New Jersey Institute of Technology
Department of Civil & Environmental Engineering

Stability of Structures /
CE 636 / Fall 2016

Faculty: Rima Taher, PhD, PE
Senior University Lecturer

- **Type of Course:**

Graduate course - Lecture format – 3 credits – Online Instruction.

- **Course Overview:**

An understanding of structural stability is a special branch of engineering mechanics of importance to structural engineers whose job is to design safe structures. In a structure, a small change in load could cause a large change in displacement. If the change in displacement is large enough, or is in a critical member of the structure, a local or member instability could lead to a total collapse of the entire structure. Instability failures are often catastrophic.
This course examines how and under what loading condition, a structure passes from a stable state to an unstable one. The stability of different structural members and systems is analyzed. The course also includes a practical look at how theory translates into design methods implemented in design specifications. All major international design specifications include provisions based on stability theory. Attention is especially focused on steel structures. Compared to structures designed using other construction materials, steel structures rely to a greater extent on stability limit states.

- **Prerequisites/ Required Skills:**

Knowledge of the basics and principles of engineering mechanics and structural analysis & design is required. Some mathematical skills in calculus and differential equations are also expected.

- **Required Text:**

Structural Stability of Steel – Concepts and Applications for Structural Engineers, by Theodore V. Galambos and Andrea E. Surovek, John Wiley & Sons, 2008.
(ISBN # 978-0-470-03778-2)

- **References:**

    - Structural Stability – Theory and Implementation by W. F. Chen and E. M. Lui Prentice Hall, 1987.
    - Theory of Elastic Stability, 2nd Edition, by S. P. Timoshenko and J. M. Gere, McGraw Hill, 1961.
    - Stability of Structures under Static and Dynamic Loads, ASCE 1977.
    - Principle of Structural Stability Theory, by A. Chajes, Prentice Hall, 1974.
    - Strength of Metal Structures, by F. Bleich, McGraw Hill, 1952.

- **Course Requirements:**

Students are required to take two tests and a final exam in addition to a few homework assignments. Moodle will be used to deliver the online course and to submit tests and assignments. The Moodle site is http://moodle.njit.edu . Students can login with their UCID and password.

Homework assignments will be posted on Moodle at the end of each major subject. A PDF file outlining the assignment will be posted, and a link will be created on Moodle for the students to upload the assignment file by the due date and time. Students must have access to a scanner to scan their homework solution pages. All pages must be combined in a single PDF and uploaded to Moodle. Students are not to post files in formats other than PDF. The instructor must be able to open and read the files. If the file is corrupt or illegible, and the instructor is unable to read the file for some reason, the student will receive an F grade for that assignment. Students are not to email the assignments directly to the instructor.

The two tests and the final exam will be given on Moodle. Tentative test dates are given below. Students need to login a few minutes before the test time (6 pm). The test sheet containing the problems to solve will be posted in PDF format. Students have 2 hours to solve the problems (3 hours for the final exam), scan their solution sheets and upload their test to Moodle as a single PDF. Moodle will be set up to get locked at 8 pm (9 pm for the final exam) therefore it is important to upload the test solution by 8 pm. Students will not be permitted to email the test or any part of it directly to the instructor. The student work must be all stored on Moodle and any emailed test files will be declined and deleted.

All students are expected to take the tests at the scheduled time. No make-up test or exam will be given if students do not show up online as scheduled unless the student has a compelling and valid reason that can be substantiated. Proof of the hardship must be presented to the instructor and possibly to the Dean of Students.

Students enrolled in this course are not to schedule vacation and holiday trips while the course is ongoing and on dates that coincide with test dates. The course will end after the final exam is given. Airline tickets must not be booked before the final exam date. The final exam week is from December 15 to December 21.

- **Grading Criteria:**

Test 1: 25% - Tentative Date: TBD
Test 2: 25% - Tentative Date: TBD
Final examination: 30% - During the final exam week.
Assignments: 20% - Due dates will be announced and posted.

- **Academic Integrity**

The NJIT Honor Code will be upheld, and any violations will be brought to the immediate attention of the Dean of Students.

- **Instructor/ Contact Information & Office Hours:**

Rima Taher, PhD, PE, Senior University Lecturer

Office Number: Weston 521.

Office Hours: TBD

E-mail: rima.taher@njit.edu

Websites: http://moodle.njit.edu

www.taherengineering.com

- **Course Content and Weekly Schedule**

Week 1:
Introduction, Course Requirements, Grading Criteria
Introduction to Stability Theory
Review: External Work & Strain Energy – Principle of Virtual Work – Principle of Stationary Total Potential Energy

Week 2:
External Work and Strain Energy (Continued)
Fundamentals of Stability Theory: Spring-Bar System, Post-Buckling Behavior, Softening Spring-Bar Structure, Equilibrium Solutions, Virtual Work Method

Week 3:
Fundamentals of Stability Theory Continued: Spring-Bar System, Post-Buckling Behavior, Softening Spring-Bar Structure, Equilibrium Solutions, Virtual Work Method

Week 4:
Fundamentals of Stability Theory Continued
Snap-Through Buckling

Week 5:
Fundamentals of Stability Theory Continued:
Multi-Degree of Freedom Systems

Week 6:
Elastic Buckling of Planar Columns: Large Deflection Solution of an Elastic Column
Elastic Buckling of Planar Columns (Continued): Differential Equation of Planar Flexure, Pin-Ended Columns, Fundamental Column Cases – Examples

Week 7:
Elastic Buckling of Planar Columns (Continued): Differential Equation of Planar Flexure, Pin-Ended Columns, Fundamental Column Cases – Examples

Week 8:
Elastic Buckling of Planar Columns (Continued)
Inelastic Column Buckling

Week 9:
Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples

Week 10:

Stability of a Rigid Frame (Continued) – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples

Week 11:
Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples

Week 12:
Beam- Column Stability: Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples

Week 13:
Beam- Column Stability (Continued): Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples
11/24 and 11/25: Thanksgiving Recess

Week 14:
Beam- Column Stability: Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples

Week 15:
Lateral / Torsional Buckling - Specification-Based Applications of Stability in Steel Design
Review for the Final Exam

Final Exam Week