Spring 2021

CE 636-852: Mech. & Stability of Structures

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NJIT New Jersey's Science & Technology University

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CE 636-851 Mech. & Stability of Structures Spring 2021

Course Description:

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:

Prerequisite: undergraduate course in theory of structural analysis. Some 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.

Canvas:

Course will be delivered through Canvas at https://Canvas.njit.edu

Instructor:

Rima Taher, PhD, PE

Office: Weston 521 – Phone: 973-596-3015

Office Hours: Online by Teleconferencing or by Phone
Thursday from 12:30 to 1:30 pm or by appointment

Email: Taher@njit.edu

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:

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

Course Sections:

Week	Date	Topic/*Assignment*
1	1/19 to 1/23	Introduction, Course Requirements, Grading Criteria Introduction to Stability Theory Review: External Work & Strain Energy – Principle of Virtual Work – Principle of Stationary Total Potential Energy Brief Math Review: Differentiation and Integration
2	1/24 to 1/30	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
3	1/31 to 2/6	Fundamentals of Stability Theory Continued: Spring-Bar System, Post-Buckling Behavior, Softening Spring-Bar Structure, Equilibrium Solutions, Virtual Work Method
4	2/7 to 2/13	Fundamentals of Stability Theory Continued Snap-Through Buckling
5	2/15 to 2/20	Fundamentals of Stability Theory Continued: Multi-Degree of Freedom Systems
6	2/22 to 2/27	Brief Math Review: Differential Equations Elastic Buckling of Planar Columns: Large Deflection Solution of an Elastic Column **Test 1: Friday February 26 from 6:30 to 8:30 pm**

7	2/28 to 3/6	Elastic Buckling of Planar Columns (Continued): Differential Equation of Planar Flexure, Pin-Ended Columns, Fundamental Column Cases – Examples.
8	3/7 to 3/13	Elastic Buckling of Planar Columns (Continued) Pin-Ended Columns, Fundamental Column Cases – Examples Inelastic Column Buckling
9	3/14 to 3/20	**Spring Recess – No Class**
10	3/21 to 3/27	Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples
11	3/28 to 4/3	Stability of a Rigid Frame (Continued) – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples **Friday April 2nd: Good Friday – No Class**
12	4/4 to 4/10	**Last Day to Withdraw: Monday April 5** Stability of a Rigid Frame (Continued) – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples
13	4/11 to 4/17	Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples **Test 2: Monday April 12 from 6:30 to 8:30 pm**
14	4/18 to 4/24	Beam- Column Stability: Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples
15	4/25 to 5/1	Beam- Column Stability (Continued): Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples
16	5/2 to 5/8	Beam- Column Stability (Continued): Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples Review for the Final Exam **Last Day of Class at NJIT: Tuesday May 4 Follows a Friday Schedule** **Reading Day 1: Wednesday May 5** **Readng Day 2: Thursday May 6**
		Final Exam Week: from Friday May 7 to Thursday May 13

Grading Policy:

Online Test 1: 25% - Tentative Date: Friday February 26 from 6:30 to 8:30 pm
Online Test 2: 25% - Tentative Date: Monday April 12 from 6:30 to 8:30 pm
Online Final examination: 30% - During the final exam week, from May 7 to May 13
Assignments: 20% - Due dates will be announced and posted.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu.

Grading Scale:

A:	**100-90**
B+:	**89-85**
B:	**84-80**
C+:	**79-75**
C:	**74-70**
D:	**69-60**
F:	**Below 60**

Attendance Policy:

Lectures will be posted online twice per week. Students must login to the Canvas course-page to view the posted lectures and do the related work at their earliest convenient time after getting notified that some new material has been posted. The instructor will verify the attendance using the features available on Canvas to track the student's attendance and online activity in the course.

Withdrawals:

In order to insure consistency and fairness in application of the NJIT policy on withdrawals, student requests for withdrawals after the deadline will not be permitted unless extenuating circumstances (e.g., major family emergency or substantial medical difficulty) are documented. The course Professors and the Dean of Students are the principal points of contact for students considering withdrawals.

NJIT Honor Code:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: *http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf*.

Course Delivery and Requirements:

Canvas will be used to deliver the course material. The various tests and exams will be given online on Canvas. Students will have to submit the course assignments using Canvas as well. The Canvas site is http://canvas.njit.edu. Students need to login with their UCID and password. Generally, lectures will be posted twice a week. An email notification will be sent to the class via email or by posting on the course Forum by the instructor after a new lecture or some new material is posted. Students must check their NJIT email and the Canvas course-page on a regular basis.

Students are required to take two tests and a final exam in addition to a few homework assignments For the online tests and exams, the course requires the use of the Respondus LockDown Browser and Respondus Monitor + webcam, as it will be indicated prior to the date of the test or exam. Instructions and video lectures will be posted online to explain the procedures and how to use these testing tools and systems.

Students will generally have 2 hours to solve and submit the online tests and 3 hours for the final exam. Students will not be permitted to email the test or any part thereof directly to the instructor. The student work must be stored on Canvas and any emailed test files will be declined and deleted.

Tentative test dates are given in this syllabus. Due to the nature of the material in this course which is not suited for multiple-choice test questions, and after discussing this matter with the program director at the civil engineering department, it was determined that the most logical and most suitable format for the tests in this course is to set a window of a couple of hours for the students to take the tests online. All students are expected to take the test online at the same time. The tests will consist of a few problems to solve. Students are supposed to show the calculation work done to solve the problems.

Considering that some online students have a day job, the faculty was instructed by the department to schedule the tests in the evening hours. For this reason, both tests and the final exam are scheduled to start at 6:30 pm on the scheduled test dates.

Students who have a conflict with another course scheduled at the same time must contact the instructor to get a different test date and time. All excuses must be substantiated and only students with legitimate excuses can have a make- up test. Please note that business and vacation trips are not considered as legitimate excuses. Illnesses and other issues must be dealt with by the Office of the Dean of Students who will determine whether the excuses are legitimate or not. Students who do not show up online as scheduled for a test will not get a make-up test unless they have an excuse that can be substantiated.

Students enrolled in this course should not 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 May 7 to May 13.

Assignment Policy:

Homework assignments will be posted on Canvas at the end of each major subject. A PDF file outlining the assignment will be posted, and a link will be created on Canvas 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 into a single PDF and uploaded to Canvas. 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, the student will receive an F grade for that assignment. Students should not email the assignments directly to the instructor.

In addition to the formal assignments, some informal homework problems and test review problems will be posted by the instructor. It is important that students attempt to solve those problems before the solution is posted. Students do not have to upload any informal homework problems and test review problems. However, it is necessary for the students to solve these problems on their own first, because these informal problems are an integral part of the course material and are needed for a proper learning of the covered topics.

Syllabus Information:

The dates and topics of the syllabus are subject to change; however, students will be consulted with and must agree to any modifications or deviations from the syllabus throughout the course of the semester.

Email Policy:

Students may email their questions to the instructor however the instructor encourages the students to post any questions related to the course material to the Forum on the Canvas course-page. Posted questions and answers will be seen by the entire class.

Items Required for this Course:

1. A copy of the textbook in print. Students should not get an electronic copy because they will be locked in the test browser during tests and will not be permitted to open electronic files.
2. A regular scientific calculator. Cell phone calculators and other electronic devices will not be permitted during the test.
3. Test monitoring requires a webcam. The student must use a computer that has a built-in webcam otherwise the student must get a webcam and install it on the computer.
4. Students must have access to a printer and scanner, or a printer with scanning capability.

Outcomes Course Matrix –

Strategies, Actions and Assignments	ABET Student Outcomes (1-7)	Program Educational Objectives	Assessment Measures
Student Learning Outcome 1: Introduce the students to the fundamentals of stability theory			
Learn about External Work & Strain Energy – Principle of Virtual Work – Principle of Stationary Total Potential Energy Apply these Methods to Various Types of Systems	1, 2, 4, 7	1, 2	Assignments, tests and class lectures and discussions
Student Learning Outcome 2: Learn how stability theory is applied to both elastic and inelastic column buckling			
Learn about the Applications of Stability Theory to the Elastic Buckling of Planar Columns: Large Deflection Solution of an Elastic Column Develop the Differential Equation of Planar Flexure; Apply the Theory to Pin-Ended Columns, and Other Fundamental Column Cases – Use Examples.	1, 2, 4, 7	1, 2	Assignments, tests and class lectures and discussions

Student Learning Outcome 3: Learn how stability theory is applied to rigid frames and beam-columns			
Learn how Stability Theory is Applied to the Stability of a Rigid Frame – Examine the Boundary Conditions for Bracing Structures – Use Examples Learn how Stability Theory is Applied to the Stability of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Use Examples	1, 2, 4, 7	1, 2	Assignments, tests and class lectures and discussions

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our Program Educational Objectives are reflected in the achievements of our recent alumni:

1. Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward safe, practical, sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. Professional Growth: Alumni will advance their technical and interpersonal skills through professional growth and development activities such a graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.
3. Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of

engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies