SE 130A: STRUCTURAL ANALYSIS

1. Catalog Description

Classical methods of analysis for statically indeterminate structures. Development of computer codes for the analysis of civil, mechanical, and aerospace structures from the matrix formulation of the classical structural theory, through the direct stiffness formulation, to production-type structural analysis programs.

2. Prerequisites

SE 110A or MAE 131A. Priority enrollment given to structural engineering majors.

3. Textbook and Other Required Materials

Textbook: K.M. Leet, C.M. Uang, and A. Gilbert, *Fundamentals of Structural Analysis*, McGraw-Hill, 3rd edition, 2008.

4. Course Outcomes

Letters in parentheses relate to the course outcomes.

To quantify safety and functionality of man-made structures, structural analysis is the primary tool to determine the internal force and displacement response of a structural system under a set of loads (concentrated or distributed loads, thermal loads, support settlements, initial stress/strain). Classical methods of analysis of determinate and indeterminate truss, beam and frame systems are presented in both flexibility and stiffness forms. Students also learn how to sketch the deflected shape and use the approximate analysis methods to verify exact or computer solution. The objective of SE 130A is to provide students with the necessary tools and an understanding of these tools from basic principles to analyze structural system. (a, c, d, e, f, j)

5. Topics Covered

a. Review of Statics
   - Reactions
   - Determinate Trusses
   - Determinate Beams and Frames
   - Sketch of Deflected Shapes

b. Deflections of Beams And Frames
   - Moment-Area Method
   - Conjugate Beam Method

c. Flexibility Method
   - Concept of Redundant
   - Fundamentals of Flexibility Method
   - Support Settlements, Temperature Change, and Fabrication Errors
   - Beams on Elastic Support

d. Slope-Deflection Method
   - Slope-Deflection Equations
   - Indeterminate Frames without Joint Translation
   - Indeterminate Frames with Joint Translation

e. Moment Distribution Method

- Locking and Unlocking Process
- Fixed End Moment, Distribution Factor, Carry-Over Factor
- Moment Distribution of Continuous Beams and Frames without Joint Translation
- Modified Stiffness Factor
- Moment Distribution with Joint Translation

f. Influence Lines
- Concept of Influence Lines for Moving Loads
- Influence Lines for Determinate Structures
- Influence Lines for Indeterminate Structures
- Muller-Breslau Principle

g. Approximate Analysis of Multistory Frames
- Analysis of Continuous Beams and Trusses
- Analysis of Unbraced Frames for Gravity Load
- Analysis of Unbraced Frames for Lateral Load: Portal Method and Cantilever Method

6. Class/Laboratory Schedule

Lectures: 4 hours of classroom instruction per week.

7. Method of Assessment and Evaluation

a. Students have to complete 7 homework assignments by hand calculations. Although students will learn the basis and the use of a commercial structural analysis software (SAP 2000) in SE 130B, a student version of another commercial software (RISA-2D) is given to students such that they can compare their hand calculated solution of indeterminate structures with the computer solution. Students are encouraged to check and compare homework assignments with each other or work in teams. However, each student has to submit separate homework solutions since grading is also based on "engineering quality" presentation (figures, calcs, graphs, etc.).

b. There are two midterms and a final comprehensive examination. All exams evaluate the student's understanding of the basic principles and competence in applying structural analysis principles to solve truss, beam and frame problems.

c. The weights of the individual class activities are: homework assignments 15%, each midterm exam 25%, and final exam 35%.

8. Relationship of Course to Program Objectives

Letters in parentheses relate to the program educational outcomes.

SE 130A and B contribute to the core structural analysis sequence for the SE curriculum. Structural Analysis is introduced as one of the core tools in the Structural Design process, which allows the quantitative evaluation of safety and functionality of structural members, subassemblages and systems (a, e, i, j). During the course, emphasis is given to the need for full and traceable documentation of calculations and analysis assumptions in support of the structural design with special recognition of clean graphical and engineering quality presentation of the analysis results (g). The students are required to learn both simple hand calculations as well as computer based

structural analysis techniques and ways to compare and check results (a, e, k). Typically, each homework problem assigned requires the formulation of its solution based on the fundamental principles of equilibrium (statics), kinematics (geometry) and constitutive laws (force-deformation relations) (a, e). SE130A focuses on classical methods of structural analysis based on both the flexibility and stiffness methods. Students learn how to apply the theories by hand calculations on small size problems and how to compare the results with black-box computer solutions (k).

9. Contribution of Course to Meeting the Professional Component

The professional component of Structural Engineering is addressed in two major ways, (1) by establishing structural analysis as the fundamental tool to assess safety and functionality of the structure and (2) by providing the analytical documentation in engineering quality from where a full record of assumptions and analysis steps provides a fully traceable record. Finally, the need to check the analysis results is emphasized by this course and practiced with every example/homework assignment.

10. Persons Who Prepared Description and Date of Preparation: F. Seible 2/24/01; C.M. Uang 5/15/07; updated, C.M. Uang 6/5/2009