and expertise to start their careers and generate creative solutions for real-world net zero energy buildings. Prerequisite: Grade of C or better in AREN 3213; Admission to the AREN Professional Program.

AREN 4343. HUMAN INTERACTION IN THE BUILT ENVIRONMENT. 3 Hours.

Understanding human interaction in the built environment is critical for assessing comfort levels and system performance. This course would cover theories of human computer interaction, environmental monitoring, and advanced data analytics. Students would be given a hands-on opportunity to build their own data acquisition system to collect and model human behavior. This course meets the emerging trend in a nexus of computer science and facility management. Prerequisite: Admission to the AREN Professional Program.

AREN 4347. REINFORCED CONCRETE DESIGN. 3 Hours.

An analysis, design and synthesis course for concrete structures, emphasizing strength design method. Topics include strength and serviceability requirements, design of one way slabs, rectangular beams, flanged sections and columns, for strength, shear, bond, bearing, and serviceability. Building codes, American Concrete Institute (ACI) specifications, material specifications, test methods, and recommended practice documents are involved. Prerequisite: Grade of C or better in AREN 3341 and admission to the AREN Professional Program.

AREN 4348. STRUCTURAL DESIGN IN STEEL. 3 Hours.

A design synthesis course for structural steel structures using Allowable Strength Design and Load Resistance Factor Design. Topics include tension members, compression members, flexural members and simple connections. Building codes, American Institute of Steel Construction (AISC) specs, material specs, test methods, and recommended practice documents. Prerequisite: Grade of C or better in AREN 3341 and admission to the AREN Professional Program.

AREN 4352. PROFESSIONAL PRACTICE. 3 Hours.

Professional practice issues in the private and public sector are addressed by visiting practitioners. Topics include project management, teamwork, obtaining work, regulatory requirements, specifications, issues in design/build, design alternatives, cost estimation, design and construction drawings, contract and construction law, legal issues, ethics and professionalism, design reports, licensure, lifelong learning, ethical and engineering practice organizations. Learning principles of engineering practice by working as a team is emphasized. Oral and written presentations are required. Prerequisite: Admission to the AREN Professional Program.

AREN 4356. ADVANCED STEEL DESIGN. 3 Hours.

Covers torsional design of beams, beams with web holes, composite design of beams, lateral-torsional buckling of beams, plate buckling, column design and behavior, frame stability, bracing requirements for compression members. Prerequisite: Grade of C or better in AREN 4348 and Admission to the AREN Professional Program.

AREN 4360. DESIGN OF STRUCTURAL MASONRY. 3 Hours.

Covers masonry unit types and mortar types, reinforcing and connections. Design of beams, columns, pilasters, and walls. Structural behavior and construction practices. Includes plain and reinforced masonry. Building Codes, Masonry Standards Joint Committee (MSJC) specifications, material specifications, test methods, and recommended practice documents. Prerequisite: Grade of C or better in AREN 3341; Admission to the AREN Professional Program.

AREN 4361. ADVANCED REINFORCED CONCRETE DESIGN. 3 Hours.

Advanced topics on structural design of concrete structures. Topics include slender columns, shear walls, torsion, deep beams, brackets, retaining walls, strut and tie model for shear torsion, two-way slabs, and shear friction. Building codes, American Concrete Institute (ACI) specifications, material specifications, test methods, and recommended practice documents are involved. Prerequisite: Grade of C or better in AREN 4347 and Admission to the AREN Professional Program.

AREN 4365. STRUCTURAL WOOD DESIGN. 3 Hours.

Covers material grade and properties of wood, design criteria using structural lumber, glue laminated lumber and structural panels. Design of bending and compression members, trusses and diaphragms. Building codes, National Design Specification for Wood Construction (NDS) specifications, material specifications, test methods, and recommended practice documents. Prerequisite: Grade of C or better in AREN 3341; Admission to the AREN Professional Program.

AREN 4383. SENIOR PROJECT. 3 Hours.

This course will provide architectural engineering students the opportunity to apply tools, skills and principles of architecture engineering towards the planning, analysis of alternatives, and designs of engineering solutions for projects identified by the instructor. Projects will address engineering standards and multiple realistic constraints. Application of computer-aided design and engineering tools will be utilized for analysis and design. Student presentations will address alternative solutions, application of building code and engineering standards within architectural context. Students will work together and submit a team project. Prerequisite: Grade of C or better in AREN 4347 and AREN 4352; Completion of all required 3000 level courses; or permission of instructor.

AREN 4391. PROBLEMS IN ARCHITECTURAL ENGINEERING. 3 Hours.

Selected problems in architectural engineering on an individual or group basis. Reference material is assigned and progress conferences are held frequently, by arrangement, with a faculty supervisor. Prerequisite: Permission of the chair of the department.

AREN 4393. INDUSTRIAL INTERNSHIP. 3 Hours.

Student to experience industrial internship under supervision of an industrial mentor and internship committee. Prerequisite: Admission to the AREN Professional Program.

AREN 4394. RESEARCH INTERNSHIP. 3 Hours.

Student to experience research internship under supervision of a CE faculty. Prerequisite: Admission to the AREN Professional Program.