

## CE 430—Analysis of Indeterminate Structures

### Elective

**2007 Catalog Data:** CE 430 Analysis of Indeterminate Structures 3 Preq CE 330, Classical and matrix-stiffness methods for the analysis of trusses, beams, and frames; computer applications.

**Prerequisites:** CE 330

**Textbooks:** Sack, R.L., *Matrix Structural Analysis*, Waveland Press, Inc., 1994  
Hibbler, R.C., *Structural Analysis*, Sixth edition, Pearson Prentice Hall, 2006.

### Course Objectives:

By the end of the course, the student will be able to:

1. **Classical equilibrium methods**—Apply the slope-deflection equations to obtain reactions, shear forces and bending moments for beams and frames.
2. **Basic stiffness method**--Formulate the fundamental equations for the stiffness method using the governing equations. The basic formulations include those of the element stiffness matrix, coordinate transformations, structural stiffness matrix, and element force transformation matrices.
3. **Applications**--Apply the direct stiffness method to calculate displacements and member forces for simple and complex articulated systems involving trusses, beams, frames and three-dimensional structures subjected to loads, settlement, as well as, other initial and thermal strains.
4. **Special topics (time permitting)**—Apply matrix condensation approaches for substructural analysis and release of generalized element end forces. Determine coordinate transformations for constraint equations, nodal coordinates and offset nodes. Solve the equilibrium equations using Gauss elimination.
5. **Computation**—Use word processors to write reports, plus spreadsheets and applied mathematical software packages (e.g., matrix interpretive programs such as MATLAB) to solve for structural response.

### Topics:

1. Analysis using the slope-deflection method of beams and rigid frames.
2. Analysis using the displacement method of beams, plane frames, space trusses, and space frames subjected to static loads, settlement, thermal effects, and fabrication errors.

**Class Schedule:** Three fifty-minute sessions per week.

**Contribution of Course to meeting the Professional Component:** This course is an engineering topic, with contributions in engineering sciences and engineering design.

**Course Outcomes:** This course is contributing toward the following educational outcomes. The table below offers details by outcome.

Outcome	Role of CE 430
(1) A firm foundation and knowledge of mathematics, science, and engineering principles and the ability to apply the knowledge (Outcome a).	Knowledge from Mechanics of Materials, CE 330 and mathematics is applied to the evaluation and design of structural components and systems. Concepts of complementary virtual work are applied for computation of structural response.
(3) An ability to design a component, system or process to meet desired needs and imposed constraints (Outcome c).	A design project is assigned for a light-gauge steel frame building. This requires students to read and interpret plans, trace load paths and check the structural integrity of the components and system.
(4) The ability to think logically, critically, and creatively	The design project and other foci of the course require the students to idealize a structure and interpret the functions of the components and system.
(5) The ability to work in multidisciplinary teams	Students are required to work in teams for all assignments and the design project.
(6) The ability to identify formulate, and solve civil engineering problems (Outcome e).	Numerous homework exercises with various levels of difficulty are assigned. The design project requires students to interpret plans, and idealize the components and system behavior.
(7) The ability to use appropriate modern techniques, skills, and tools, including computer applications necessary for engineering practice (Outcome k).	The software MATLAB is used throughout the course.
(8) An understanding of professional ethics and integrity and an engineer's responsibilities to the profession and society (Outcome f).	Professional philosophy and responsibility is stressed throughout the course through anecdotal information and the emphasis on public safety.
(9) The ability to communicate effectively in written, oral, and graphical forms (Outcome g).	Reports and assignments require text and annotated output. Students working as teams are continually required to communicate by written and oral modes.
(10) Recognition of the importance of life-long learning and the benefits of being active in professional societies such as ASCE (Outcome i)	Students are encouraged to attend student chapter meetings and participate in concrete canoe and bridge competitions sponsored by ASCE. Through anecdotal information students are encouraged to seek licensure and are made aware of the need for advanced and continuous learning.

Prepared by: Ronald L. Sack, June 2007