

## **REQUIREMENTS FOR THE M.S. DEGREE IN ENGINEERING**

### **General Requirement for Admission to the Program:**

1. Satisfaction of all requirements for admission to the University (see University catalog section regarding Graduate Programs).
2. A bachelor's degree in Engineering or in an allied field with some equivalency to Engineering from an accredited university or college.
3. Approval by the College of Engineering and Computer Science and the Department.

### **For Advancement to Classified Graduate Status:**

1. Satisfaction of University requirements for classified status (See University catalog section regarding Graduate Programs).
2. Completion of all requirements noted on individual admissions documents.
3. Submit tentative program of study to the CEAM graduate coordinator.
4. Approval by the Department Graduate Coordinator.

### **For the Degree:**

1. Satisfaction of University requirements for the M.S. Degree (see University catalog section regarding Graduate programs).
2. Completion of 30-33 units under the Thesis, Project, or the Comprehensive Examination Plan as follows:

#### **A. Thesis Plan (30 units)**

- i) 24 units of course work applicable to the M.S. degree; of which, at least 15 units must be taken in engineering courses at the 500-level or above.
- ii) an additional 6 units of CE or AM 698 (Thesis), and successful defense of Thesis.

#### **B. Project Plan (30 units)**

- i) 27 units of course work applicable to the M.S. degree; of which, at least 18 units must be taken in engineering courses at the 500-level or above.
- ii) an additional 3 units of CE or AM 698 (Graduate Project) culminating in a comprehensive report.

#### **C. Comprehensive Exam Plan (33 units)**

- i) 30 units of course work applicable to the M.S. degree; of which, at least 21 units must be taken in engineering courses at the 500-level or above.
- ii) an additional 3 units of CE or AM 697 Directed Comprehensive Study.

### **STRUCTURAL ENGINEERING OPTION SPECIAL REQUIREMENTS:**

1. Students entering the program are expected to have completed Soil Mechanics (CE 426) and Structures I (CE 335), Reinforced Concrete Design (CE 438), and Structural Steel Design (CE 439). Admitted students who have not completed such courses as part of an

undergraduate program must satisfactorily complete them prior to continuing in the program. These courses cannot be applied toward the formal degree program of study.

2. This program is intended primarily for students holding a B.S. in Civil Engineering or in a closely related field. Prospective students whose undergraduate degree is not in a closely related field should contact the Department in order to discuss additional prerequisite courses with a faculty advisor.
3. The total number of 400-level units in the formal program of study for students pursuing the Thesis, Project, or Comprehensive Examination Plans may not exceed 9.

## REQUIRED COURSES (30-33 UNITS)

1. **Culminating Experience** (3-6 units)
  - CE 697 Comprehensive Exam..... 3
- or**
- CE 698 Graduate Project (3) **or** Graduate Thesis (6)
2. **Required Core Courses** (0-7 units)
  - AM 410 Vibration Analysis ..... 3
  - CE 436/L Structures II and Lab ..... 3/1

**NOTE:** If AM 410 and CE 436 or equivalent were completed as part of an undergraduate degree program, additional Group I or Group II units must be included in the graduate program.

3. **Group I Courses** (12-15 units), selected with the guidance and prior approval of the faculty advisor and Department.
  - CE 526 Geotechnical Foundation Design..... 3
  - CE 638 Advanced Reinforced Concrete Design..... 3
  - CE 639 Advanced Structural Steel Design ..... 3
  - ME 501A Seminar in Engineering Analysis..... 3
  - CE 641 Earthquake Engineering..... 3
4. **Group II Courses** (12-15 units), selected with the guidance and prior approval of the faculty advisor and Department.
  - AM 610 Advanced Mechanical Vibrations..... 3
  - AM 618 Theory of Elastic Stability ..... 3
  - AM 619 Theory of Plates and Shells ..... 3
  - AM 636 Structural Dynamics ..... 3
  - AM 637 Optimum Structural Design..... 3
  - AM 640 Energy and Approximate Methods in  
Elastomechanics ..... 3
  - AM 642 Finite Element Method in Mechanics ..... 3
  - AM 644 Advanced Finite Element Methods..... 3
  - CE 437 Timber Design..... 3
  - CE 643 Foundation Design..... 3

## **COURSE LIST-APPLIED MECHANICS**

(See also related courses in engineering materials listed under Manufacturing Systems Engineering and Management.)

### **LOWER-DIVISION:**

**AM 196A-Z. EXPERIMENTAL TOPICS COURSES IN APPLIED MECHANICS (1-4)**

**AM 296A-Z. EXPERIMENTAL TOPICS COURSES IN APPLIED MECHANICS (1-4)**

### **UPPER-DIVISION:**

**AM 316. ENGINEERING DYNAMICS (3)**

**Prerequisites:** CE 240; MATH 280. **Corequisite:** AM 317. Vector calculus and kinematics, force, equations of motion, energy and momentum principles applied to the dynamic behavior of rigid and deformable solids. Design considerations. **(Design units: 0.5)**

**AM 317. MECHANICS LAB (1)**

**Prerequisites:** CE 340. **Corequisite:** AM 316. Experimental analysis of the responses of various configurations of deformable solids to static and dynamic forces. Design of mechanics experiments. One 3-hour lab per week. **(Design units: 0.5)**

**AM 396A-Z. EXPERIMENTAL TOPICS COURSES IN APPLIED MECHANICS (1-4)**

**AM 400A. APPLIED MECHANICS DESIGN CLINIC I (1-3)**

**Prerequisite:** Senior or graduate standing in Applied Mechanics or related discipline with senior or graduate program on file, acceptable academic record, and written approvals from faculty sponsor and Department Chair. **(Design units vary)**

**AM 400B. APPLIED MECHANICS DESIGN CLINIC II (1-3)**

**Prerequisite:** AM 400A. Continuation of AM 400A. **(Design units: varies)**

**AM 410. VIBRATION ANALYSIS (3)**

**Prerequisite:** AM 316; CE 340. Study of the vibratory motion of linear single degree of freedom systems. Equation of motion, free vibration response and transient and steady state excitation. Introduction to multi-degree-of-freedom systems. **(Design units: 0)**

**AM 421. AEROSTRUCTURES I (3)**

**Prerequisite:** CE 340. Introduction to basic theory of aircraft and missile structural analysis; torsion of multicell sections, elastic axis wing sections, warping of box beams, shear webs with web cut-outs; shear lag, origin of thermal stresses; external constraints, fundamental equations of uncoupled isotropic thermoelasticity and their applications in aircraft structures. **(Design units: 0)**

**AM 496A-Z. EXPERIMENTAL TOPICS COURSES IN APPLIED MECHANICS (1-4)**

**AM 499A-C. INDEPENDENT STUDY (1-3)**

**Prerequisite:** Senior or graduate standing in Applied Mechanics with senior or graduate program on file, and written approvals of faculty sponsor and Department Chair. Admission is based on evidence of ability to pursue independent study in depth and approval of a proposal submitted prior to registration in the course. **(Design units vary)**

## **GRADUATE LEVEL COURSES:**

(300-level courses in Applied Mechanics do not carry credit for a Master's degree in Engineering).

### **AM 509. METHODS OF APPLIED MECHANICS (3)**

**Prerequisites:** AM 316; MATH 280. Survey of methods used in Applied Mechanics. Emphasis on the formulation and solution of problems by the application of appropriate mathematical tools. Application of differential equations, matrix techniques, Fourier series, Laplace Transforms and energy methods to vibration, stability, elasticity and structures problems. **(Design units: 0)**

### **AM 610. ADVANCED MECHANICAL VIBRATIONS (3)**

**Prerequisite:** AM 410; CE 436. Vibration of multi-degree of freedom lumped parameter systems; formulation of equations of motion using Newton's 2nd law and analytical mechanics, determination of natural modes, response by the normal mode method. Emphasis on matrix formulation and computer applications. Exact solutions for continuous systems.

### **AM 618. THEORY OF ELASTIC STABILITY (3)**

**Prerequisite:** Instructor consent. Treatment of stability problems and the stability criteria. Elastic and inelastic buckling of bars, lateral buckling of beams, the stability of frameworks, buckling of rings, curved bars, arches, buckling of thin plates and thin shells, general theory of cylindrical shells, shells having the form of a surface of revolution.

### **AM 619. THEORY OF PLATES AND SHELLS (3)**

**Prerequisite:** Instructor consent. Cylindrical bending of uniformly loaded plates, symmetrical bending of circular plates, rectangular plates with various edge conditions, plates of various shapes, membrane theory of shells, general theory of cylindrical shells, shells having the form of a surface of revolution.

### **AM 621. AEROSTRUCTURE II (3)**

**Prerequisite:** AM 421. Analysis of semimonocoque aircraft structures. Stress, deflection and stability are considered for linear and nonlinear material behavior. Finite element methods are applied to continuous systems. Discussion of structural vibration loads and flutter.

### **AM 636. STRUCTURAL DYNAMICS (3)**

**Prerequisite:** AM 610. Vibration of structural systems with emphasis on approximate solutions to continuous systems; assumed modes, Rayleigh-Ritz, Finite Element Applications, nonlinear vibrations. Numerical techniques for computer application. Response spectra for multi-degree-of-freedom systems. Advanced topics.

### **AM 637. OPTIMUM STRUCTURAL DESIGN (3)**

Synthesis of structural components and systems employing parametric computer solutions. Applications to weight, cost, and trade-off criteria, including practical constraints on geometry. Least weight design of cable, column and beam elements and system of elements. Introduction to computer automated design and design space concepts. Examples from aerospace and civil engineering fields.

### **AM 640. ENERGY AND APPROXIMATE METHODS IN ELASTOMECHANICS (3)**

**Prerequisite:** Instructor consent. Theory and application of energy methods in continuous systems using the calculus of variations approach. Derivation of the total potential and complementary energy expressions via virtual work principles. The study of stability configurations of mechanical systems. Development and application of Castigliano's and Engesser's theorems.

Approximate methods using Rayleigh-Ritz, Galerkin, and Kantorovich formulations. Hamilton's principle and its applications.

**AM 642. FINITE ELEMENTS METHOD IN MECHANICS (3)**

**Prerequisites:** AM 410; CE 436. Study of structural mechanics problems by use of finite element method. Course will cover review of background information, formulation of the various basic elements, assemblage of elements and application of the method to selected topics in structural mechanics.

**AM 644. ADVANCED FINITE ELEMENT METHODS (3)**

**Prerequisite:** AM 642; instructor consent. Includes a brief review of the fundamentals of the finite element method; potential energy basis of finite elements; and isoparametric formulations. Applications of general civil and aerospace structures are considered, especially plates, general shells, vibration and stability analyses, and nonlinear problems in structural mechanics.

**AM 645. NONLINEAR MECHANICS (3)**

**Prerequisite:** AM 610. Introduction to nonlinear problems. Analytic approaches to some closed form solutions of nonlinear differential equations. Vibrations of systems subjected to nonlinear restoring forces. Nonlinear constitutive relations in elasticity. Poincare's method and Phase Plane plots for stable and unstable singular points. Routh Hurwitz Criteria, Conservative systems. Limit cycles, Lyapunov's direct method. Survey of perturbation techniques with time dependent coefficients. Mathieu's Equation, etc.

**AM 649. SEMINAR IN APPLIED MECHANICS (3)**

Advanced studies of topics of current interest in the field of applied mechanics. Consists, in part, of an intensive study of selected papers from current literature.

**AM 695A-Z. EXPERIMENTAL TOPICS COURSES IN APPLIED MECHANICS (1- 4)**

**AM 696A-C. DIRECTED GRADUATE RESEARCH (3)**

**Prerequisite:** AM 698; approvals of faculty advisor and either Department Graduate Coordinator or Department Chair.

**AM 697. DIRECTED COMPREHENSIVE STUDIES (3)**

(Credit/No Credit Only)

**AM 698. THESIS (6) OR GRADUATE PROJECT (3)**

**Prerequisite:** Advancement to candidacy for the MS degree and written approvals of faculty advisor and Department Graduate Coordinator or Department Chair.

**AM 699A-C. INDEPENDENT STUDY (1-3)**

**Prerequisite:** Classified status in the MS program and written approvals from faculty sponsor and Department Graduate Coordinator or Department Chair. Admission is based in part on evidence of the ability to pursue independent study or research in depth and approval of a proposal submitted prior to the time of registration.

## COURSE LIST-CIVIL ENGINEERING

### LOWER-DIVISION:

#### CE 196A-Z. EXPERIMENTAL TOPICS COURSES IN CIVIL ENGINEERING (1-4)

#### CE 208. ARCHITECTURE AND STRUCTURES (2)

Not available for credit towards an engineering degree. Non-technical treatment of the inter-relationships between form, strength, and stability. Fundamental concepts of structures and aesthetic aspects of structures. (Available for General Education, Section E, Applied Arts and Sciences)

#### CE 240. ENGINEERING STATICS (3)

**Prerequisite:** PHYS 220A/L. **Corequisite:** MATH 150B. Analysis of the distribution of forces on and within bodies in static equilibrium. Free body diagrams, equilibrium equations and the method of sections. Includes a limited introduction to the subject of strength of materials. **(Design units: 0)**

#### CE 280/L. COMPUTER APPLICATIONS IN CIVIL ENGINEERING and LAB (1/1)

**Prerequisite:** CE240. Development of computer skills related to the field of Civil Engineering. Introduction of Windows, email and internet usage. Introduction to Office suite, word processing, spreadsheets with VBA applications, presentation and publishing softwares. Development of programming skills. Application of CAD to the development of structural and architectural drawings, dimensioning, grading plans, contour lines, sections. Analysis and design of structural systems using structural engineering packages. Development of algorithms and computer codes for the solution of Civil Engineering problems. 1 hour of lecture and 3 hours of lab per week.

#### CE 296A-Z. EXPERIMENTAL TOPICS COURSES IN CIVIL ENGINEERING (1-4)

### UPPER-DIVISION:

#### CE 308/L. SURVEYING and LAB (2/1)

**Corequisite:** 308L. Fundamentals of plane and geodetic surveying. Concepts of linear and angular measurements, precision, errors and corrections. Field problems in chaining, differential and profile leveling, triangulation and highway curves. 2 hours lecture; one 3-hour lab. **(Design units: 0)**

#### CE 335/L. STRUCTURES I and COMPUTATIONAL LAB (3/1)

**Prerequisite:** CE 340. **Corequisite:** CE 335. Determination of the force distribution and deflections in statically determinant and indeterminant structures using the classical, non-matrix methods of structural analysis. **LAB:** Structural analysis problem solving session. Computer applications of structural analysis and design. 3 hours of laboratory per week. **(Design units: 0)**

#### CE 340. STRENGTH OF MATERIALS (3)

**Prerequisite:** CE 240; MATH 280. Analysis of the stresses and deflections in members and basic structural systems. Axial, torsional, bending and shear stresses and deflections. Introduction to structural stability. Design of structural components. **(Design units: 0.5)**

#### CE 396A-Z. EXPERIMENTAL TOPICS COURSES IN CIVIL ENGINEERING (1-4)

**CE 400A. CIVIL ENGINEERING DESIGN CLINIC I (1-3)**

**Prerequisite:** Senior or graduate standing in Civil Engineering or related discipline with senior or graduate program on file, acceptable academic record, and written approvals from faculty sponsor and Department Chair. (Design units vary)

**CE 400B. CIVIL ENGINEERING DESIGN CLINIC II (1- 3)**

**Prerequisite:** CE 400A. Continuation of CE 400A. (Design units vary)

**CE 408/L. SURVEYING WITH GPS APPLICATIONS and LAB (1/1)**

**Prerequisites:** CE 308/L. **Corequisite:** 408L. Surveying with Global Positioning Systems (GPS): point positioning, differential positioning, differencing techniques, survey planning, real-time kinematic (RTK) surveys, vertical positioning, random errors and survey specifications, horizontal curves, vertical curves, horizontal control and vertical control. 1 hour lecture; 3 hours lab per week. (Design Units: 0)

**CE 426/L. SOIL MECHANICS and LAB (3/1)**

**Corequisite 426L.** Soil as a foundation for structures and as a material of construction. Lab experiments to be performed to obtain data to determine soil physical properties. 3 hours lecture; 3 hours lab per week. (Design units: 1)

**CE 433/L. TRANSPORTATION SYSTEMS and LAB (2/1)**

**Prerequisite:** MSE 304. Principles, theories and practices in transportation engineering, administration and financing, planning surveys and data analysis; traffic flow, location and geometric design of systems, urban planning and mass transportation. Problems in planning, design and operations. 2 hours lecture; 3 hours design lab per week. (Design units: 1)

**CE 434. CONSTRUCTION PRACTICES AND MATERIALS (2/1)**

**Prerequisite:** Senior standing in engineering. Overview of engineering construction materials and practices from site preparation to final project completion. Job planning, costs, specifications, equipment and material selection, excavation, hauling, compaction, erection techniques, and other related construction practices and equipment. 2 hours lecture; 3 hours lab per week. (Design units: 1)

**CE 436/L. STRUCTURES II and LAB (3/1)**

**Prerequisite:** CE 335. **Corequisite 436L.** Study of structural analysis and design problems using matrix methods. Complete development of the flexibility and stiffness methods of analysis. Computer applications to structural analysis and design. 3 hours lecture; 3 hours lab per week. (Design units: 1.5)

**CE 437. TIMBER DESIGN (3)**

**Prerequisite:** CE 335. Elements of timber design. Timber tension members, beams, column and connections. Special systems of plywood diaphragms and shear walls for seismic loads. Temporary construction structures, formwork, shoring. Design of a typical timber building. 3 hours lecture. (Design units: 3)

**CE 438. REINFORCED CONCRETE DESIGN (3)**

**Prerequisite:** CE 335. Basic concepts in the design of reinforced concrete structures. Applications to beams, columns, slabs, shear walls, footing, and composite construction. (Design units: 3)

**CE 439. STRUCTURAL STEEL DESIGN (3)**

**Prerequisite:** CE 335. Basic concepts in the design of steel structures. Design in steel of tension and compression members, beams, columns, welded and bolted connections; eccentrically loaded and moment resistant joints; plate girders. Introduction to computer-aided design. **(Design units: 3)**

**CE 460/L. ENGINEERING HYDROLOGY and LAB (2/1)**

**Prerequisite:** ME 390. **Corequisite 460L.** Surface Hydrology for the design of drainage, flood control, water storage and distribution systems. Topics include hydrologic cycle, meteorology, surface and ground water movement, interrelation between precipitation and runoff; hydrograph analysis, flood routing, risk assessment. Hydrologic model development and analysis using computers emphasized for design of storm drainage systems, flood protection, water storage and reservoir operations. 2 lecture hours; one 3-hour lab. **(Design units: 1)**

**CE 487. WATER POLLUTION (3)**

Recommended Corequisite: ME 490 or 493. Design of engineering systems for control of water pollution. Treatment of industrial wastes. Municipal waste-water treatment. **(Design units: 1)**

**CE 488A/L. CIVIL ENGINEERING SENIOR DESIGN I and LAB (1/1)**

**Prerequisite:** Senior class standing with senior program on file. **Corequisite 488AL.** 1st semester of a 2-semester sequence capstone design experience simulating professional practice in civil engineering. (CE 488A and CE 488B must be completed within the same academic year.) Undertakes the preliminary design of a complex engineering project. Addresses ethics of engineering practice, professional life-long learning requirements, written and oral engineering design project presentations, and methods of technical problem solving. (Offered fall semester.) 1 hour lecture; 3 hours lab per week. **(Design units: 1)**

**CE 488B. CIVIL ENGINEERING SENIOR DESIGN II (2)**

**Prerequisite:** CE 488A. Continuation of CE 488A. (CE 488A and CE 488B must be completed within the same academic year.) Final design stage of the project initiated in CE 488A is undertaken, with emphasis on working in project teams. (Offered spring semester.) 6 hours of lab per week. **(Design units: 2)**

**CE 496A-Z. EXPERIMENTAL TOPICS COURSES IN CIVIL ENGINEERING (1-4)**

**CE 499A-C. INDEPENDENT STUDY (1-3)**

**Prerequisite:** Senior or graduate standing in Civil Engineering with senior or graduate program on file, and written approvals of faculty sponsor and Department Chair. Admission based on evidence of ability to pursue independent study in depth and approval of a proposal submitted prior to registration in the course. **(Design units vary)**

**GRADUATE LEVEL COURSES:**

(300-level courses in Civil Engineering do not carry credit for a Master's degree in Engineering)

**CE 526. GEOTECHNICAL FOUNDATION DESIGN (3)**

**Prerequisite:** CE 426. Soil mechanics aspects of foundation design. Shear strength and compressibility of soil. Lateral pressures and retaining structures. Strength and deformation laws for spread footings, piers, piles and caissons. Analysis of mat foundations. Eccentric and inclined foundation loads. **(Design units: 1.0)**

**CE 638. ADVANCED REINFORCED CONCRETE DESIGN (3)**

**Prerequisite:** CE 438. Advanced topics in concrete design, including frames and slabs.

**CE 639. ADVANCED STRUCTURAL STEEL DESIGN (3)**

Prerequisite: CE 439. Advanced topics in structural steel design such as frames, bridges, and buildings.

**CE 641. EARTHQUAKE ENGINEERING (3)**

**Prerequisites: AM 410; CE 335.** Study of the earthquake problem. Topics covered include plate tectonics, seismology, dynamic response of structures, dynamics of sites, and design for earthquakes.

**CE 643. FOUNDATION DESIGN (3)**

**Prerequisite: CE 438.** Design of foundations for structures. Topics include pile foundations, grade beams, continuous and mat footings and retaining walls.

**CE 649. SEMINAR IN CIVIL ENGINEERING (3)**

Advanced studies of topics of current interest in the field of civil engineering. The course will consist in part of an intensive study of selected papers from current literature.

**CE 695A-Z. EXPERIMENTAL TOPICS COURSES IN CIVIL ENGINEERING (1-4)**

**CE 696. DIRECTED GRADUATE RESEARCH (3)**

**Prerequisite: CE 698 and approvals of faculty advisor and either Department Graduate Coordinator or Department Chair.**

**CE 697. DIRECTED COMPREHENSIVE STUDIES (3)**

(Credit/No Credit Only)

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**Prerequisite: Advancement to candidacy for the MS degree and written approvals of faculty advisor and Department Graduate Coordinator or Department Chair.**

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