

# ARCHITECTURAL ENGINEERING (AE)

## AE 124: Architectural Engineering Orientation

### 1 Credits

Introduction to architectural engineering; lectures and discussions with special reference to the relation of architectural engineering to the building industry. AE 124 Architectural Engineering Orientation (1) (FYS) This course is designed to help students decide whether they do or do not want to major in Architectural Engineering. It has four major goals. The first is to introduce the role of the architectural engineer in the building industry. The second is to introduce the concepts of integrated building systems design and construction management. The third is to familiarize students with the Architectural Engineering curriculum, department facilities, and faculty. The fourth and final goal is to develop an awareness and interest in the periodicals and publications related to buildings. This course will provide students with access to the regular faculty of the program, a feature that continues throughout the students' 5 year career in Architectural Engineering. Students and faculty will be connected through discussion of topics related to the building industry and the areas that future A E students will be studying. Since this program operates under enrollment control, this course will address entrance to the major, the requirements placed on the freshman year, and the selection process. Additionally, special features of the program will be discussed, including option selection, which takes place after 3 years, the study abroad program at the University of Leeds, and the integrated graduate/undergraduate program. Depending upon the semester in which the course is taken, students will be provided with either an opportunity to participate in the annual AE Career Fair or the 5th year thesis presentations. Students will take field trips to buildings and construction sites on campus to reinforce the material learned in class. As a result of this class, all students should be better prepared to make a decision as to whether or not the wish to apply for this major at the end of their first year.

### First-Year Seminar

## AE 202: Introduction to Architectural Engineering Concepts

### 3 Credits

Introduction to profession of architectural engineering, building envelope systems, sustainable design, fire protection systems, and engineering economics. AE 202 Introduction to Architectural Engineering Concepts (3) As the first course after students are admitted into the major, AE 202 is designed to expose students to two aspects the profession: the interdisciplinary nature of architectural engineering and the concept of professional practice. Technical areas of focus chosen for this course are building envelope and fire protection. These disciplines of architectural engineering require students to sufficiently understand the application of a number of disciplines in the creation of successful and integrated solutions. Students will learn to integrate architectural design and detailing, structural analysis and design, the influence of thermal science, construction processes and building codes in the proper execution of the design of specific building systems. Social and environmental responsibility will be introduced through the discussion of sustainable design. Understanding the Green design concepts and the LEED certification system provides the practical basis for the students to put idealism to work. Early exposure to professional practice

and engineering economics provides students with a framework of understanding to manage the relationships of the myriad of technical courses. This course is designed to provide students an appreciation that the practice of architectural engineering includes proper executions of business and management practices. Students will also learn to analyze design options based on economic factors. The course utilizes lectures, practicums, examinations, projects and presentations to deliver and reinforce the technical content. The course offers students opportunity to work in team settings and to present their work orally to their peers. The broad coverage of the technical and social issues and professional skills intentionally involves students early in their education to all the ABET educational outcomes. The projects present opportunities to engage students in discussion and application of social and ethical responsibilities. The course is open to architectural engineering students in the second year with an ENGAE standing. Students in other curricula may enroll in this course with prior approval of the program.

## AE 202H: Introduction to Building Mechanical Systems

### 3 Credits

Introduction to thermal, psychrometric, energy and human comfort issues in buildings; building form and the natural environment; plumbing systems.

### Honors

## AE 210: Introduction to Architectural Structural Systems

### 3 Credits

Qualitative study of architectural structural systems; historical development of structures; insights of structural analysis and synthesis; comparative structural types. This course is intended for Architecture students. AE 210 Introduction to Architectural Structural Systems (3) is an introductory course in structural analysis and engineering mechanics (primarily statics) with an emphasis on buildings. This course was created specifically for Penn State architecture students. The course is designed to give students an understanding of the behavior of building structural and related architectural elements under a variety of loading conditions. AE 210 is designed to provide students with an understanding of the interpretation and application of structural aspects of building code requirements, particularly in the area of design loads. In addition, this course provides the necessary prerequisite knowledge for two additional structural design courses that are required for architecture students.

**Prerequisite:** algebra, trigonometry

## AE 211: Introduction to Environmental Control Systems

### 3 Credits

Qualitative study of humans in macro- and micro-architectural environmental systems. This course is intended for Architecture students. AE 211 Introduction to Environmental Control Systems (3) introduces Architectural students to building thermal environmental and building mechanical issues. Thermal environmental issues include: thermal comfort, natural environmental impacts, heat transfer through the building envelop, heating and cooling design, noise and vibration of mechanical systems, and building energy consumption. Building mechanical system issues include: heating, ventilating and air-conditioning systems. Emphasis is placed on building design in response to the technical, environmental and societal challenges, with a focus on sustainable design principles and guidelines applied to mechanical

systems. The course utilizes lectures, practicums, examinations, projects and presentations to deliver and reinforce the technical content. The course offers students opportunity to work in team setting and to present their work orally to their peers. The broad coverage of the technical and social issues and professional skills challenges the architecture students to incorporate technical issues as an integral part of the overall building design. The course is required for students enrolled in the undergraduate architecture program. The course is not available to architectural engineering students.

AE 221: Architectural Building Materials

3 Credits

The structural and architectural use of building materials; commercial standardization, classification, and description as encountered in the building trades. AE 221 Architectural Building Materials (3) The course objective is for students to understand building materials and methods. It is taught using a combination of these methods, 1) job site visits to current construction projects on campus, 2) guest speakers from manufacturers, engineering firms, building code organizations, construction managers and contractors, 3) video series of building construction, and other various DVD's, 4) visits to local building suppliers and testing facilities, 5) bus trip to several manufacturing, fabrication, milling plants, 6) hands-on mock-ups of construction assemblies, and 7) actual material samples. This course prepares students for further study in the advanced architectural engineering courses. Student evaluation and individual grades are based on a combination of homework, projects, quizzes, attendance and a final cumulative exam. The major part of the final grade is from six (6) quizzes of which the lowest quiz grade is dropped. Special facilities consist of 1) the drafting room, where various drawings and specifications are utilized to understand materials, 2) the computer lab, where students have access to the internet, which provides them with information from manufactures, suppliers and construction trade organizations, 3) the material samples room, where actual material samples and fasteners are examined and understood, 4) the hands-on mock-up room, where true size mock-ups are built by student groups and 5) the structures testing lab, where concrete beams, wood trusses, etc. built by the students are load tested to understand construction methods and failures.

**Concurrent:** A E 222

AE 221H: Architectural Building Materials

2 Credits

The structural and architectural use of building materials; commercial standardization, classification, and description as encountered in the building trades.

Honors

AE 222: Building Modeling and Documentation

3 Credits

Materials and methods of construction used in residences, and preparation of working drawings for a small building. The course objective is for students to understand construction documents, communicate construction information with sketches and to create drawings and specifications. The course is organized around a series of modules related to working drawings. These modules consist of: 1) reading and interpreting construction documents, 2) hand drawn sketches, from existing mock-ups, from existing drawings, from

assigned details of existing campus buildings, from only given material and connection parameters, 3) CAD drawings of plans, elevations, wall sections, building sections, details, schedules. The final partial construction documents will be in accordance to CAD standards and various codes, including zoning, International Building Code, ADA, etc. This course prepares students for further study in the advanced architectural engineering courses. Student evaluation and individual grades are based on a combination of homework, projects, in class assignments, exams, quizzes and attendance. In class assignments are generally short and given to demonstrate a concept or as practice. Special facilities consist of: 1) the drafting room, where various drawings and specifications are utilized and where students prepare sketches, 2) the computer lab, where students have access to computer aided design software, presentation software and communication software, 3) the material samples room, where actual material samples and fasteners are examined and understood and 4) the hands-on mock-up room, where true size mock-ups that represent the students drawings are built by student groups.

**Prerequisite:** EDSGN130 or EDSGN100; Concurrent: A E 221

AE 222H: Working Drawings

3 Credits

Materials and methods of construction used in residences, and preparation of working drawings for a small building.

Honors

AE 297: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in-depth, a comparatively narrow subject which may be topical or of special interest.

AE 308: Introduction to Structural Analysis

4 Credits

Algebraic and graphical methods of analysis of determinate members, deflections; introduction to indeterminate analysis methods. Course includes practicums. AE 308 Introduction to Structural Analysis (4) In this introductory course, students develop skills to perform analysis of structures, with emphasis on buildings and their structural elements. The objectives of this course are as follows: 1) to determine loads that the buildings/structural elements are likely to be subjected to during the lifetime of the building; 2) to discuss procedures used to determine reactions and internal forces in trusses, beams, and frames; 3) to introduce methods that can be used to calculate deflections. These objectives can be seen as three general steps that define structural analysis. Although the main emphasis in this course is the analysis of planar, statically determinate structures, an introduction to the analysis of indeterminate structures is also given. The course is required to be taken by all architectural engineering undergraduate students in the third year. A knowledge of statics and strength of materials is required and this course serves as prerequisite for steel and concrete design courses in the Architectural Engineering Program.

**Prerequisite:** E MCH211 , E MCH213

## AE 308H: Introduction to Structural Analysis

4 Credits

Algebraic and graphical methods of analysis of determinate members, deflections; introduction to indeterminate methods.

Honors

## AE 309: Architectural Acoustics

3 Credits

Acoustical design for good hearing conditions and noise control; construction details, materials, acoustical properties of room shapes; sound absorption, transmission. Course includes practicums. AE 309 Architectural Acoustics (3) Architectural acoustics encompasses four distinct areas of study: room acoustics, sound isolation, mechanical system noise and vibration and sound reinforcement. The course concentrates on the performance of the building components as they impact on the acoustical environment. The goal of good acoustical design is to provide an environment to afford occupants of a building a high quality listening environment and to minimize intrusion by offending noises. By manipulation of building materials, spatial relationships and geometry, the students learn to improve acoustical performance of a building. Through lectures, practicums, projects, tours to campus performance venues and examinations, the concepts of acoustical design are delivered and reinforced. The course offers students opportunity to work in team settings and to present their work orally to their peers. The course is required for all architectural engineering students, typically taken in the 3rd-year. PHYS 213 is a prerequisite for this course. This course is a prerequisite for Advance Architectural Acoustics and Noise Control. Students not in the architectural engineering curriculum are encouraged to consult with the instructor prior to enrolling in the course.

**Prerequisite:** A E 221 , A E 222 , PHYS 213

## AE 310: Fundamentals of Heating, Ventilating, and Air Conditioning

3 Credits

Fundamental principles and engineering procedures for the design of heating, ventilating, and air-conditioning systems, including energy utilization and constraints. AE 310 Fundamentals of Heating, Ventilating, and Air Conditioning (3) AE 310 explores the fundamentals of the heating, ventilating and air-conditioning (HVAC) systems that control environmental conditions inside buildings. HVAC systems have common basic components, although they may significantly differ in physical appearance and arrangement. The course considers a variety of HVAC systems and presents methods of analyzing air-conditioning processes. HVAC systems maintain not only an acceptable level of thermal comfort within conditioned spaces, but also a healthy environment. Hence, the conditions for a comfortable and healthy indoor environment, such as physiological considerations, environmental indices, and control of indoor air quality are defined. The design of a successful HVAC system requires an accurate estimate of the peak rate at which energy must be added to (heating load) or removed from (cooling load) a space. Therefore, the various types of heat transmission in buildings and methods for estimating them are discussed in order to prepare students to estimate buildings energy consumption and size HVAC systems properly. The target audience is Architectural Engineering students at a junior level who have taken AE 202 "Introduction to

Environmental Systems in Buildings," and ME 23 "Introduction to Thermal Science.

**Prerequisite:** M E 201 ; Prerequisite or concurrent: A E 202

## AE 311: Fundamentals of Electrical and Illumination Systems for Building

3 Credits

Fundamental principles, systems, and planning concepts for electrical and illumination systems in modern buildings.

**Prerequisite:** or concurrent: E E 211 , PHYS 212

## AE 372: Introduction to the Building Industry

3 Credits

Introduction to the building industry; owner, designer responsibilities; documents, bidding procedures; design-construct contracts; project management; insurance, labor relations.

**Prerequisite:** sixth-semester standing in Architectural Engineering

## AE 401: Design of Steel and Wood Structures for Buildings

3 Credits

Application of principles of engineering mechanics to layout, analysis, design, and detailing of structural elements in steel and wood of simple buildings. AE 401 Design of Steel and Wood Structures for Buildings (3) AE 401 is a first course in structural steel and wood design taken by all undergraduate Architectural Engineering students in the 6th or 7th semester. It applies the principles of engineering mechanics to layout, analysis, design, and detailing of structural steel elements. The course covers the principles of structural design, structural safety, structural stability, steel as a material, methods of structural steel design, design of tension members, design of columns, design of beams (flexure, shear, deflection, bearing, web crippling, web yielding), combined stresses (beam columns), fasteners/connections. It also treats wood design, including material characteristics, beam design, column design, and fasteners. After completion of the course students will be able to design simple wood and steel structures.

**Prerequisite:** A E 221 , A E 222 , A E 308

## AE 402: Design of Concrete Structures for Buildings

3 Credits

Application of principles of engineering mechanics to layout, analysis, design, and detailing of structural elements in concrete of simple buildings. AE 402 Design of Concrete Structures for Buildings (3) This course is designed to provide all Architectural Engineering students with an ability to analyze and design reinforced concrete and an understanding of the theoretical behavior of reinforced concrete members. The primary focus is on the analysis and design of one-way systems comprised of slabs, beams, and columns. Evaluation methods include, but are not limited to, exams and homework assignments. A prerequisite knowledge of structural analysis is necessary. It is a required course in the Architectural Engineering curriculum. Additionally, this course provides the necessary prerequisite knowledge for several upper level concrete courses in both Civil and Architectural Engineering.

**Prerequisite:** A E 221 , A E 222 , A E 308

## AE 403: Advanced Steel Design for Buildings

3 Credits

Continuation of A.E. 401. Advanced analysis, design, and detail of the structural elements in wood and steel. AE 403 Advanced Steel Design for Buildings (3) AE 403 is designed for 4th year Architectural Engineering students in the structural option, to build on the design and analysis base developed in the first course in steel design. This course is intended to develop competency in analysis and design of multi-story steel buildings subjected to gravity, wind and earthquake loadings, including study of connections, framing systems, composite design and plastic design of steel members. The course prerequisites include determinate and indeterminate analysis and structural design of steel members. It will cover such topics as types of construction, the design process, loading and load cases, floor systems, floor vibration, moment rotation characteristics of connections, plastic analysis, multi-story frames, braced and unbraced frames, seismic design, leaning columns, drift, composite design and connections.

**Prerequisite:** A E 401 , A E 430

## AE 404: Building Structural Systems in Steel and Concrete

3 Credits

Basic analysis, design, and detailing of steel and concrete structural elements for buildings, emphasizing systems design and comparisons. AE 404 is not permitted for AE Structural Option students or for Architecture students. AE 404 Building Structural Systems in Steel and Concrete (3) The course is designed for architectural engineering students in the Construction, Mechanical Systems and Lighting/Electrical options to gain an ability to design simple building members in steel and concrete using current professional standards, specifications and guidelines. Students will learn to combine these members into simple structural systems and compare the performance and load carrying characteristics of these systems. The course will also address general performance parameters of these materials, construction issues and key systems-integration issues for beams, columns, flooring and roofing systems, and lateral bracing systems constructed in steel and concrete. This course is considered to be the terminal course for non-structural option AE students, and is designed to provide a general understanding of design, construction and integration issues that affect these structural systems. This course may not be taken by AE Structural Option students or Architecture students.

**Prerequisite:** A E 221 , A E 222 , A E 308

## AE 405: Geotechnical Engineering

4 Credits

Course prepares students for understanding, analysis, evaluation, and design of the most commonly used shallow foundation systems to support buildings. All structural loads on buildings, most notably gravity loads and win/seismic lateral loads, are transferred to the soil supporting the building. In order for the building to safely deliver these loads to the soil and avoid settlement issues and soil failure, a proper foundation system must be designed. Design of foundation systems is a function of soil material properties, foundation material, and the selected foundation system. This course educates the student on the basics of soil mechanics for foundation design, and educates the student on how to select and design the most commonly used types of foundation systems. Course is intended to provide students with the

knowledge, tools, and understanding of material properties, analysis and design principles, and methods necessary for successful construction of foundation systems within the framework of quality control, code compliance, economic consideration and safety, while minimizing failure risks. The course is required for Architectural Engineering students in the Structural and Construction Options, but other students may take the course with permission by the instructor.

**Prerequisite:** ( AE 308; CE 340, ) ( AE 402; AE 404 )

## AE 421: Architectural Structural Systems I

3 Credits

Qualitative and quantitative analysis and design of architectural structures, force flow; structure configurations; measurement and experiments; design studio critique.

**Prerequisite:** A E 210 , 3 credits in mathematics

## AE 422: Architectural Structural Systems II

3 Credits

Continuation of A E 421, with emphasis on structural configuration and construction assemblies.

**Prerequisite:** A E 421

## AE 424: Environmental Control Systems I

3 Credits

Fundamental principles and applications of environmental systems in buildings. This course is intended for Architecture students. AE 424 Environmental Control Systems I (3) This course is a complement to AE 211. Environmental control systems other than the thermal environmental systems are covered in this course. AE 424 introduces architecture students to building illumination, acoustical, fire protection, electrical and plumbing design issues. Emphasis is placed on building design as a response to the technical, environmental and societal challenges. The course utilizes lectures, practicums, examinations, projects, presentations and field trips to deliver and reinforce the technical content. The course offers students opportunity to work in team settings and to present their work orally to their peers. The broad coverage of the technical and social issues and professional skills intentionally involves students in discussion and application of social and ethical responsibilities. The course is required for students enrolled in the undergraduate architecture program. AE 211 is a prerequisite for this course. The course is not available to architectural engineering students.

**Prerequisite:** A E 211

## AE 430: Indeterminate Structures

3 Credits

Classical methods of analysis for beams, frames, arches, and secondary stresses as applied to buildings; introduction to modern methods.

**Prerequisite:** A E 308



**AE 431: Advanced Concrete Design for Buildings**

3 Credits

Continuation of AE 402. Advanced analysis, design, and detail of concrete masonry, prestressed and reinforced concrete. AE 431 Advanced Concrete Design for Buildings (3) This is the last course in reinforced concrete design in the Architectural Engineering curriculum, and builds on previously learned skills in reinforced concrete design and analysis of statically determinate and statically indeterminate systems. Successful students will come away with sufficient understanding of the theoretical basis of concrete design to be able to learn any further aspect of concrete design on their own, and a set of specific critical skills needed by any structural designer involved with reinforced concrete structures. These skills include:- Identification of the assumptions and weakness of the theory of reinforced concrete members. - Detailed design of reinforced concrete beams and girders. - Design of reinforced concrete slabs by the direct design method. - Design of reinforced concrete slabs by the equivalent frame method. - Analysis of reinforced concrete members subjected to torsion, to determine bending and torsional moments. - Design of reinforced concrete members subjected to torsion. - Design of reinforced concrete columns, slender and non-slender. - Design of reinforced concrete columns in biaxial bending. This course is taught by a combination of lectures, solution of example problems, and design projects.

**Prerequisite:** A E 402 , A E 430**AE 432: Design of Masonry Structures**

3 Credits

Analysis and design of unreinforced and reinforced masonry: non-bearing walls, bearing walls, shear walls, masonry building systems. AE 432 Design of Masonry Structures (3) This course is intended to prepare students in Architectural Engineering and related disciplines such as Civil Engineering and Agricultural and Biological Engineering to design load-bearing and non load-bearing masonry structures. Although the emphasis will be on reinforced masonry, the design of unreinforced masonry will also be covered. The course will begin with a discussion of the materials used in masonry construction: clay units, concrete units, mortars, grout, and reinforcement. Since masonry is designed by allowable stress methods, a discussion of allowable stress design, as compared to load and resistance factor design, is necessary from the outset. The first design applications to be discussed will be non load-bearing walls, reinforced and unreinforced. This will be followed by a brief coverage of the topic of columns. The next topic will be load-bearing walls, reinforced and unreinforced. The discussions of load-bearing walls will describe two methods for their design: the use of a straight-line interaction formula and the construction of interaction diagrams. The analysis of systems of shear walls will be described in detail, followed by shear wall design. The design of particular building systems, both low-rise and mid-rise will either be covered by lectures, or by other exercises.

**Prerequisite:** A E 402 or C E 341**AE 444: Micro CADD Applications for Buildings**

3 Credits

Application of microcomputer based CADD systems to architectural engineering problems including graphics, system customization, and AI programming techniques.

**Prerequisite:** A E 222 ; CMPSC201 or CMPSC202**AE 453: Load and Energy Use Simulations for Buildings**

3 Credits

Course examines measurement and mathematical modeling techniques for predicting and determining energy use of whole buildings and important subsystems. Building systems use more primary energy utilization and generate more emissions than either the U.S. transportation or industrial manufacturing sectors. Due to the significance of the building sector on national energy used and emissions profiles, the development of quantitatively predictive energy and performance simulation of buildings is a rapidly advancing technical field. The Architecture and Architectural Engineering communities are pursuing aggressive programs to establish a data-based, protocol methodologies and computer based modeling tools that enable accurate predictions of the expected energy utilization and indoor environment performance of alternative building designs. The developing modeling tools are to be integrated with on-site performance measurements and protocol based energy auditing of facilities. Expected performance characteristics predicted by the modeling tools are compared with the measured values. The building design community is evolving to design simulation methodologies used by the transportation and manufacturing sectors. In this course, the means of measuring and monitoring of the energy use associated with a building system, both on whole building and significant subsystems - lighting, heating ventilation and air conditioning, occupant operated equipment - are reviewed. Inverse modeling techniques of using the data with associated significant independent variables, such as ambient weather parameters and occupant density, to establish, empirical expected building energy use models, as well as document energy efficiency renovation impacts are detailed. Industry established building performance rating scales which use such data are discussed. Fundamental heat transfer and thermal capacitance relationships as used by the engineering design community are discussed along with linearization approximations and Fourier series techniques used to simplify the resulting complex, coupled partial differential equations that result from energy balancing model equations. Analytical and numerical approaches to solving the equations to arrive at predicted thermal loads developed by a building system are reviewed. Readily available, building simulation software packages commonly used in the building design community to determine energy used by equipment configurations to meet predicted loads are discussed. Students are required to exercise one of the standard software tools to model a specific building facility.

**Prerequisite:** A E 310, A E 454**AE 454: Advanced Heating, Ventilating, and Air Conditioning**

3 Credits

Engineering design and performance analysis procedures for complex commercial building systems, including energy conservation techniques; design project.

**Prerequisite:** A E 310**AE 455: Advanced Heating, Ventilating, and Air Conditioning System Design**

3 Credits

Design of several different systems for a course project building; control strategy; economic comparisons using life-cycle cost techniques.

**Prerequisite:** A E 454

## AE 456: Solar Energy Building System Design

3 Credits

Solar radiation, collectors, and thermal storage; design and analysis of a heating system using system-simulation computer program.

**Prerequisite:** seventh-semester standing in Engineering

## AE 457: HVAC Control Systems

3 Credits

Theory of automatic control. HVAC control applications. Control system components, control loops, development and documentation of control logic, control commissioning. AE 457 HVAC Control Systems (3) The objective of the course is to develop the knowledge and skills necessary to understand, design, document, and diagnose problems in HVAC control systems. The course builds on knowledge of HVAC system function and design obtained in prior courses in the curriculum and prepares students for advanced design courses and the capstone project. The course begins with an introduction to concepts and terminology of automatic control, followed by detailed study of control system components: sensors, controlled devices, and controllers. Understanding of these fundamentals is then applied to the development and documentation of controls for common HVAC systems and the commissioning of control systems. Relevant standard and guideline documents are referenced as necessary.

**Prerequisite:** A E 454

## AE 458: Advanced Architectural Acoustics and Noise Control

3 Credits

Advanced consideration of noise control in buildings; ventilating system noise and vibration; acoustic design variables.

**Prerequisite:** A E 309

## AE 461: Architectural Illumination Systems &amp; Design

3 Credits

Lighting units & photometry; lighting equipment; design criteria, calculation methods; the design process; energy codes. AE 461 Architectural Illumination Systems & Design (3) This course will prepare students to design basic lighting systems by providing them with background information and experience to do the following: 1. Develop their knowledge of lamp, luminaire, and control types and evaluate their applicability to a particular design situation. 2. Establish fundamental design criteria for a variety of lighting applications. 3. Conduct appropriate and accurate analyses of lighting systems to assess system performance and evaluate its ability to meet design criteria. 4. Implement a completed design by specifying all of the components of the system and providing an appropriate system layout. This is the first full-semester lighting course that students receive in the Architectural Engineering Department's Lighting/Electrical Option.

**Prerequisite:** A E 311

## AE 463: Daylight Analysis of Roman Architecture

3 Credits

Solar geometry, building orientation and form, daylight design methods, characterization of interior and exterior lighting conditions. Offered in Rome. Analysis of Roman architecture from the perspective of daylight. Topics include solar geometry; building orientation and form; daylight design methods including toplighting and sidelighting strategies; illuminance meters; characterization of interior and exterior lighting conditions; site visits. Course includes development of a software tool to compute solar geometry and daylight availability for any location on the globe and for clear, overcast, and cloudy sky conditions. The software tool will also run in reverse, providing time of day and year when the sun is in a desired position for any latitude and longitude. Offered on location in Rome.

**Prerequisite:** ARCH 130A, ARCH 202

## AE 464: Advanced Architectural Illumination Systems &amp; Design

3 Credits

Flux transfer theory; advanced lighting and control systems; emergency lighting; daylighting; visual performance issues; psychological aspects of lighting. AE 464 Advanced Architectural Illumination Systems & Design (3) This is the final undergraduate architectural lighting course in the Lighting/Electrical Systems Option. The course focuses on advanced topics related to lighting design such as luminous flux transfer and its application to lighting analysis procedures, advanced issues in photometry, advanced control systems, and advanced topics in lighting design. The light design topics include the psychological aspects of lighting, and design for complex spaces such as museums, stores, and video conferencing. The course includes a weekly hands-on practicum experience, homework, exams and a design project.

**Prerequisite:** A E 461

## AE 466: Computer Aided Lighting Design

3 Credits

Design and analysis for outdoor area; floodlighting; and interior applications, including design criteria; economic analysis; modeling algorithms; and visualization. AE 466 Computer Aided Lighting Design (3) The goal of this course is to cultivate an understanding of good lighting design practice through a series of design and analysis problems. Course topics include design criteria, design practice, and the application of lighting hardware and analysis procedures for outdoor area lighting, economic analysis of lighting systems, interior lighting design and lighting system visualization. Commercially available computer software is applied to approximately seven design projects, which students present in either PowerPoint or submit in a short report format. Students, faculty and outside professionals critique the project solutions. The critiques enhance the learning experience for all students through the evaluation of different lighting solutions applied to the same design problem.

**Prerequisite:** A E 444 , A E 461

## AE 467: Advanced Building Electrical System Design

3 Credits

Design of electrical systems for commercial and industrial facilities emphasizing design practice and integration with codes and standards.

**Prerequisite:** A E 311 , E E 211

## AE 468: Advanced Building Electrical and Communication Systems

3 Credits

Special Building Electrical and Communication Systems is an elective course within the architectural engineering program. It addresses specialized components and analysis of building electrical systems, cost and availability of electrical energy, and power quality. Students will also develop an a more in-depth understanding of alternative electrical sources, the National Electric Code, advanced design issues of electrical systems, as well as other electrical and building communication issues. In addition, part of the course will focus on the fundamentals of special systems typically included within the electrical discipline scope of work such as fire alarm, access control, surveillance, voice, video and data systems. Upon completion of this course, students will be able to explain the fundamentals of special electrical and communication systems within a building.

**Prerequisite:** AE 467

## AE 469: Photovoltaic Systems Design and Construction

3 Credits

Criteria and analysis methods pertaining to the design and construction of photovoltaic (PV) systems and their integration with buildings. AE 469 Photovoltaic Systems Design and Construction (3) This course provides students with a working understanding of the design and construction of photovoltaic (PV) systems and their applications in buildings, and is intended for students in Engineering and Energy Engineering. The course provides an overview of PV systems and common applications in residential and commercial buildings including the determination of solar irradiance and insolation based on latitude and climate as well as site survey and assessment methods for the positioning of PV systems. Technical topics include solar module components, DC-AC power inversion, energy storage systems, and system sizing and design. The integration of PV systems with building electrical and mechanical systems, including discussions of the pertinent building codes, utility interconnection, and the economic analysis of PV systems, is also included in this course. Upon the completion of the course, students will be able to calculate and account for the factors affecting the performance of PV systems in various climates and conditions, distinguish the features and performance variables of solar modules and inverters in the design of PV systems, calculate string sizing and inverter matching variables in the design of PV systems, communicate the critical design features of safe and efficient PV system integration with buildings and utilities, evaluate and quantify the factors affecting the successful installation and performance of PV systems in variable settings, and will develop inquiry skills needed to assess new products entering the solar energy marketplace. In addition to understanding the key issues with system design, students will be able to utilize this understanding to choose components properly and to design a basic grid-tied system for a chosen building. Students will also be able to conduct an economic analysis of PV systems in the context of residential and commercial building construction.

**Prerequisite:** E E 210 or E E 211

## AE 470: Residential Building Design and Construction

3 Credits

Managerial aspects; architectural and code considerations; cost estimating, design, and construction of structural, plumbing, HVAC, and electrical systems.

**Prerequisite:** A E 372 or C E 332 ; seventh-semester standing in Architectural Engineering or Civil Engineering

## AE 471: CONSTRUCTION MANAGEMENT OF RESIDENTIAL BUILDING PROJECTS

3 Credits/Maximum of 3

Understanding residential project planning, management, contracts, budget, administration, and execution; discussion of the life cycle of a residential construction business. AE 471 Construction management of Residential Building Projects (3) The course Construction Management of Residential Building Projects is designed to introduce the students to a general understanding of the construction industry, basic principles of project planning and management, contracts, budget and project administration and execution as applied to residential building construction. The content of the course is intended to provide the student with the knowledge, tools, and understanding of processes and tasks necessary to manage residential building projects to completion successfully and within the framework of quality control, code compliance, and safety, while minimizing risks. The scope of the residential construction considered in this course is primarily focused on single-family dwellings and multi-family dwellings. Furthermore, most of the topics covered can be applicable to new construction, remodeling, as well as repair projects.

**Prerequisite:** 6th semester standing

## AE 472: Building Construction Planning and Management

3 Credits

The objective of AE 472 is to introduce students in the construction management option of the Architectural Engineering program to the process in which building construction contractors acquire building projects, and the range of services typically provided on these projects. Upon completion of this course, students will have a working understanding of the preconstruction process and methods of acquiring negotiated work in building construction. They will be capable of assembling estimates, schedules, cash-flow curves, and site plans for building projects, and will have a working knowledge of competitive presentation strategies and develop professional presentation skills. The content of the course centers upon the process in which companies plan for and acquire projects as construction managers and general contractors. Specific topics include schematic estimating and scheduling, design coordination of structural, architectural, and mechanical systems, value engineering processes, and site planning. The financial aspects of construction work are also presented, including project financing, cash flow, and accounting. A significant portion of the course is also devoted to the development of strategic and competitive business presentation, including risk assessment, fee structure, team dynamics, and technical presentation skills. The class relies heavily upon the application of all content by students in the context of a team project. The project involves the distribution of a "Request for Proposal" for which students prepare a competitive proposal for an actual building

construction project planned on the Penn State University Campus. Class activities include the presentation of key issues followed by in-class or independent exercises to reinforce themes and strategies to be applied in the project proposal. Students are assessed on their performance on discussion quizzes, independent exercises, class participation, a team presentation, and exams.

**Prerequisite:** AE 475

AE 473: Building Construction Management and Control

3 Credits

Building construction project planning; construction cost, schedule, quality and safety control systems; project cost accounting; change management; construction company management. AE 473 Building Construction Management and Control (3) The goals of this course are for students to learn how to perform detailed construction planning, identify potential problems during construction, and manage changes throughout a construction project. By completing this course, students will better understand the role of the general contractor/construction manager in analyzing the construction aspects of a building project and designing the construction engineering and management systems to effectively execute the project. The main course objectives include learning how to perform and implement detailed planning for a construction project together with monitoring the project progress and performance including detailed cost control. Other course objectives emphasize gaining knowledge of the key decisions that construction executives make when managing a construction company and identifying potential projects to pursue. Students will also be introduced to the management of changes which occur throughout a project and how to negotiate changes. Finally, ethical standards for a professional engineer and their impact on decisions within the construction industry are important course learning objectives. The course is taught via a combination of teaching methods that rely on problem based learning through both in and out of class activities; lectures by faculty and industry experts; project case studies; student presentations; and team and individual assignments. Completion of AE 472 is a prerequisite for this course.

**Prerequisite:** A E 472

AE 474: Building Construction Estimating

3 Credits

Construction estimating and cost engineering fundamentals; quantity take off; pricing, bid preparation; estimating, cost accounting by computer.

**Prerequisite:** A E 372

AE 475: Building Construction Engineering I

3 Credits

Project planning, supervision, inspection of architectural and structural operations in major buildings; mobilization, coordination of trades; offsite testing and fabrication.

**Prerequisite:** A E 372

AE 476: Building Construction Engineering II

3 Credits

Construction of mechanical and electrical systems in major buildings; fire protection, sound control, elevating; trade coordination; manufacturers' developments; computer application.

**Prerequisite:** A E 309 , A E 475

AE 481: Comprehensive Architectural Engineering Senior Project I

4 Credits

Building project selection and preparation of overall plan; preliminary investigation of building design and construction issues; creation of individual Capstone Project Electronic Portfolio (CPEP) and project proposal required. AE 481 Comprehensive Architectural Engineering Senior Project I (4) The course sequence of AE 481 and AE 482 comprises the capstone engineering design program for Architectural Engineering students. AE 481 is taken by all undergraduate architectural engineering (A E) students and also serves as the writing intensive course requirement in A E. Based on an actual building project model, students will investigate the building, perform technical analysis, develop project criteria and prepare a written proposal for more detailed work to be accomplished in AE 482. Evaluation methods include but are not limited to written reports, verbal and written presentations, faculty consultations and development of a capstone project electronic portfolio (CPEP).

**Prerequisite:** ARCH 441 , fifth-year architectural engineering standing in major area of emphasis  
Writing Across the Curriculum

AE 481M: Comprehensive Architectural Engineering Senior Project I

4 Credits

Building project selection and preparation of overall plan; preliminary investigation of building design and construction issues; creation of individual Capstone Project Electronic Portfolio (CPEP) and project proposal required.

Honors

Writing Across the Curriculum

AE 482: Comprehensive Architectural Engineering Senior Project II

4 Credits

Continuation of AE 481 Engineering analysis of building systems; emphasis on analysis and design of building structural, mechanical, lighting/electrical, and construction related systems. Final written report, web-based project portfolio and verbal presentation are required. AE 482 Comprehensive Architectural Engineering Senior Project II (4) AE 482 is the second half of the capstone engineering design project for Architectural Engineering students. The course is taken by all undergraduate architectural engineering and serves as a direct follow up to AE 481. Students perform detailed option specific work in conjunction with individual proposals written in AE 481. Students are also required to demonstrate work in the breadth areas of architectural engineering. Evaluation methods include but are not limited to written reports, verbal and written assignments, faculty consultations, maintaining their capstone project electronic portfolio, a final comprehensive written report and a verbal presentation to a faculty jury.



**Prerequisite:** A E 481W

AE 486: Professional Engineering Practice

3 Credits

A study of the influences which affect the practice of architectural engineering, particularly codes, ethics, legal considerations, and contract documents.

**Prerequisite:** seventh-semester standing

AE 494M: Senior Honors Thesis

4 Credits

Comprehensive Architectural Engineering Senior Project development and planning with an honors thesis focus. In this course, an honors student in architectural engineering will work on a real-world building project which the student has selected and for which the student has obtained drawings and specifications, as well as the owner's permission to use this project as their undergraduate thesis project. Students enrolling in this course are required to complete the following: - Develop and initiate a plan for their undergraduate senior project in Architectural Engineering which will also serve as their Schreyer Honors College thesis. Through this thesis, the student demonstrates a command of relevant scholastic work and a personal contribution to that scholarship. - Secure an honors thesis adviser and meet with that person to select an in-depth and/or integration focus for their Honors Thesis work. The student then develops a formal proposal describing the focus area for the undergraduate senior project and honors thesis, outlining the analyses, investigations, and design elements of this work and the tools that will be employed. - Summarize the existing conditions present in this building project as it relates to their AE option, systems integration, and the honors thesis topic. - Conduct a thorough review of the relevant literature that has been published in the area that is the focus of the honors thesis, including details on the relevant building, construction, and energy codes that govern this work. - Commence work on the investigation, analysis, and design portion of the thesis, together with the general activities required of all AE students in their undergraduate capstone projects.

**Prerequisite:** ARCH 441, fifth-year architectural engineering standing in major area of emphasis

Honors

Writing Across the Curriculum

AE 496: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

AE 496H: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

Honors

AE 497: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

AE 498: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in-depth, a comparatively narrow subject which may be topical or of special interest.

AE 498F: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in-depth, a comparatively narrow subject which may be topical or of special interest.