University of Pavia

IUSS School of Advanced Studies

Civil Engineering for Mitigation of Risk from Natural Hazards

Course: Foundation Engineering and Earth Retaining Structures
a.y.: 2025 - 2026
Lecturer: Prof. Dr. Renato Maria Cosentini, Dr. Nikolaos Ntritsos
Date: March 30 to May 5, 2026
Classroom:

Course schedule

Week	Date	Lecture hours	Tutorial hours	Classroom	Subject	Tot h
1	30/03	9:00 – 12:00 14:30 – 16:00		EUC2	**I. Soil mechanics review** Fundamentals of soil behaviour	4.5
	31/03	9:00 – 12:00 14:30 – 16:00		EUC2	Soil characterisation: Laboratory tests	4.5
	01/04	14:30 – 16:00		EUC1	Soil characterisation: in-situ tests	1.5
	02/04		9:00 – 11:00	EUC2	Contact hours – Interaction on homework	2
	03/04	9:00 – 12:00 14:30 – 16:00		EUC2	**II. Shallow Foundations** Introduction, Bearing Capacity of Foundations	4.5
2	13/04	9:00 – 12:00 14:30 – 16:00		EUC2	Foundation Settlements	4.5
	14/04	9:00 – 11:00 14:30 – 16:00		EUC2	Factors to Consider in Foundation Design, Spread Footing analysis and design. Application of EC7, ULS and SLS	3.0
	15/04		9:00 – 11:00	EUC2	Contact hours – Interaction on homework	2.0
	16/04	9:00 – 11:00 14:30 – 16:00		EUC2	Soil-Foundation-Structure Interaction Plinth	3.0
	17/04	9:00 – 11:00 14:30 – 16:00		EUC2	Beams on Elastic Foundations (Winkler) Beam, Grid and Mat Foundations	3.0
3	20/04	9:00 – 12:00		EUC2	**III. Deep Foundations** Introduction, Deep Foundation Types, Construction Methods, Load Transfer Mechanisms	3.0
	21/04	9:00 – 12:00 14:30 – 16:00		EUC2	Piles: Axial Load Capacity	4.5
	22/04	9:00 – 12:00 14:30 – 16:00		EUC2	Piles: Settlement, Group Effects	4.5
	23/04	9:00 – 11:00 14:30 – 16:00		EUC2	Piles Under Lateral Loading	3.5
	24/04		10:00 – 12:00	EUC2	Contact hours – Interaction on homework	2.0
4	27/04	9:00 – 12:00 14:30 – 16:00		EUC2	Pile Foundations – The Design Process (EC7 provisions)	4.5
	28/04	9:00 – 12:00 14:30 – 16:00		EUC2	**IV. Earth Retaining Structures** Types of Retaining Systems, Lateral Earth Pressure, Gravity Walls	4.5
	30/04	9:00 – 11:00 14:30 – 16:00		EUC2	Flexible Retaining Walls	3.5
5	05/05	9:00 – 11:00		EUC2	FINAL EXAM	3.0

Textbooks:

- Geotechnical Engineering, 2nd ed., Renato Lancellotta, Spon Text, 2008
- Foundation Analysis and Design, Joseph E. Bowles, McGraw-Hill, 1997
- Piles and Pile Foundations, Carlo Viggiani – Alessandro Mandolini – Gianpiero Russo, Spon Press, 2011
- Eurocode 7: Geotechnical Design Worked examples, European Commission, Joint Research Centre, Institute for the Protection and Security of the Citizen, ISBN 978-92-79-33759-8, ISSN 1831-9424, doi: 10.2788/3398

Objectives: This course aims to apply the principles of soil mechanics to the analysis and design of foundation systems and earth-retaining structures. The main objectives of the course are as follows:

a) Develop an understanding of fundamental concepts of soil mechanics and the interaction of structures with soils, for the proper design of foundation systems.
b) Acquire a conceptual framework of basic and adaptable ideas to manage current and complex problems faced by civil engineers effectively.
c) Learn how to apply simple basic ideas to provide acceptable solutions to various geotechnical problems.

Students are expected to grasp concepts and procedures to evaluate the ultimate limit state and the serviceability limit state of shallow, deep foundations, and earth-retaining structures.

Pre-requirements: Students are required to have already mastered the Soil Mechanics and Structural Mechanics courses.

Course structure: The course includes lectures covering theoretical topics and tutorials to help students understand the course material. The support material (PowerPoint slides, scientific papers) will be made available to students in PDF format.

Weekly homework assignments will be given, and students are expected to submit each assignment according to the schedule provided at the beginning of the course.

Assessment and grading criteria: The final exam will include a written test with some questions on the programme and calculation exercises that must be completed within 3 hours. It's a closed-note and closed-book exam, and a compendium with the main formulas will be provided if needed. No phones or other electronic devices will be allowed, except for a calculator if needed.
The **final grade** is calculated as follows:

Homework assignments:	30%
Written final exam	65%
Class participation	5%

Course topics: The course first provides a general overview of the issues and investigation methods available for characterising the geotechnical aspects of a site and defining design parameters. It then covers the problems related to designing direct and deep foundations and earth retaining structures.
Eurocode 7 (Geotechnical Design) and the main aspects of performance-based design will also be addressed, introducing the concepts of Service Limit State and Ultimate Limit State.

The topics related to shallow foundations will cover the following aspects:

a) Evaluation of the soil shear resistance or ultimate bearing capacity under a foundation load and estimation of the settlements.
b) Analysis of the soil-structure interaction using a Winkler-type foundation.

c) Examining engineering examples about the design, construction, and concept of various shallow foundations.
d) Utilisation of EC7 for analysing problems and designing shallow foundations.

The topics related to deep foundations will cover the following aspects:

a) Analysis of the most common construction of piles.
b) Evaluation of the static pile capacity
c) Analysis of the lateral pile response to load
d) Evaluation of the ultimate pile capacity and settlements for pile and pile groups.
e) Analysis and design of single piles and pile groups using EC7 guidelines.

Finally, the topics related to earth-retaining structures will cover the following aspects:

a) Analysis of the theoretical background of the lateral earth pressure problem (active and passive earth pressure).
b) Evaluation of the basic principles for analysis and design of the reinforced earth, gravity, and concrete cantilever wall; the sheet-pile cantilever and anchored walls.
c) Analysis of sliding, overturning and rotational wall stability.
d) Examination of engineering examples of retaining structures using EC7 analysis and design.