CIVIL 416 - MATRIX STRUCTURAL ANALYSIS
(15 Points, FC 2010)

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PHILOSOPHY & PURPOSE:
To provide:
1. An understanding of the principles of the Direct Stiffness Method of structural analysis, the basis of most structural and finite element analysis programs.
2. Experience in the application of a commercial structural analysis program (SAP2000) that implements the direct stiffness method, to a range of practical structures. An introduction to modelling techniques – overcoming some of the problems and pitfalls.
3. An introduction to the matrix formulation and solution of linear, nonlinear, stability and dynamic problems.

ASSESSMENT: 50% 3 hr exam
15% 1 hr test
35% coursework (4 assignments)

PRACTICAL: Computer work requiring the use of a structural analysis program.
Possible laboratory and field measurement of structural response.

COURSE OUTLINE:

1. *Discrete methods of analysis* versus the classical continuum approach. Review of the fundamental concepts of equilibrium, compatibility and constitutive relationships.
2. *Development of the direct stiffness method* and its application to linear analysis of skeletal structures such as trusses and frames. Techniques to deal with the lack of fit, temperature effects, internal releases and prescribed displacements.
3. *The application of stationary principles* to finite element analysis. The general development of 2D and 3D elements and iso-parametric formulations.
4. *Nonlinear and stability analysis:* sources of nonlinearity in structures, material nonlinearity, finite displacement and geometric nonlinearity, contact nonlinearity, plastic collapse, calculation of critical loads and post-buckling behaviour and general solution techniques.
5. *Dynamic analysis of large structural systems using matrix methods*, matrix implementation of time stepping algorithms such as constant average acceleration, Wilson-θ and Chang's explicit algorithms for time history analysis.

TEXTS:

Cook, R.D. *Concepts and Applications of Finite Element Analysis*, John Wiley 1981. (Good for basic understanding of the Direct Stiffness Method, covers more than needed for this course - expensive).
Chopra, A. K. *Dynamics of Structures*, Prentice Hall 1995. (covers more than this course needs)
Felippa, C.A. Introduction to Finite Element Methods, Online textbook, Available freely from http://www.colorado.edu/engineering/CAS/courses.d/IFEM.d/Home.html (course book style, very easy to read)
Wilson, E. L. *Three Dimensional Static and Dynamic Analysis of Structures: A Physical Approach with emphasis on Earthquake Engineering*, CSI 1998. (author also created the SAP program code)