

# USC Viterbi

School of Engineering  
*Sonny Astani Department  
of Civil and Environmental  
Engineering*

## **CE 543 Structural Instability and Failure**

**Units: 4**

**Spring—Day—Time:** Friday, 1-4:20 PM

**Location:** KAP 167

**Instructor:** Qiming Wang

**Office:** BHE 222

**Office Hours:** Tuesday, Thursday 3-5 PM

**Contact Info:** [qimingw@usc.edu](mailto:qimingw@usc.edu)

**Teaching Assistant:** TBD

**Office:**

**Office Hours:**

**Contact Info:**

**IT Help:** TBD

**Hours of Service:**

**Contact Info:**

## Course Description

### Catalogue Description

Stability analysis of columns, frames, plates, circular rings, and shells; Energy-based method; Dynamic analysis of structural stability; Elastic fracture mechanics; Small-strain plasticity.

### Extended Course Description

CE543 - Structural Instability and Failure presents a full range of theoretical topics with the goal of providing students with a fundamental understanding of instabilities and failures of engineering structures. Students will learn the stability analysis of columns, frames, plates, circular rings, and shells, energy-based methods to analyze stability problems, and dynamic analysis of structural stability. Students will also learn the elastic fracture mechanics and small-strain plasticity.

### Learning Objectives and Outcomes

Loading-bearing engineering structures widely exist in areas of civil, mechanical, and aerospace engineering. Their instabilities and failures are key safety issues that should be considered during the design and analysis of these engineering structures. Therefore, it is critical that engineers and managers have a fundamental understanding of instabilities and failures of engineering structures to facilitate their engineering design, analysis, prediction, assessment, and management. Upon completing of the course, students will be able to determine the instability and failure conditions of structural systems, and use such information to enhance the design and analysis process for diverse problems in civil, mechanical and aerospace engineering.

**Recommended Preparation:** Undergraduate strength of materials class on the level of CE 225.

### Course Notes

Lecture notes written by the instructor will be distributed to students through the blackboard system prior to the corresponding lectures. The lecture notes will cover the essential contents and supplementary information of the lectures. The lecture notes will be treated as reading materials to support the lectures.

### Reference Materials

The following optional textbooks can be supplementary materials for the course:

1. G. Simitzes and D. Hodges, "Fundamentals of Structural Stability," Butterworth-Heinemann, Elsevier Inc., 2006, First Edition, ISBN-13: 978-0750678759.
2. C. H. Yoo and S. Lee, "Stability of Structures: Principles and Applications," Butterworth-Heinemann, First Edition, Elsevier Inc., 2011, ISBN-13: 978-0123851222.
3. M. Lal Gambhir, "Stability Analysis and Design of Structures," Springer, 1st edition 2004.
4. Z. Bazant and L. Cedolin, "Stability of Structures," Oxford University Press, Inc., 1991.
5. S. Timoshenko and J. Gere, "Theory of Elastic Stability," 2nd Edition, McGraw-Hill Inc., 1961.
6. V. Bolotin, "The Dynamic Stability of Elastic Systems," Holden-Day, Inc., 1964.
7. Luis A. Godoy, "Theory of Elastic Stability: Analysis and Sensitivity," Taylor & Francis Group, 2000.
8. W. Xie, "Dynamic Stability of Structures," Cambridge University Press, 2006.
9. T.L. Anderson, "Fracture Mechanics : Fundamentals and Applications" (third edition), CRC Press, 2004.
10. Morton E. Gurtin, Eliot Fried & Lallit Anand, "The Mechanics and Thermodynamics of Continua", Cambridge University Press, 2010.

### Description and Assessment of Assignments

Each assignment will include 2-3 problems related to the corresponding lecture. The assignment may take one of the following three forms: (1) analysis problems with analytical answers, (2) analysis problems with numerical and graphical answers, or (3) writing essays or report on structural instability and failure issues. These assignments will allow students to integrate the lecture and reading materials to demonstrate their knowledge of structural instability and failure. The grading rubric will follow 10 points for each assignment.

## Grading Breakdown

Content	Points	% of Grade
Homework	10x11=110	30
Midterm exam	100	30
Final exam	100	40
<b>TOTAL</b>		100

## Grading Scale

Course final grades will be determined using the following scale

A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

## Assignment Rubrics

10 points for each assignment

## Assignment Submission Policy

The assignment should be submitted in the hand-writing paper during the class or electronic PDF via email before the deadline described in the course schedule table.

## Grading Timeline

The assignment will be graded and returned to the students following the course schedule table.

## Additional Policies

Late assignments will not be accepted. Students should email the instructor in advance when they are absent for a lecture. Absences for reasons of a religious holiday, serious illness, death in the student's immediate family, or required participation in university-sponsored activities are, with the appropriate documentation, considered excused absences.

## Course Schedule: A Weekly Breakdown

Week	Friday	Topics	Readings	HW assign	HW due
1	8/26	Basic concept of structural stability	Lecture note 1, Simiteses Ch 2	HW 1	
2	9/2	Buckling of column I	Lecture note 2, Simiteses P47-67	HW 2	HW 1
3	9/9	Buckling of column II	Lecture note 3, Simiteses P72-79, Timoshenko P76-82	HW 3	HW2
4	9/16	Buckling of frame I	Lecture note 4, Simiteses P103-111, Timoshenko P59-62	HW 4	HW 3
5	9/23	Buckling of frame II	Lecture note 5, Simiteses P112-126, Timoshenko P62-76	HW 5	HW4
6	9/30	Energy-based method	Lecture note 6, Simiteses Ch 5-6	HW 6	HW 5
	10/7	Midterm exam			
	10/14	Fall Recess			
9	10/21	Buckling of plate	Lecture note 7, Timoshenko Ch 8-9	HW 7	HW 6
10	10/28	Dynamic stability	Lecture note 8, Simiteses Ch 12	HW 8	HW 7
11	11/4	Plastic buckling	Lecture note 9, Timoshenko Ch 3	HW 9	HW 8
12	11/11	Veterans Day			
13	11/18	Fracture mechanics	Lecture note 10, Anderson P25-59	HW 10	HW 9
	11/25	Thanksgiving holiday			
	12/2	Research on structural stability and failure	Lecture note 11		HW 10
	12/9	Final exam			

## Statement on Academic Conduct and Support Systems

### Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” [policy.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

### Support Systems:

*Student Health Counseling Services - (213) 740-7711 – 24/7 on call*  
[engemannshc.usc.edu/counseling](http://engemannshc.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call*  
[suicidepreventionlifeline.org](http://suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 – 24/7 on call*  
[engemannshc.usc.edu/rsvp](http://engemannshc.usc.edu/rsvp)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED) | Title IX - (213) 740-5086*  
[equity.usc.edu](http://equity.usc.edu), [titleix.usc.edu](http://titleix.usc.edu)

Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.

*Bias Assessment Response and Support - (213) 740-2421*  
[studentaffairs.usc.edu/bias-assessment-response-support](http://studentaffairs.usc.edu/bias-assessment-response-support)

Avenue to report incidents of bias, hate crimes, and microaggressions for appropriate investigation and response.

*The Office of Disability Services and Programs - (213) 740-0776*  
[dsp.usc.edu](http://dsp.usc.edu)

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

*USC Support and Advocacy - (213) 821-4710*  
[studentaffairs.usc.edu/ssa](http://studentaffairs.usc.edu/ssa)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity at USC - (213) 740-2101*  
[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

*USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

*USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.