

## 2011-13 Cal Poly Catalog

### Architectural Engineering Department

#### ARCE-ARCHITECTURAL ENGINEERING

Note: All ARCE majors must obtain a grade of C- or better in ARCE courses that are prerequisites for other ARCE courses.

##### ARCE 211 Structures I (3)

Introduction to the role of structures in the making of buildings. Introduction to statics and creation of simple three-dimensional structures. Development of skills to analyze structures composed of axial force (truss) members. 2 lectures, 1 activity. Prerequisite: For ARCE majors: PHYS 141, MATH 142; for ARCH and CM majors: PHYS 121 or PHYS 141, MATH 142 or MATH 182.

##### ARCE 212 Structures II (3)

Introduction to the role of structures in the making of buildings. Introduction to shear and moment diagrams using the principles of statics and the application of the diagrams to simple three-dimensional structures. Development of skills, particularly free body diagrams, to analyze structures composed of bending (beams) members. 2 lectures, 1 activity. Prerequisite: ARCE 211.

##### ARCE 221 Elementary Structures (3)

Forces on building structures. Static equilibrium and stability of structural systems. Shear and bending moment diagrams. 3 lectures. Prerequisite: PHYS 141, MATH 142.

##### ARCE 222 Introduction to Mechanics of Structural Members (3)

Stress-strain relationships. Stresses and deformations in structural members due to axial force, shear, torsion, and moment. 3 lectures. Prerequisite: ARCE 221.

##### ARCE 223 Mechanics of Structural Members (3)

Advanced topics of stresses in beams. Plastic bending, unsymmetrical bending. Combined stresses. Stress transformation. Buckling. Deflection of beams. 3 lectures. Prerequisite: ARCE 212 or ARCE 222. Concurrent for ARCE majors: ARCE 224 and ARCE 351.

**ARCE 224 Mechanics of Structural Members Laboratory (1)** 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. Concurrent: ARCE 223.

##### ARCE 225 Dynamics (3)

Dynamics of particles and rigid bodies. Introduction to vibrations of spring/mass/damper systems. 3 lectures. Prerequisite: ARCE 211 or ARCE 221 and MATH 241.

##### ARCE 226 Structural Systems for Architects (3)

Description, behavior and comparison of structural building systems. Concepts of structural stability, load flow, framing schemes and building configuration related to vertical and lateral loads. For architecture and construction management students. 3 lectures. Prerequisite: ARCE 212 or ARCE 222.

##### ARCE 227 Structures III (2)

Continuation of selected concepts covered in ARCE 211 and ARCE 212. Advanced topics in two-dimensional and three-dimensional equilibrium of structural building systems. 2 lectures. Prerequisite: ARCE 222 or ARCE 212.

##### ARCE 240 Additional Engineering Laboratory (1-2)

Total credit limited to 4 units, with a maximum of 2 units per quarter. 1 or 2 laboratories.

##### ARCE 257 Structural CAD for Building Design (2)

Emphasis on the use of computer graphics software to represent a building's structural system and its individual elements. 1 lecture, 1 laboratory. Prerequisite: ARCH 133, CM 115.

##### ARCE 260 History of Structures (4) C3

Social, symbolic, and technical importance of landmark structures. Analysis of breakthrough ideas that led to major advances in building design. Contextualization of these advances. Tools by which to assess and critique structural art as a separate and distinct art form. 4 lectures. Fulfills GE C3.

*New course, effective Summer 2012.*

##### ARCE 270 Selected Topics (1-4)

Directed group study of selected topics. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Open to undergraduate students and consent of instructor.

##### ARCE 302 Structural Analysis (4)

Analysis of statically indeterminate structures using virtual work, slope deflection, the force method and moment distribution. Analysis of structural systems using approximate methods and influence lines. 4 lectures. Prerequisite: ARCE 223 and ARCE 227. Concurrent for ARCE majors: ARCE 352.

##### ARCE 303 Steel Design I (3)

Analysis and design of steel structural members subjected to bending, shear and axial forces. 3 lectures. Prerequisite: ARCE 223. Corequisite for ARCE majors: ARCE 371. Corequisite for ARCE minors: ARCE 226.

##### ARCE 304 Timber Design (3)

Analysis and design of timber structural members subjected to bending, shear, and axial forces. Wood diaphragms, shear walls and their connections. 3 lectures. Prerequisite: For ARCE majors: ARCE 371. For ARCE minors: ARCE 223 and ARCE 226.

##### ARCE 305 Masonry Design (2)

Design of load-bearing walls, shear walls, columns and beams in masonry. 2 lectures. Prerequisite: For ARCE majors: ARCE 371. For ARCE minors: ARCE 223 and ARCE 226.

##### ARCE 306 Matrix Analysis of Structures (3)

Analysis of statically indeterminate structures by direct stiffness method including continuous beams, plane trusses, and frames. Introduction to finite-element methods. 3 lectures. Prerequisite: ARCE 302. Concurrent: ARCE 353.

##### ARCE 311 Structures for Landscape Architects (3)

Structural concepts related to landscape architecture. Design of retaining walls, decks, trellises, bridges and large-scale covered spaces. 3 lectures.

##### ARCE 315 Small Scale Structures (4)

Introduction to structures that use timber and steel as the primary construction material. Introduction to gravity load carrying systems and lateral load resisting systems using steel and timber elements. Development of skills to analyze structures using free body diagrams and the concept of load flow. 4 lectures. Prerequisite: ARCE 226.

##### ARCE 316 Large Scale Structures (4)

Introduction to structures that use steel and concrete as the primary construction material. Introduction to gravity load carrying systems and lateral load resisting systems using steel and concrete elements. Development of skills to analyze structures using free body diagrams and the concept of load flow. 4 lectures. Prerequisite: ARCE 315.

##### ARCE 351 Structural Computing Analysis I (1)

Computer calculations, programming basics and technical reporting. Emphasis on use of spreadsheets as a tool to analyze structural elements. 1 laboratory. Prerequisite: ARCE 212 or ARCE 222. Concurrent: ARCE 223.

##### ARCE 352 Structural Computing Analysis II (1)

Computer calculations, programming and technical reporting. Emphasis on use of two-dimensional structural analysis software to analyze a building's structural system and its individual elements. 1 laboratory. Concurrent: ARCE 302.

##### ARCE 353 Structural Computing Analysis III (1)

Emphasis on the use of nonplanar structural analysis software to analyze a building's structural system and its individual elements. 1 laboratory. Prerequisite: ARCE 352. Concurrent: ARCE 306.

##### ARCE 354 Numerical Analysis Laboratory (1)

An intensive survey of numerical analysis techniques used for solving engineering problems. Topics include integration, ordinary differential equations, and the eigenproblem. 1 laboratory. Prerequisite: MATH 244 and ARCE 353. Concurrent: ARCE 412.

##### ARCE 371 Structural Systems Laboratory (3)

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. 3 laboratories. Prerequisite: ARCE 223, ARCE 227, and third year standing in Architectural Engineering. Corequisite: ARCE 302.

##### ARCE 372 Steel Structures Design Laboratory (3)

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. 3 laboratories. Prerequisite: ARCE 257, ARCE 302, ARCE 303, ARCE 352 and ARCE 371. Cannot be taken concurrently with ARCE 451 or ARCE 452.

**ARCE 400 Special Problems for Advanced Undergraduates (1–3)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 6 units, with a maximum of 3 units per quarter. Prerequisite: Consent of instructor and department head.

**ARCE 403 Advanced Steel Structures Laboratory (3)**

Advanced topics in design and construction of steel structures, such as: plate girders, plastic design of beams and frames, and composite beam design, load and resistance factor design, and advanced topics related to moment frames and braced frames. 3 laboratories. Prerequisite: ARCE 372.

**ARCE 410 Integrated Building Envelopes (4)**

Multidisciplinary exploration of the value and collaboration required of an integrated project team approach to the design and construction of sophisticated building envelopes. Team taught by instructors and practitioners from each of the following disciplines: architecture, architectural engineering and construction management. 4 lectures. Prerequisite: Fourth year standing or consent of instructor. Recommended: Third year design and analysis courses; ARCE 302, ARCE 372.

**ARCE 412 Dynamics of Framed Structures (3)**

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. Prerequisite: ARCE 225 or ME 212, MATH 244, and ARCE 306. Concurrent: ARCE 354.

**ARCE 414 Precast Concrete (3)**

Precast and prestressed concrete principles, materials and techniques of construction. Design of basic precast elements and connections and prestressed concrete fundamentals as applied to precast concrete. Design potentials, aesthetics, cost and construction time as related to buildings and other structures. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 415 Interdisciplinary Capstone Project (5)**

Team based interdisciplinary capstone / senior project 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. 5 laboratories. Prerequisite: ARCE 303, ARCE 304, ARCE 305, ARCE 444, ARCE 372 or ARCE 451, or consent of instructor.

**ARCE 421 Soil Mechanics (3)**

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. 2 lectures, 1 laboratory. Prerequisite: ARCE 212 or ARCE 222, GEOL 201.

**ARCE 422 Foundation Design (3)**

Soil-bearing capacity; sizing and design of spread footings. Design and analysis of earth-retaining structures. Analysis of the stability of slopes. 3 lectures. Prerequisite: ARCE 421.

**ARCE 423 Advanced Foundation Design (3)**

Design, analysis, and construction issues related to shallow and deep foundation systems, mat foundations, retaining walls, and grade beams. Studies investigation the impact of sub-grade structural systems on building behavior and cost. 3 laboratories. Prerequisite: ARCE 422 and ARCE 444.

**ARCE 444 Reinforced Concrete Laboratory (3)**

Theory and design of basic reinforced concrete elements: non-slender columns, beams, tee beams and one way slabs. 3 laboratories. Prerequisite: ARCE 371 and ARCE 302.

**ARCE 445 Prestressed Concrete Design Laboratory (3)**

Design and analysis of prestressed concrete structures. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 446 Advanced Structural Systems Laboratory (3)**

Concepts and issues involved in the design of complex structures including tall buildings, shells, arches and tension structures. 3 laboratories. Prerequisite: ARCE 226 or ARCE 371.

**ARCE 447 Advanced Reinforced Concrete Laboratory (3)**

Advanced topics in the design of reinforced concrete structures with emphasis on isolated and combined foundations, retaining walls, seismic-resistant ductile frames and yield line theory. 3 laboratories. Prerequisite: ARCE 444.

**ARCE 448 Seismic Rehabilitation Laboratory (3)**

Overview of the general rehabilitation process and philosophy. Evaluation and analysis of existing structures to determine expected performance due to seismic loads. Development of basic rehabilitation strategies for buildings. 3

laboratories. Prerequisite: ARCE 303, ARCE 304, ARCE 305, ARCE 412, ARCE 444.

**ARCE 449 Cold Formed Steel Design Laboratory (3)**

Analysis and design of cold formed steel structural members subjected to bending, shear, and axial forces. Project based design and constructability of cold formed structural systems including gravity framing, diaphragms, shear walls and their connections. 3 laboratories. Prerequisite: ARCE 303 and ARCE 451.

**ARCE 451 Timber and Masonry Structures Design and Constructability Laboratory (3)**

Timber and masonry 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. 3 laboratories. Prerequisite: ARCE 257, ARCE 304, ARCE 305, and ARCE 371. Cannot be taken concurrently with ARCE 372 or ARCE 452.

**ARCE 452 Concrete Structures Design and Constructability Laboratory (3)**

Cast in place concrete 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. 3 laboratories. Prerequisite: ARCE 257, ARCE 444, and ARCE 372 or ARCE 451. Cannot be taken concurrently with ARCE 372 or ARCE 451.

**ARCE 453 Interdisciplinary Senior Project Laboratory (3)**

Interdisciplinary projects by interdisciplinary teams under faculty supervision that go beyond topics covered in the ARCE curriculum. Projects must include integration with other disciplines outside of structural or architectural engineering. 3 laboratories. Prerequisite: ARCE 372, ARCE 451, ARCE 452, ARCE 483 or consent of instructor and department head.

**ARCE 460 Collaborative Design Laboratory (2)**

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. Total credit limited to 4 units. 2 laboratories. Prerequisite: ARCE 372 or ARCE 451 and consent of instructor.

**ARCE 470 Selected Advanced Topics (1–4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

**ARCE 471 Selected Advanced Laboratory (1–4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**ARCE 473 Advanced Timber and Masonry Structures Laboratory (3)**

Emphasis on long span industrial/warehouse type buildings. Use of steel in timber/masonry construction and constructability. Holes in diaphragms, out-of-plane wall behavior and sub-diaphragms, perforated wood and masonry shear walls, pre-manufactured shear walls, masonry retaining walls, connections including post-installed anchors. 3 laboratories. Prerequisite: ARCE 372, ARCE 422, ARCE 444 and ARCE 451.

**ARCE 480 Senior Seminar (1)**

Discussion of selected topics that are of current interest to the structural engineering profession. 1 seminar. Prerequisite: Senior standing.

**ARCE 483 Seismic Analysis and Design (4)**

Introduction to dynamic response analysis of building structures with emphasis on earthquake ground motion. Earthquake resistant design of buildings in accordance with building codes. Application of computer programs and physical models for seismic design. Laboratory studies utilizing physical models for studying the behavior of building structures subjected to simulated ground motions. 3 lectures, 1 activity. Prerequisite: ARCE 372, ARCE 412.

**ARCE 485 Cooperative Education Experience (6) (CR/NC)**

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 for two consecutive quarters. Formal report and evaluation

by work supervisor required. No major credit allowed; total credit limited to 12 units. Credit/No Credit grading only. Credits to not count toward graduation in the ARCE Degree Program. Prerequisite: Sophomore standing and consent of department head.

**ARCE 490 History of Structures (3)**

Understanding the social, scientific, and symbolic importance of landmark structures. Emphasis on post industrial revolution structures; Gothic cathedrals also studied. 3 lectures. Prerequisite: Junior standing. *Course replaced by ARCE 260, effective Summer 2012.*

**ARCE 495 Cooperative Education Experience (12) (CR/NC)**

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 for two consecutive quarters. Formal report and evaluation by work supervisor required. No major credit allowed; total credit limited to 24 units. Credit/No Credit grading only. Credits to not count toward graduation in the ARCE Degree Program. Prerequisite: Sophomore standing and consent of instructor.

**ARCE 501 Advanced Structural Mechanics (3)**

Principles, concepts, and techniques of advanced structural mechanics. Studies of displacement, strain, stress, strain-displacement relation and constitutive models in three dimensions. Failure criteria. Introduction into energy principles and approximate solutions. 3 lectures. Prerequisite: ARCE 306, ARCE 353.

**ARCE 502 Nonlinear Structural Behavior I (3)**

Principles, concepts, and behavior of structures loaded beyond their linear-elastic limit. Elastic-plastic behavior of truss, beam, and frame structures. Buckling and post-buckling behavior of columns. Behavior of beam-columns and the principle of superposition. Second-order elastic behavior of frames. 3 lectures. Prerequisite: ARCE 306 and ARCE 353.

**ARCE 503 Nonlinear Structural Behavior II (3)**

Principles, concepts, and techniques of nonlinear structural analysis currently used in practice. Classification of nonlinear problem types. Investigation of typical iterative solution strategies. Studies in material and geometric nonlinearities in spring, truss, and frame elements. Use of current nonlinear analysis software. 3 lectures. Prerequisite: ARCE 502.

**ARCE 504 Finite Element Method for Building Structures (3)**

Basic 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 dynamic response of buildings to earthquake, wind, and moving loads. Use of finite-element computer programs. 3 seminars. Prerequisite: MATH 244, ARCE 306, ARCE 501.

**ARCE 511 Structural Systems Behavior (3)**

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. Prerequisite: ARCE 371, ARCE 403, ARCE 452, ARCE 483.

**ARCE 521 Architectural Structures (3)**

Static and dynamic loads, structural equilibrium and stability, structural configurations and systems, response to dynamic loads, behavior of structures. 2 seminars, 1 activity. Prerequisite: Graduate standing in Architecture.

**ARCE 522 Structural Systems (3)**

Exploration of the relationship between structural systems and architectural form. Understanding of structural stability and structural order is developed through construction of a series of small scale models. Historical perspectives are presented along with the effects of available materials and technology on structural possibilities. 3 seminars. Prerequisite: Graduate standing in Architecture.

**ARCE 523 Seismic Design for Architects (3)**

Introduction to the earthquake resistant design of buildings. Observed behavior of buildings during earthquakes. Recent developments of seismic design procedures, provisions, and building codes. Influence of architectural form on seismic response. 3 lectures. Prerequisite: Graduate standing in Architecture.

**ARCE 570 Selected Advanced Topics (1-4)**

Directed group study of selected topics for graduate students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1-4 lectures. Prerequisite: Graduate standing or consent of instructor.

**ARCE 571 Selected Advanced Laboratory (1-4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1-4 laboratories. Prerequisite: Graduate standing or consent of instructor.

**ARCE 598 Structural Engineering Design Project (3)**

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. Students shall enroll in 3 quarters. Total credit limited to 9 units. 3 laboratories. Prerequisite: ARCE 371, ARCE 403, ARCE 452, ARCE 483.