Department of Civil Engineering
Faculty of Engineering
Chulalongkorn University

Course Syllabus

1. Course number:	2101-611
2. Credits:	3
3. Course title:	Matrix Analysis of Structures
4. Faculty/Department:	Faculty of Engineering
	Department of Civil Engineering
5. Semester:	Second semester
6. Academic year:	2004
7. Instructors:	Prof. Dr. Panitan Lukkunaprasit
	Assist. Prof. Dr. Roengdeja Rajatabhothi
	Dr. Chatpan Chintanapakdee
8. Prerequisites:	2101-601 Advanced Structural Theory
9. Course status:	Approved elective
10. Program name:	Master of Engineering or Ph.D.
11. Level:	Graduate
12. Hours per week:	3 hours of lecture

13. Course content:

Basic structure of computer programs for matrix analysis of structures; 3-d truss; Grid structures; Space frames; Sub-structure method; Non-prismatic members; Analysis of 2-d and 3-d multi-story buildings; Initial strain problems; Differential column shortening in tall buildings; Simplified analysis to consider torsion of buildings; Nonlinear analysis including geometric and material nonlinearity; Application of SAP2000 or ETABS to analyze elastic and inelastic structures and checking results.

14. Course description:

14.1 Objectives:

Upon completing the course, students should fully understand the important concepts, implementation, and applications of structural analysis using matrix formulation. They should be able to apply the methods to analyze and ultimately develop the skills to understand behaviors of large and complex structures.

14.2 Course outline:

Week 1-7	**Matrix Formulation of Stiffness Method for Truss Analysis** • Preliminaries • Analysis of Deformations: Linear and Nonlinear Geometry • Member Deformation - Joint Displacement Equations • Generation of Geometric Transformation Matrix ***A*** • Member Force - Member Deformation Equations • Member Force - Joint Displacement Equations • Joint Force Equilibrium Equations • Coordinate Transformation for Arbitrary Restraint Directions • Direct Stiffness Method • Effect of Joint Numbering on Bandwidth • Introduction of Boundary Conditions • Treatment of Fully and Partially Restrained Joints • Methods of Solving Governing Equations **Specialized-Member Stiffness Matrices** • Beam Member • Frame Member • Grid Member • Space Frame Member • Transformation of Coordinates • Vertical Members **Substructuring Techniques** • Algorithm for Partial Condensation • Multi-Level Substructuring • Frontal Method • Pre-Front Procedure • Data Management • Frontal Assembly • Frontal Reduction and Backward Substitution • Substructuring

Week 8-12	**Analysis of 2-d and 3-d multi-story buildings**
	• Frame-shear wall interaction
	• Examples of tall building systems
	• General concept of analysis
	• Members with rigid zones
	• Shear wall members
	• Analysis of large multi-story buildings using sub-structure method
	  • Symmetrical structures
	  • Unsymmetrical structures

	Simplified analysis to consider torsion of buildings • Rigid floor diaphragm • Concept of center of rigidity **Initial strain problems (Temperature change, creep, shrinkage, etc.)** • Differential column shortening in tall buildings

Week 13-16	**Non-prismatic members**
	• Stiffness matrices
	• Fixed-end moments
	
	Nonlinear analysis of structures
	• Geometric nonlinearity
	  • Analysis of structures with large displacements
	  • P-delta effects
	• Material nonlinearity
	• Nonlinear static analysis (pushover analysis)
	
	Application of SAP2000 to solve problems, checking of results
	• Linear elastic structures
	• Inelastic structures

14.3 Teaching method: Lecture

14.4 Media: Board and transparencies

14.5 Evaluation:

Assignments	=	15%
Term project	=	10%
Midterm I	=	15%
Midterm II	=	15%
Final exam	=	45%
Total	=	100%

15. References:

McGuire, W., Gallagher R.H., and Ziemian, R.D., "Matrix Structural Analysis," Second Edition, John Wiley and Sons, Inc., 2000.

Ghali, A., Neville, A.M., "Structural Analysis—A Unified Classical and Matrix Approach," Second edition, Chapman and Hall, London, 1978.

Sack, R.L., “Matrix Structural Analysis,” PWS-KENT, Boston, 1989.

McCormac, J.C., Nelson, J.K., “Structural Analysis—A Classical and Matrix Approach,” Second Edition, Addison-Wesley, 1996.

Tartaglione, L.C., “Structural Analysis,” International Edition, McGraw-Hill, Singapore, 1991