

**EM 727: Theory of Elastic Stability**  
**Fall Semester 2008**  
**Department of Aerospace Engineering & Engineering Mechanics**  
**San Diego State University**

**Catalog Description:** Stability of elastic systems. Differential equations of stability by summation of forces and moments, and by the variational method. Applications. Prerequisites: Engineering Mechanics 621.

**Course Description:** Stability of elastic structural components under conservative external loads. Concept of stability of equilibrium: bifurcation point buckling and limit point buckling. Stability analysis using dynamics and energy method. Critical load analysis by energy methods and by adjacent equilibrium. Variational methods for continuum structural models. Approximate analyses by the Rayleigh-Ritz and Galerkin methods. Applications to rigid discrete systems, beam columns, frames and plates.

**Meeting Time and Venue:** Monday and Wednesday 7:00 – 8:00 p.m. Engineering Bldg E-326.

**Instructor:** Dr. Satchi Venkataraman, Associate Professor, 309 Engineering Building, e-mail: [satchi@mail.sdsu.edu](mailto:satchi@mail.sdsu.edu)

**Office hours:** MTW 1:00-2:00 pm, and at other times by appointment only.

**Textbook:** Robert M. Jones, *Buckling of Bars, Plates, and Shells*, Bull Ridge Publishing, © 2006.

**Website:** The URL for the course web site is <http://blackboard.sdsu.edu>. You can access it using your RED ID and web portal access password. The website will be used to communicate reading assignments, homework, references, and useful links.

**Assessment and Grading:** The learning will be assessed through homework assignments, tests, class exercises, small projects and the final exam. The distribution of grades is as follows: Homework, Class exercises and projects: 30%, Exam 1: 25% Exam 2: 25% Final exam and/or project 20%. Exams will comprise of in-class and take-home parts. Final exam will be a combination of a written exam and a project.

**Homework:** Submissions for homework assignments can be handwritten solutions or computer generated. In either case it must be legible and detailed. In case of computer assignments, a computer print out alone is not acceptable. A summary of the solution, its implementation and a discussion of results must be submitted. Computer programs submitted must be commented or annotated with sufficient detail.

Students may discuss and work together, but assignments turned in for grading must represent their individual effort and learning. Students are discouraged from turning in homework late because this hinders the instructor from providing timely feedback. Therefore late homework will be only accepted up to one class period late with 20% penalty. In special and extenuating circumstances, the instructor will provide an exemption to this rule. All assignments submitted shall be considered graded work unless otherwise noted. All aspects of your coursework are covered by the honor system. You are expected to demonstrate professional integrity in all your academic work.

## List of References:

- Alfutov, N. A., *Stability of Elastic Structures*, Springer Verlag, 2000.
- Allen, H. G., and Bulson, P.S., *Background to Buckling*, McGraw Hill Book Company, 1980.
- Chen, W. F., and Lui, E. M., *Structural Stability: Theory and Implementation*, Elsevier Science Publishing Co, Inc, 1987.
- Brush, D. O., and Almroth, B. O., *Buckling of Bars, Plates and Shells*, Mc Graw Hill Co., 1975.
- Structural Stability in Engineering Practice*, Edited by Aljos Kollár, Taylor and Francis Group, 1999.
- Bazant, Z. P., and Cedolin, L., *Stability of Structures: Elastic, Inelastic, Fracture, and Damage Theories*, Dover Publications, 2003.
- George J. Simitses and Dewey H. Hodges, *Fundamentals of Structural Stability*, Butterworth-Heinemann, 2006.

## Outline of Course Topics

### I. Introduction to stability analysis

### II. Discrete Models (rigid bars and springs)

- Concept of multiple equilibrium configurations for a given load level, geometric nonlinearities
- Concept of pre-buckling conditions, pre-buckling configuration
- Linear buckling analysis
- Concepts of bifurcation, bifurcation point, symmetric bifurcation, asymmetric bifurcation
- Use of energy principles to study stability, change in total potential energy
- Concept of post-buckling
- Concept of limit point
- Use of dynamics to study stability
- Use of dynamics to move from one equilibrium solution to another

### III. Introduction to Variational Methods

### IV. Stability of Beams

- Derivation of the governing differential equations and boundary conditions
- Influence of boundary conditions
- Pre-buckling conditions
- Linear buckling analysis

### V. Introduction to the Rayleigh-Ritz Technique

### VI. Stability of Plates

- Derivation of governing equations and boundary conditions
- Pre-buckling conditions
- Application of the Rayleigh-Ritz technique/Kantorovich method