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Fall 2019

CE 636-851: Mechanics & Stability of Structures

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JOHN A. REIF, JR. DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING

NJIT New Jersey Institute of Technology

Mechanics & Stability of Structures **Faculty: Rima Taher, PhD, PE**
CE 636-851 / Fall 2019 **Senior University Lecturer**

Prerequisite: undergraduate course in theory of structural analysis. Topics include structural design concept; stability criteria; elastic and inelastic buckling; column buckling; lateral buckling of beams; stability of frames; stability of plates and shell; local buckling and post-buckling.

- **Type of Course:**

  Graduate course - Lecture format – 3 credits – Online Instruction: https://Moodle.njit.edu

- **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:**

  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.

- **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 into 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, 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.

This course requires the use of Respondus LockDown Browser and Respondus Monitor with a webcam for the online tests and final exam. Refer to the section below for more information regarding Respondus.

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 (6:30 pm). Students have 1.5 hours to solve the problems (2.5 hours for the final exam), an additional 30- minute time will be given to the students in order to scan their solution sheets and upload their test to Moodle as a single PDF. It is known that the general test time for traditional courses on campus is one full period or 1 hour and 25 minutes. The additional 30-minute time is given for scanning and uploading purposes only.

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 work done in order 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 those 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 will not be permitted to email the test or any part thereof directly to the instructor. <u>The student work must be all stored on Moodle and any emailed test files will be declined and deleted.</u>

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 December 14 to December 20.

- **Use of Respondus LockDown Browser and Webcam for Online Exams**

  Respondus LockDown Browser is a locked browser for taking assessments or quizzes in Moodle. It prevents you from printing, copying, going to another URL, or accessing other applications during a quiz. If a Moodle quiz requires that LockDown Browser be used, you will not be able to take the assessment or quiz with a standard web browser.

  This course requires the use of Respondus LockDown Browser and Respondus Monitor with webcam for online tests and final exam. The webcam can be built into your computer or can be the type that plugs in with a USB cable. Watch this short video to get a basic understanding of LockDown Browser and the webcam feature. A student Quick Start Guide (PDF) is also available.

1. Download and install LockDown Browser from this link: http://www.respondus.com/lockdown/download.php?id=264548414

2. Once your download has finished, locate the "LockDown Browser" shortcut on the desktop and double-click it. (For Mac users, launch "LockDown Browser" from the Applications folder.)

3. You will be brought to the Moodle login page within the LockDown Browser, click "Login with your UCID" to log in with your NJIT UCID and password and then click Login.

4. Under "My courses", click on the course in which you have to take the exam that requires the LockDown Browser.

5. After you enter the course, find the exam and click on it.

6. A confirmation prompt will appear, click the "Start attempt" button. Once a quiz has been started with LockDown Browser, you cannot exit until the Submit all and finish button is clicked.

7. If you are required to use a webcam (Respondus Monitor), you will be prompted to complete a Webcam Check and other Startup Sequence steps.

- **Grading Criteria:**

  Test 1: 25% - Tentative Date: Thursday, October 10
  Test 2: 25% - Tentative Date: Monday, November 18
  Final examination: 30% - During the final exam week of December 14 to December 20. To be determined based on the final exam schedule of other courses.

Assignments: 20% - Due dates will be announced and posted.

- **Academic Integrity**

  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.

  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.

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

  Rima Taher, PhD, PE, Senior University Lecturer
  Office Number: Weston 521.
  Office Hours: Tuesday from 1:15 to 2:15 and by appointment.
  E-mail: Taher@njit.edu

- **Course Content and Weekly Schedule**

  Week 1: 9/3 to 9/6
  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

  Week 2: 9/9 to 9/13
  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: 9/16 to 9/20
  Fundamentals of Stability Theory Continued: Spring-Bar System, Post-Buckling Behavior, Softening Spring-Bar Structure, Equilibrium Solutions, Virtual Work Method

  Week 4: 9/23 to 9/27

Fundamentals of Stability Theory Continued
Snap-Through Buckling

Week 5: 9/30 to 10/4
Fundamentals of Stability Theory Continued:
Multi-Degree of Freedom Systems

Week 6: 10/7 to 10/11
Test 1: Thursday, October 10 – Time: 6:30 to 8:30 pm
Brief Math Review: Differential Equations
Elastic Buckling of Planar Columns: Large Deflection Solution of an Elastic Column

Week 7: 10/14 to 10/18
Elastic Buckling of Planar Columns (Continued): Differential Equation of Planar Flexure, Pin-Ended Columns, Fundamental Column Cases – Examples
Elastic Buckling of Planar Columns (Continued): Differential Equation of Planar Flexure,

Week 8: 10/21 to 10/25
Elastic Buckling of Planar Columns (Continued)
Pin-Ended Columns, Fundamental Column Cases – Examples
Inelastic Column Buckling

Week 9: 10/28 to 11/1
Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples

Week 10: 11/4 to 11/8
Stability of a Rigid Frame (Continued) – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples

Week 11: 11/11 to 11/15
Stability of a Rigid Frame – End Restrained Columns - Boundary Conditions for Bracing Structures – Examples
Monday, November 11, Last Day to Withdraw

Week 12: 11/18 to 11/22
Test 2: Monday, November 18 – Time: 6:30 to 8:30 pm
Beam- Column Stability: Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples

Week 13: 11/25 to 11/29
Beam- Column Stability (Continued): Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples
Tuesday, November 26: Thursday Schedule

Wednesday, November 27: Friday Schedule

11/28 and 11/29: Thanksgiving Recess – No class

Week 14: 12/2 to 12/6
Beam- Column Stability (Continued): Behavior of Beam-Columns, Elastic Limit Interaction Relationships, Amplification Factors – Examples

Week 15: 12/9 to 12/13
Review for the Final Exam

Last Day of Class at NJIT: Wednesday, December 11
Reading Days: Thursday December 12, and Friday, December 13
Final Exam Week: December 14 to 20