

ARCHITECTURAL ENGINEERING

<https://arce.calpoly.edu>

The Architectural Engineering Department is an integral part of the College of Architecture and Environmental Design, and it shares and supports the mission of the College. The mission of the architectural engineering program is to educate students to be successful in the practice of structural engineering. The department has several overall program objectives, which are: to advance in the profession through a combination of continuing education, graduate studies, lifelong learning and professional society participation; obtain a PE license and be working toward an SE license; communicate effectively with colleagues, clients and the public; and display leadership, initiative, creativity, teamwork, ethical behavior, work ethic and technical expertise in the chosen profession while exhibiting confidence and humility.

To eventually attain these overall program objectives, the following student learning outcomes must be satisfied. At the time of graduation, we expect our graduates to be able to: identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics; apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors; communicate effectively with a range of audiences; recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts; function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives; develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions; and acquire and apply new knowledge as needed, using appropriate learning strategies. To attain these outcomes, the program provides a balance of theoretical (analytical) and experimental courses.

The Architectural Engineering program carefully addresses architectural design, constructability issues, life safety and economy of construction. In addition, course projects address realistic design criteria, such as economic implications and environmental, social, ethical and sustainability issues. Using integrated design projects, modern technological tools, and the latest design codes to address these goals, the department emphasizes the advantages of a close, interdisciplinary team-based approach to design and construction.

The use of interdisciplinary projects allows students to hone their communication, critical thinking, and project management skills by working in multidisciplinary teams. As students learn more about building design, they become cognizant of the ethical implications of design, specifically of how political and societal issues affect the engineering of the built environment, both on a local scale and on a broader international scale. These larger societal issues motivate students to engage in life-long learning, allowing them to use their skills in professional structural engineering practice.

The department's learn-by-doing philosophy is part of a pedagogy which emphasizes design-centered laboratories, integrating theory and design, culminating in a senior project capstone design experience.

The Architectural Engineering Program is accredited by the Engineering Accreditation Commission of ABET (<http://www.abet.org>).

Undergraduate Programs

- Architectural Engineering (BS) (<https://catalog.calpoly.edu/architecture-environmental-design/architectural-engineering/architectural-engineering-bs/>)

Undergraduate Minors

- Architectural Engineering Minor (<https://catalog.calpoly.edu/architecture-environmental-design/architectural-engineering/architectural-engineering-minor/>)

Graduate Programs

- Architectural Engineering (MS) (<https://catalog.calpoly.edu/architecture-environmental-design/architectural-engineering/architectural-engineering-ms/>)

ARCE Courses

ARCE 1110 Introduction to Architectural Engineering (2 units)

Term Typically Offered: F

Introduction to the architectural engineering discipline and profession. 1 lecture, 1 activity. Formerly ARCE 106.

ARCE 1121 Structural Principles I (3 units)

Term Typically Offered: F, SP, SU

Prerequisite: One of the following: PHYS 121, PHYS 1121, PHYS 141, or PHYS 1141; and MATH 119, MATH 1007, or Appropriate Math Placement.

Introduction to static equilibrium and the creation of simple three-dimensional structures. Analysis of axial force (truss) members. Introduction to shear and moment diagrams using the principles of static equilibrium. Free body diagrams to analyze structures composed of bending (beams) members. 3 lectures. Formerly ARCE 211.

ARCE 2211 Structural Principles II (3 units)

Term Typically Offered: F, SP

Prerequisite: ARCE 211 or ARCE 1121 (C- or better required for Architectural Engineering majors); and MATH 141 or MATH 1261. Concurrent: ARCE 224 or ARCE 2212 for Architectural Engineering majors.

Advanced topics of stresses in beams. Plastic bending. Unsymmetrical bending. Combined stresses. Stress transformation. Buckling. Deflection of beams. Internal forces and stability of beams and frames. 3 lectures. Formerly ARCE 223.

ARCE 2212 Structural Principles II Laboratory (1 unit)

Term Typically Offered: F, SP

Prerequisite: ARCE 211 or ARCE 1211. Concurrent: ARCE 223 or ARCE 2211. Recommended: Completion of GE Area 1B with a grade of C- or better (GE Area A3 for the 2020-26 catalogs).

Experimental investigations of material properties. Experimental studies of stresses and deflections in beams, including plastic bending, and unsymmetrical bending. Stress transformations via strain gages for combined loading cases. Culminating lab experience: A student run, self-designed experiment. 1 laboratory. Formerly ARCE 224.

ARCE 2222 Structural Systems Laboratory (2 units)

Term Typically Offered: F, SP

Prerequisite: Architectural Engineering major; Sophomore standing; ARCE 223 or ARCE 2211 (C- or better required for Architectural Engineering majors).

Studies in the relationship of structural framing to overall building geometry. Emphasis on the stability of structural configurations, calculation of building loads and development of a complete gravity and lateral load path. 2 laboratories. Replaced ARCE 371.

ARCE 2223 Structural Drawings (2 units)

Term Typically Offered: SP

Prerequisite: ARCE 106 or ARCE 1110.

Analog and digital drawing and 3D modeling to represent structural systems and elements in buildings. The conventions of 2D media formats to communicate 3D form. 1 lecture, 1 laboratory. Formerly ARCE 257.

ARCE 2270 Special Topics (1-3 units)

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Directed group study of special topics. The Schedule of Classes will list topic selected. Repeatable up to 6 units. 1 to 3 lectures. Formerly ARCE 270.

ARCE 2280 History of Structures (3 units)

Term Typically Offered: SP

2026-28 or later catalog: GE Area 3A

2020-26 catalogs: GE Area C1

Understanding the social, symbolic and technical importance of landmark structures. Analysis of breakthrough ideas that led to major advances in building design. Contextualizing these advances. Tools by which to assess and critique structural art as a separate and distinct art form. 3 lectures. Fulfills GE Area 3A (GE Area C1 for students on the 2020-26 catalogs). Formerly ARCE 260.

ARCE 3301 Introduction to Structural Systems (4 units)

Term Typically Offered: F, SP

Prerequisite: ARCE 211 or ARCE 1121.

Description, behavior and comparison of structural building systems. Concepts of structural stability, load flow, framing schemes, and building configuration for vertical and lateral loads. Introduction to gravity load carrying systems and lateral load resisting systems using timber, steel and concrete. Not open to Architectural Engineering majors. 4 lectures. Formerly ARCE 315.

ARCE 3311 Structural Analysis (3 units)

Term Typically Offered: F

Prerequisite: ARCE 223 or ARCE 2211 (C- or better required for Architectural Engineering majors). Concurrent: ARCE 352 or ARCE 3312 for Architectural Engineering majors.

Analysis of statically indeterminate structures using virtual work, the force method, slope deflection and the direct stiffness method. Introduction to finite-element methods. Plastic analysis methods for beams and frames. 3 lectures. Formerly ARCE 302.

ARCE 3312 Structural Analysis Laboratory (1 unit)

Term Typically Offered: F

Prerequisite: CSC 231 or CSC 1031. Concurrent: ARCE 302 or ARCE 3311.

Computer calculations, programming and technical reporting. Emphasis on two-dimensional structural analysis using Python and commercial structural analysis software to analyze building structural systems and individual structural elements. 1 laboratory. Formerly ARCE 352.

ARCE 3331 Timber Design (2 units)

Term Typically Offered: F

Prerequisite: One of the following: ARCE 371, ARCE 2222, ARCE 315, or ARCE 3301.

Analysis and design of timber structural members subjected to bending, shear, and axial forces. Wood diaphragms, shear walls and connections. 2 lectures. Formerly ARCE 304.

ARCE 3332 Timber Design and Constructability Laboratory (2 units)

Term Typically Offered: SP

Prerequisite: ARCE 257 or ARCE 2223; and ARCE 304 or ARCE 3331.

Timber framed project incorporating structural system configuration and selection, structural analysis for gravity and lateral loads, and construction drawings and specifications. Integration of building services and architectural design, constructability issues, and relationships between construction methods and cost. Cannot be taken concurrently with ARCE 4442 or ARCE 4462. Field trip required. 2 laboratories. Formerly ARCE 451.

ARCE 3341 Steel Design (2 units)

Term Typically Offered: SP

Prerequisite: One of the following: ARCE 371, ARCE 2222, ARCE 315, or ARCE 3301.

Analysis and design of steel structural members subjected to bending, shear and axial forces. 2 lectures. Formerly ARCE 303.

ARCE 3353 Soil Mechanics and Foundation Design (4 units)

Term Typically Offered: F

Prerequisite: ARCE 211 or ARCE 1121. Recommended: GEOL 201 or GEOL 2240.

Principles of soil mechanics, including rudiments of geology, soil classification, gravimetric and volumetric relations, compaction, methods and testing, shear strength of soil and strength theories. Soil-bearing capacity; sizing and design of spread footings, driven piles and drilled shafts. 3 lectures, 1 laboratory. Formerly ARCE 421.

ARCE 3381 Geometric Architectural Load Flow (3 units)

Term Typically Offered: TBD

2026-28 or later: Upper-Div GE Area 2/5

2020-26 catalogs: Upper-Div GE Area B

Prerequisite: Junior standing; completion of GE Area 1 with grades of C- or better (GE Area A for the 2020-26 catalogs); completion of GE Area 2 with a grade of C- or better (GE Area B4 for the 2020-26 catalogs).

Equilibrium and load flow in structures via geometric visualization and programming. Use of a programmed drawing environment to study the flow of loads through a building. Mathematical insights into Virtual Work and both Castigliano's Theorems. Historical analysis and context. Course is offered online only. 3 lectures. Fulfills GE Areas Upper-Division 2 or Upper-Division 5 (GE Area Upper-Division B for students on the 2020-26 catalogs). Formerly ARCE 360.

ARCE 4400 Special Problems for Advanced Undergraduates (1-3 units)

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Individual investigation, research, studies, or surveys of selected problems. Repeatable up to 6 units. Formerly ARCE 400.

ARCE 4411 Structural Dynamics (3 units)

Term Typically Offered: SP

Prerequisite: MATH 244 or MATH 2341; and ARCE 302 or ARCE 3311. Concurrent: ARCE 354 or ARCE 4412.

Analysis of structures subjected to dynamic loads with single- and multi-degrees of freedom. Development of techniques for analysis of structures in response to time varying loads. 3 lectures. Formerly ARCE 412.

ARCE 4412 Structural Dynamics Computing Laboratory (1 unit)

Term Typically Offered: SP

Prerequisite: ARCE 352 or ARCE 3312. Concurrent: ARCE 354 or ARCE 4411.

Computer calculations, programming and technical reporting. Dynamic response of framed structures using Python and commercial structural analysis software. Emphasis on seismic loading and response. 1 laboratory. Formerly ARCE 354.

ARCE 4413 Seismic Analysis and Design (3 units)

Term Typically Offered: F

Prerequisite: ARCE 303 or ARCE 3341; ARCE 412 or ARCE 4411; and ARCE 354 or ARCE 4412. Corequisite: ARCE 444 or ARCE 4461.

Dynamic response analysis of building structures emphasizing earthquake ground motion. Earthquake resistant design of buildings in accordance with building codes. Laboratory studies utilizing computer programs and physical models for studying the behavior of building structures subjected to ground motions. 2 lectures, 1 laboratory. Formerly ARCE 483.

ARCE 4421 Architectural Engineering Building Systems (2 units)

Term Typically Offered: SP

Prerequisite: Junior standing and Architectural Engineering major.

Principles and practices for the sustainable design, fabrication, and installation of architectural engineering building systems. Including air/gas, water/waste water, electrical, and control systems. Methods and materials used for fabrication and installation. Including cost and schedule considerations. 2 lectures. Formerly ARCE 476.

ARCE 4442 Steel Structures Design Laboratory (2 units)

Term Typically Offered: F

Prerequisite: ARCE 371 or ARCE 2222; ARCE 257 or ARCE 2223; ARCE 304 or ARCE 3311; ARCE 352 or ARCE 3312; and ARCE 303 or ARCE 3341.

Steel framed project incorporating structural system configuration and selection, structural analysis for gravity and lateral loads, and construction drawings and specifications. Integration of building services and architectural design, constructability issues, and relationships between construction methods and cost. Cannot be taken concurrently with ARCE 3332 or ARCE 4462. 2 laboratories. Formerly ARCE 372.

ARCE 4461 Reinforced Concrete and Masonry Design (4 units)

Term Typically Offered: F

Prerequisite: ARCE 371 or ARCE 2222; and ARCE 302 or ARCE 3311.

Theory and design of structural elements in masonry (beams, columns, and bearing/shear walls) and reinforced concrete (beams, one-way slabs, and non-slender columns). 3 lectures, 1 laboratory. Formerly ARCE 444.

ARCE 4462 Senior Project - Reinforced Concrete and Masonry Laboratory (2 units)

Term Typically Offered: SP

Prerequisite: ARCE 257 or ARCE 2223; ARCE 372 or ARCE 4442; and one of the following: ARCE 451, ARCE 3332, ARCE 372, or ARCE 4442.

Cast-in-place concrete and masonry senior project incorporating structural system configuration and selection, structural analysis for gravity and lateral loads, construction drawings and specifications. Integration of building services and architectural design, constructability issues, relationships between construction methods and cost. Cannot be taken concurrently with ARCE 3332 or ARCE 4442. 2 laboratories. Formerly ARCE 452.

ARCE 4470 Special Advanced Topics (1-3 units)

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Directed group study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 6 units. 1 to 3 lectures. Formerly ARCE 470.

ARCE 4471 Special Advanced Laboratory (1-3 units)

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Directed group laboratory study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 6 units. 1 to 3 laboratories. Formerly ARCE 471.

ARCE 4482 Independent Project (1-3 units)

Term Typically Offered: F, SP

Prerequisite: Senior standing and consent of instructor.

Projects under faculty supervision that explore topics covered in the Architectural Engineering curriculum. Projects may include integration with other disciplines outside of structural or architectural engineering. Repeatable up to 3 units. Formerly ARCE 453.

ARCE 4484 Interdisciplinary Project (3 units)

Term Typically Offered: SP

Prerequisite: Senior standing and consent of instructor.

Team-based interdisciplinary course. Analysis and evaluation of interdisciplinary challenges associated with integrating the design and construction processes to deliver a project with respect to the design, budget, schedule, quality, and performance expectations of a client. 3 laboratories. Formerly ARCE 415.

ARCE 4485 Cooperative Education Experience (1-4 units)

Term Typically Offered: TBD

CR/NC

Prerequisite: Sophomore standing and consent of department head.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course. Formal report and evaluation by work supervisor required. Repeatable up to 8 units. Credit/No Credit grading only. Formerly ARCE 485.

ARCE 4486 Collaborative Design Laboratory (2 units)

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Investigation of the collaborative nature of the design process as it relates to the architectural engineer and related disciplines. Development of skills necessary to create a successful design team through the development of specific projects. Repeatable up to 4 units. 2 laboratories. Formerly ARCE 460.

ARCE 4495 Cooperative Education Experience (4-8 units)

Term Typically Offered: TBD

CR/NC

Prerequisite: Sophomore standing and consent of department head.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course. Formal report and evaluation by work supervisor required. Repeatable up to 16 units. Credit/No Credit grading only. Formerly ARCE 495.

ARCE 5488 Engineering Risk Analysis (4 units)

Term Typically Offered: TBD

Prerequisite: STAT 312, STAT 3210, or graduate standing.

Introduction to the basic concepts of probability theory, statistics, and decision theory as they pertain to problems in civil and environmental engineering. Emphasis placed on the use of probabilistic modeling, Bayesian statistics, risk analysis, and decision theory. 4 lectures. Crosslisted as ARCE/CE 5488. Formerly CE 488.

ARCE 5511 Advanced Structural Mechanics (3 units)

Term Typically Offered: F

Prerequisite: One of the following: ARCE 302, ARCE 3311, ARCE 352, ARCE 3312, or graduate standing.

Principles of advanced structural mechanics. Studies of displacement, strain, stress, strain-displacement relationships, yield criteria, failure criteria, energy methods in approximate solutions, shape functions, introduction to plates, buckling and torsion. 3 lectures. Formerly ARCE 501.

ARCE 5512 Nonlinear Structural Behavior (3 units)

Term Typically Offered: F

Prerequisite: ARCE 302 or ARCE 3311; and ARCE 352 or ARCE 3312; or graduate standing.

Principles, concepts and behavior of structures loaded beyond their linear elastic limit, including trusses beams and frames. Classification of nonlinear problem types. Iterative solution strategies. Studies of material and geometric nonlinearities. Use of current nonlinear analysis software and computer coding. 3 lectures. Formerly ARCE 502.

ARCE 5521 Finite Element Method for Building Structures (3 units)

Term Typically Offered: SP

Prerequisite: ARCE 501 or ARCE 5511; and MATH 244, MATH 2341, or graduate standing.

Concepts of equilibrium and compatibility. Stiffness and flexibility properties of various types of finite elements. Development and application of displacement and force methods. Elastic stability and response of buildings to earthquake, wind, and moving loads. Use of finite-element computer programs. 3 lectures. Formerly ARCE 504.

ARCE 5522 Performance-Based Structural Systems Behavior (3 units)

Term Typically Offered: SP

Prerequisite: ARCE 502 or ARCE 5512.

Design, performance, and construction issues related to structural systems. Further development of design and analysis techniques necessary for performance-based engineering of structural systems. Assessment of advantages and limitations of different structural forms and systems. 3 laboratories. Formerly ARCE 511.

ARCE 5570 Special Advanced Topics (1-3 units)

Term Typically Offered: TBD

Prerequisite: Graduate standing and consent of instructor.

Directed group study of special topics for graduate students. The Class Schedule will list topic selected. Repeatable up to 6 units. 1 to 3 lectures. Formerly ARCE 570.

ARCE 5571 Special Advanced Laboratory (1-3 units)

Term Typically Offered: TBD

Prerequisite: Graduate standing and consent of instructor.

Directed group laboratory study of special topics for advanced students. The Class Schedule will list topic selected. Repeatable up to 6 units. 1 to 3 laboratories. Formerly ARCE 571.

ARCE 5582 Advanced Structural Systems (3 units)

Term Typically Offered: TBD

Prerequisite: ARCE 483, ARCE 4413, or graduate standing.

Concepts and issues involved in the linear and non-linear design of complex structures including tall buildings, long-span structures and advanced seismic systems. 2 lectures, 1 laboratory. Formerly ARCE 546.

ARCE 5583 Advanced Reinforced Concrete Design (3 units)

Term Typically Offered: TBD

Prerequisite: Graduate standing.

Advanced topics in the design of reinforced concrete structures with emphasis on foundations, retaining and shear walls, moment frames and two-way slabs. 2 lectures, 1 laboratory.

ARCE 5584 Prestressed Concrete Design (3 units)

Term Typically Offered: TBD

Prerequisite: Graduate standing and consent of instructor.

Design and analysis of prestressed concrete elements and structures. 2 lectures, 1 laboratory.

ARCE 5586 Seismic Rehabilitation (3 units)

Term Typically Offered: SP

Prerequisite: ARCE 301 or ARCE 3331; ARCE 303 or ARCE 3341; ARCE 483 or ARCE 4413; and ARCE 444 or ARCE 4461.

Introduction to the seismic rehabilitation process and philosophy. Evaluation and analysis of existing buildings to determine expected performance due to seismic demands. Development of basic seismic rehabilitation strategies for buildings. 2 lectures, 1 laboratory. Formerly ARCE 548.

ARCE 5597 Comprehensive Examination (0 units)

Term Typically Offered: SP

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Culminating exam for master's in Architectural Engineering demonstrating independent thinking using material focused on the core program courses. Scheduled in the final semester of the graduate program. Credit/No Credit grading only.

ARCE 5598 Project (3 units)

Term Typically Offered: F, SP

Prerequisite: Graduate standing.

Independent development, research, and conclusion of a graduate project by individuals or teams specializing in the area of architectural or structural engineering. Projects may include graduate students from other disciplines. Repeatable up to 6 units. Formerly ARCE 598.