January 10, 2018

University of Southern California
Viterbi School of Engineering
Sonny Astani Department of Civil & Environmental Engineering

CE 599 SEISMIC PROTECTIVE SYSTEMS

Units: 3
Spring 2018—Wednesday—6:30-9:10 pm
Location: GFS 207

Instructor: Marios Panagiotou, PhD, PE
Office: KAP 200A
Office Hours: Wednesday 5:15-6:15 pm at **GFS 207**
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Course Description

The course develops an advanced understanding of analysis, behavior and design of structural systems used for seismic protection and enhanced seismic performance. The focus is on buildings and bridges. Seismic isolation, supplemental energy dissipation and controlled rocking systems are presented. The mechanical behavior of elastomeric and friction isolation devices is discussed. Passive, semi-active and active damping devices are covered. Rocking walls, frames and foundations are considered. Applications to new and existing structures are presented. ASCE 7 code provisions are compared with the state of the art of research and practice. The computational nonlinear analysis of seismic systems, using existing software, is presented. The development of active damping and controllable semiactive damping strategies are discussed.

Learning Objectives

The course develops an advanced understanding of seismic protective systems in terms devices, components as well as at the system level. Comprehension of how code requirements compare with the state of the art of research and practice is achieved. Basic understanding of computational nonlinear analysis, using existing software, of such systems is attained.

Recommended Preparation:

A background on the seismic design and nonlinear behavior of structures is very helpful. Students should have a background in structural analysis/mechanics (on the level of CE 458) and structural dynamics (preferably at the level of CE 541a).

Course Notes

There is no single textbook used in this course. Copies of lecture slides and other class information (videos, journal papers, reports) will be posted on Blackboard.

Main References and Suggested (Not Required) Readings

1. Christopoulos C. and Filiatrault A., 2006. Principles of Passive Supplemental Damping and Seismic Isolation. IUSS Press, Pavia, Italy.

2. Kelly J.M and Constantinidis D.A., 2011. Mechanics of Rubber Bearings for Seismic and Vibration Isolation. Wiley

3. Priestley MJN, Calvi GM, Kowalsky MJ, 2007. Displacement Based Seismic Design of Structures. IUSS Press, Pavia, Italy.

Code Provisions

1. American Society of Civil Engineers, 2010. ASCE 7-10 Minimum design loads for buildings and other structures.

Software

ETABS 2016 Ultimate, 2016. CSi Analysis Reference Manual, Computers and Structures, Inc., CA.
The software is accessible via ***Enhanced Desktop***. An evaluation version can be obtained from the following link:
https://www.csiamerica.com/support/downloads/software-evaluation-request?productnid=222

Description and Assessment of Assignments

Five homework assignments (one every 2 or 3 weeks) will count for **30%**, in total, of the course grade. A term project and a final examination will count for **20%**, and **50%** of the grade, respectively.

Term Project

The term project will include the seismic analysis and design of a structure (building, bridge, other) using one of the seismic protective systems covered in the course. The design validation will require nonlinear response history analysis using the software ETABS Ultimate and three ground motions. The term project will be introduced in the eigth to ninth week of the course and will due at the beginning of the last lecture. During the last lecture each student will give a 10-minute-presentation of his/her project results. Different structures and design objectives will be given as options so that each student works on a different case.

Grading Timeline

Unless otherwise noted in homework assignments and exams, homework assignments and exams will be returned within ten days after submission.

Course Schedule: A Weekly Breakdown

Details of the course content described below may change depending on the interest of students and course development during the semester.

	Topics/Daily Activities
Week 1	Basis of conventional and high-performance seismic design
Week 2	Earthquake ground motion characteristics and nonlinear dynamic response of SDOF and MDOF oscillators and of conventional structural systems
Week 3	Linear / nonlinear dynamic analysis of base isolated buildings
Week 4	Linear / nonlinear dynamic analysis of base isolated buildings
Week 5	Mechanical behavior and design of rubber bearings
Week 6	Mechanical behavior and design of friction bearings
Week 7	Seismic design of base-isolated buildings
Week 8	Seismic design of base-isolated buildings
Week 9	Passive, semi-active and active damping devices and control strategies
Week 10	Passive, semi-active and active damping devices and control strategies
Week 11	Seismic isolation of bridges
Week 12	Seismic design/retrofit of buildings with viscous dampers and buckling restrained braces
Week 13	Seismic design of structures using post-tensioned walls, frames, and rocking foundations
Week 14	Seismic design of structures using post-tensioned walls, frames, and rocking foundations
Week 15	Presentation of term projects
FINAL	

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. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu