University of Pavia

IUSS School of Advanced Studies

Civil Engineering for Mitigation of Risk from Natural Hazards

Course: Dynamics of Structures
Lecturers: Prof. Gerard O'Reilly, Prof.ssa Giulia Scalet
Teaching Assistant: Serkan Hasanoğlu
Date: 23/09/2024 – 18/10/2024
Classroom:

- Aula MS1, Dept Civil Eng and Architecture, via Adolfo Ferrata 3, Pavia (GS)
- Aula 1-17/Aula 1.16, IUSS, Palazzo del Broletto, Piazza della Vittoria 15, Pavia (GOR)

Brief Contents Description and Course Syllabus
It is commonly accepted that every structural engineering major should have a minimum introduction to dynamics of structures to serve as a prelude to more advanced courses in earthquake engineering, blast-resistant design, random vibrations and wind engineering. This course is designed to serve this purpose. It is a basic graduate level course which studies the vibration characteristics and dynamic response of structural systems to dynamic excitations generated by earthquakes, wind, impact and blast.

By the end of the course, the student is expected to have a basic understanding of:

- Discrete single-degree, multi-degree and continuous vibratory systems,
- Free and forced vibration response of discrete and continuous systems,
- Applications in structural design.

The only requirement for this course is a customary exposure to an introductory course on dynamics, such as the basic undergraduate course: Dynamics of Rigid Bodies. The knowledge of basic mathematics, particularly the solution differential equations and numerical methods are also used extensively in this course.

Suggested reading material
In addition to specific papers and handouts indicated/delivered during classes, the following general textbooks are recommended.
• Chopra A., "Dynamics of Structures", Prentice Hall, Third Edition, 2007
• Clough R.W., Penzien J., "Dynamics of structures", Computers & Structures Inc, 2003

Software
• Matlab: The Mathworks, 2012. MATLAB 2012b Release, Statistics Toolbox, available at http://www .mathworks.com/products/matlab/.
• Seismosoft: "SeismoStruct - A computer program for static and dynamic nonlinear analysis of framed structures". 2018. (http://www.seismosoft.com/seismostruct)
• SAP2000, Computers and Structures, Inc., 2020.
• Mazzoni et al.: "OpenSEES - The open system for earthquake engineering simulation", PEER, UC Berkeley, 2006. (http://opensees.berkeley.edu)

Grading
Homework assignments: 35%
Midterm: 25%
Final exam: 40%

Course schedule

Week	Date	Lecture hours Italian Time	Tutorial hours GMT	Subject Dynamics of Structures	Tot h
1 (GS) @Aula MS1 Dicar	23/09/24 Mon	09:00-12:00		Equation of motion for SDOF systems, its solution	3
	25/09/24 Wed	09:00-12:00		Free vibration response, viscous damping, Response to harmonic excitation	3
	27/09/24 Fri	09:00-12:00		Response to general excitation, response spectrum	3
	25/09/24 Wed		15:00-17:00	Tutorial on the modelling of SDOF systems	2
	27/09/24 Fri		14:00-16:00	Tutorial on response spectrum	2
2 (GS @Aula MS1 Dicar)	30/09/24 Mon	11:00-13:00		Generalized SDOF systems	3
	02/10/24 Wed	09:00-12:00		Numerical evaluation of dynamic response for SDOF systems (I)	3
	04/10/24 Fri	09:00-11:00		Numerical evaluation of dynamic response for SDOF systems (II)	3
	30/09/24 Mon		14:00-17:00	Tutorial on numerical solution of SDOF systems (I)	2
	02/10/24 Wed		13:00-15:00	Tutorial on numerical solution of SDOF systems (II)	2
	04/10/24 Fri		14:00-17:00	Tutorial on homework problems	2
3 (GOR) @IUSS	07/10/24 Mon	09:00-12:00 AULA 1.17		Equations of motion for MDOF systems, Static condensation	3
	09/10/24 Wed	09:00-12:00 AULA 1.6		Natural frequencies and modes, Modal and spectral matrices	3
	11/10/24 Fri	09:00-12:00 AULA 1.16		Orthogonality of modes, Normalisation of modes, Solution for undamped free vibration	3
	07/10/24 Mon		14:00-16:00 AULA 1.17	Tutorial on assignment problem	2
	09/10/24 Wed		14:00-16:00 AULA 1.6	Tutorial on assignment problem	2
	11/10/24 Fri		14:00-16:00 AULA 1.16	Tutorial on assignment problem	2
4 (GOR) @IUSS	14/10/24 Mon	09:00-12:00 AULA 1.17		Damping in structures, Constructing a damping matrix, Solution for damped free vibration	3
	15/10/24 Tue	14:00-17:00 AULA 1.17		Modal response analysis for damped forced vibration, and for linear system subjected to earthquakes	3
	16/10/24 Wed	09:00-12:00 AULA 1.17		Response spectrum analysis, Distributed mass systems, Equivalent SDOF analysis	3
	14/10/24 Mon		14:00-16:00 AULA 1.17	Tutorial on assignment problem	2

	16/10/24 Wed		14:00-16:00 AULA 1.17	Tutorial on assignment problem	2
	18/10/24 Fri	09:00 AULA1.16		**Final Exam**	3