UME Graduate School
understanding and managing extremes
IUSS

PAVIA RISK CENTRE

SEISMIC ISOLATION AND DISSIPATION

SPRING 2017

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Course Dropbox : https://www.dropbox.com/sh/juz8o6rx1m2hf8b/AADzP1v2SyvEVElW2q_HeTRQa?dl=0
Teaching Assistant and Project Peer Reviewer: Paul Steneker (paulsteneker@gmail.com)

GENERAL OBJECTIVES

The basic principle of conventional earthquake-resistant design is to ensure an acceptable safety level while avoiding catastrophic failures and loss of life. When a structure does not collapse during a major earthquake, and the occupants can evacuate safely, it is considered that this structure has fulfilled its function even though it may never be functional again. Generally, this approach can be considered adequate for most types of structures. However for important structures, safer methods are required, while keeping economic factors in mind. For example, avoiding collapse is not sufficient for facilities that must remain functional immediately after an earthquake: hospitals, police stations, communication centers, and so on.

Over the last 30 years, a large amount of research has been conducted into developing innovative earthquake-resistant systems in order to raise the safety level while keeping construction costs reasonable. Most of these systems are intended to dissipate the seismic energy introduced into the structure by supplemental damping mechanisms and/or to isolate the main structural elements from receiving this energy through isolation systems.

The main objective of the course is to familiarize Structural Engineers with the various innovative systems that have demonstrated considerable potential through analytical studies, experimental testing and actual structural implementation. The discussion will focus on passive energy dissipation systems and base isolation systems.

At the end of the course, Structural Engineers should be able to:

- Provide a critical comparison of various systems.
- Model and design various systems with general structural engineering software.
- Recommend optimum systems for particular seismic design or retrofit projects.

CLASS SCHEDULE

Lectures: Tuesdays, Wednesdays and Thursdays 9:00 am to 1:00 pm
First Class: Tuesday June 27 at 9:00 am

Project Tutorials:
Tuesdays, Wednesdays and Thursdays: 2:30 pm to 5:30 pm: AF & PS in classroom.

Office Hours:
Mondays and Fridays 1:00 pm to 4:00 pm: PS in CAR College Reading Room,
by e-mail appointment to PS only, 24-hour notice required.

GRADING

Evaluation	% of Final Mark	Documentation
Project Report	50%	Open
Project Oral Presentation and Examination	25%	Open
Final Written Examination	25%	1-A4 Sheet

REQUIRED TEXT

- Christopoulos, C. and Filiatrault, A. 2006. "Principles of Passive Supplemental Damping and Seismic Isolation," IUSS Press, University of Pavia, Italy, 2006. Order online at :
  http://www.iusspress.it/pc/viewPrd.asp?idcategory=21&idproduct=33

or

  http://www.amazon.com/Principles-Passive-Supplemental-Damping-Isolation/dp/8873580378/ref=sr_1_3?ie=UTF8&s=books&qid=1230769301&sr=1-3

- Slide sets available on the course Dropbox:
  https://www.dropbox.com/sh/juz8o6rx1m2hf8b/AADzP1v2SyvEVElW2q_HeTRQa?dl=0

PROJECT

The objective of the project is to evaluate the effect and recommend an optimum innovative system for the seismic retrofit of a particular building structure. Students are divided into teams of four or five during the first lecture. Each team will be working on the same building structure but will have to consider different specified earthquake design ground motions. Each assignment will represent a phase of the project, and will be related to a particular innovative system discussed in the class. For each system, an optimum retrofit strategy will be sought.

Each team will hand in only one project report at the last lecture. The project report must reflect the various phases of the project and must include the optimum solution for each system. A final recommendation among the various systems studied must be given at the end of the report.

A Peer Reviewer (PR) will monitor the progress of each team. Each team must meet privately with the PR at least twice during the semester. It is the responsibility of each team to contact the PR to schedule each meeting. During each meeting, the team must present an update of its progress in the project and seek "big picture" advice from the PR if required. After each meeting, the PR will prepare a letter to the team that provides its opinion on the progress of the team and concerns if any. Each team must include the two letters from the PR in its final project report and describe how the comments from the PR were addressed in the execution of the project. If comments from the PR were not addressed, justifications must be provided.

After the last lecture, each team will make an oral presentation to the class on the main findings of their project. This session will be open to the public.

Note: At the end of the project, each team member will be asked to grade anonymously the performance of all teammates (including him or herself) during the project. This informal grading will help the instructor to grade the project report for each student in the class.

COURSE CONTENT

Chapter 1	**Introduction**
Chapter 2	**Review of Seismic Design Philosophies and Analysis Methods**
Chapter 3	**Energy Concepts in Earthquake Engineering**
Chapter 4	**Basic Concepts of Structures with Passive Energy Dissipating Systems**
Chapter 5	**Metallic and Friction (Hysteretic) Dampers**
Chapter 6	**Viscous and Viscoelastic Dampers**
Chapter 7	**The ASCE 7-10 Design Provisions for Structures with Passive Energy Dissipating Systems**
Chapter 8	**Theory of Linear Seismically Isolated Systems**
Chapter 9	**Seismic Isolation Systems**
Chapter 10	**The ASCE 7-10 Design Provisions for Seismically Isolated Buildings**
Chapter 11	**The AASHTO Design Guide Specifications for Seismically Isolated Bridges**
Chapter 12	**Tuned-Mass Dampers**
Chapter 13	**Self-Centering Systems**

COURSE SCHEDULE

Week	Date / Location	Lecture hours	Project tutorial hours	Subject	Total hours
1	27/6/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 1: Course Presentation, Chapters 1-2: Introduction, Review of Seismic Design Methods. Project Tutorial: Phase 1, RUAUMOKO & DYNAPLOT software demonstration, Q&A.	7
	28/6/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 2: Chapters 3-4: Energy and Basic Concepts. Project Tutorial: Phase 2, Energy Computation in RUAUMOKO demonstration and SeismoSpect software demonstration, Q&A.	7
	29/6/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 3: Chapter 5: Hysteretic Dampers. Project Tutorial: Phase 3, Using Matlab with RUAUMOKO and DYNAPLOT software, Q&A.	7
2	4/7/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 4: Chapter 6: Viscous and Viscoelastic Dampers. Project Tutorial: Phase 4, Modeling of hysteretic dampers in RUAUMOKO, Q&A.	7
	5/7/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 5: Chapter 7: ASCE7-10 Provisions for Buildings with Passive Supplemental Damping Systems. Project Tutorial: Phase 5, Modeling of viscous dampers in RUAUMOKO, Q&A.	7
	6/7/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 6: Chapter 8: Theory of Linear Seismic Isolation. Project Tutorial: Review Problem No. 1, Q&A.	7
3	11/7/17 EUCENTRE 1	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 7: Chapter 9: Seismic Isolation Systems. Project Tutorial: Phase 6, Modeling of lead-rubber bearings in RUAUMOKO, Q&A.	7
	12/7/17 EUCENTRE 1	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 8: Chapter 10: ASCE 7-10 Isolation Provisions. Project Tutorial: Phase 7, Review Problem No. 2, Q&A.	7
	13/7/17 EUCENTRE 1	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 9: Chapter 11: AASHTO Guide for Isolated Bridges. Project Tutorial: Oral Project Presentation Instructions, Review Problem No. 3, Q&A.	7
4	18/7/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 10: Chapter 12: Self-centring Systems. Project Tutorial: Q&A.	7
	19/7/17 Sala del Camino	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	Lecture 11: Chapter 13: Tuned-mass Dampers. Project Tutorial: Review Problem No. 4, Q&A.	7
	20/7/17 EUCENTRE 1	9:00 am to 1:00 pm	2:30 pm to 5:30 pm	AM: Oral Project Presentations. PM: Oral Examinations.	7
	21/7/17 EUCENTRE 1	9:00 am to 12:00 pm		AM: Final written examination	3
				Total	**87**