

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

Coordinating unit:	250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit:	751 - DECA - Department of Civil and Environmental Engineering
Academic year:	2015
Degree:	MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Compulsory) MASTER'S DEGREE IN CIVIL ENGINEERING (PROFESSIONAL TRACK) (Syllabus 2012). (Teaching unit Compulsory) MASTER'S DEGREE IN CIVIL ENGINEERING (RESEARCH TRACK) (Syllabus 2007). (Teaching unit Optional) MASTER'S DEGREE IN GEOTECHNICAL AND EARTHQUAKE ENGINEERING (Syllabus 2009). (Teaching unit Optional) MASTER'S DEGREE IN CIVIL ENGINEERING (RESEARCH TRACK) (Syllabus 2009). (Teaching unit Optional)
ECTS credits:	6
Teaching languages:	English

Teaching staff

Coordinator:	SEBASTIAN OLIVELLA PASTALLE
Others:	EDUARDO ALONSO PEREZ DE AGREDA, ANTONIO GENS SOLE, ALBERTO LEDESMA VILLALBA, SEBASTIAN OLIVELLA PASTALLE

Opening hours

Timetable:	Hours of assistance to students are carried out both during the intervals between classes and through personally agreed hours or agreed hours by e-mail
------------	---

Degree competences to which the subject contributes

Specific:

8200. The ability to apply knowledge of soil and rock mechanics to the study, design, construction and operation of foundations, cuts, fills, tunnels and other constructions over or through land, whatever its nature and state, and whatever the purpose of the work.

Teaching methodology

The course consists of 4 hours per week of classroom activity.

The 4 hours are devoted to theoretical lectures/ practical lectures and laboratory practical sessions, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises. Some sessions are "hands on" using geotechnical software.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

Learning objectives of the subject

Students will learn to use analytical and numerical models to conduct geomechanical analyses of geotechnical structures. They will also learn to diagnose geomechanical factors in situations encountered in geotechnical engineering.

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

Upon completion of the course, students will be able to:

Use analytical and numerical models to conduct geomechanical analyses of geotechnical structures, and diagnose geomechanical factors in situations encountered in geotechnical engineering;

Use nonlinear critical-state models to analyse geotechnical processes involving soil-rock interactions, including hydromechanical coupling;

Plan, design, construct and maintain foundations, embankments, tunnels and other geotechnical structures.

Advanced study of critical-state theories (state parameters in sand models) and description of real behaviour; Aspects of the real behaviour of soils and rocks, including nonlinearity (focusing on small deformations), structure (bonding), mechanical and hydraulic anisotropy, softening (progressive localization and fracture), yield strength, behaviour of unsaturated soils and liquefaction; Case studies examining the influence of these aspects on engineering applications; Planning, design, construction and maintenance of foundations, cut-slopes, embankments, tunnels and other geotechnical structures

Study load

Total learning time: 150h	Theory classes:	25h 58,8m	17.32%
	Practical classes:	13h 01,2m	8.68%
	Laboratory classes:	13h 01,2m	8.68%
	Guided activities:	1h 58,8m	1.32%
	Self study:	96h	64.00%

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

Content

<p>Theme 1. Geomaterials</p>	<p>Learning time: 4h 48m Theory classes: 2h Self study : 2h 48m</p>
<p>Description: General description of natural materials. Soils. Formation, structure, sedimentary basins, residual soils, cemented soils. Hard soils and soft rocks. Discontinuities in massive rocks. Creep. Geomechanical analysis: continuum media, discrete elements, joints.</p> <p>Specific objectives: An introduction to geomaterials is carried out.</p>	
<p>Theme 2. Hydro-mechanical coupling in geomaterials</p>	<p>Learning time: 19h 12m Theory classes: 4h Practical classes: 2h Laboratory classes: 2h Self study : 11h 12m</p>
<p>Description: Flow and deformation coupling. Formulation based on displacements and pressures. Undrained conditions, undrained shear strength. Consolidation. Drained conditions. Extension of the coupled formulation to the thermo-hydro-mechanical behaviour of porous media (including vapour migration). Generalized constitutive laws for mechanical, hydraulic and thermal. Introduction to numerical methods in geotechnical analysis. Excavation and construction of elements. Initial stresses. Mesh extension. Structural elements.</p> <p>Application to cases that use simple models in order to become familiar with boundary value problems, initial conditions and boundary conditions, intervals, structural elements, properties of programs.</p> <p>Specific objectives: Development of the formulation Development of the formulation. To be able to incorporate or eliminate terms associated to processes depending on the type of problems to be solved. To learn the basic aspects of numerical methods applied for the solution of geotechnical problems. Practical session to introduce geotechnical modelling.</p>	

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

<p>Theme 3. Geomechanical behaviour of clays and sands</p>	<p>Learning time: 14h 23m Theory classes: 4h Laboratory classes: 2h Self study : 8h 23m</p>
<p>Description: Stress strain response of clays. Critical state theory and Cam-clay model Typical behaviour fo sands. State parameters. Liquefaction. Cyclic movility.</p> <p>Analitical and numerical simulation of oedometric and triaxial tests in saturated soils using coupled models.</p> <p>Specific objectives: To understant the experimental response of argillaceous soils subjected to a general stress-strain path. To be able to anticipate, in a qualitative way, the response in a laboratory experiment. Understanding the experimental response of granular soils subjected to general stress-strain sollicitations. To be able to anticipate, in a qualitative way, the response in a laboratory experiment. To learn using modelling tools and its application to simulate laboratory tests including parameter determination and stablishing the capabilities and limitations of the equations considered.</p>	
<p>Theme 4. Unsaturated soils</p>	<p>Learning time: 19h 12m Theory classes: 6h Laboratory classes: 2h Self study : 11h 12m</p>
<p>Description: Suction. Behaviour of unsaturated soils: expansion and collapse deformations. Elastic models. State variables. Models for unsaturated geomaterials. Barcelona Basic Model and other models. Swelling and collapse. Shear strength.</p> <p>Expansive and collapsible soils. Soil structure. Compaction criteria and representation of compaction in the models. Swelling pressure. Simulation of oedometric and triaxial tests in unsaturated soils using coupled models. Embankment construction, effect of rain. Earth dam construction, reservoir filling and rapid drawdown.</p> <p>Specific objectives: To introduce the basic concepts of unsaturated soils, and the deformations proces taking place. To show the different state variables that can be used in constitutive models according to different model capabilities. To describe the derivation of models for unsaturated geomaterials and to understand the physical processes that help to derive the macroscopic models. To understand the processes of expansión/swelling in soils, the applications that can be considered or the problems that may appear due to expansion/swelling in soils, how the structure is modified during swelling and collapse, and how these processes are represented in constitutive models. To reach, by means of practice, the knowledge of the response of unsaturated and saturated soils and the models that can be used to reproduce the response against loading and inundation proceses.</p>	

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

<p>Theme 5. Hard soils and soft rocks.</p>	<p>Learning time: 14h 23m Theory classes: 4h Practical classes: 2h Self study : 8h 23m</p>
<p>Description: Behaviour of bonded soils. Results of oedometric and triaxial tests. Description of processes causing the bonding and their influence on the response of geomaterials.</p> <p>Extension of models to incorporate bonding. Introduction of the concept of residual strength. Softening by bonding degradation. Drained and undrained conditions.</p> <p>Progressive failure. Application to slope failure.</p> <p>Specific objectives: Understanding the mechanisms that explain the features observed in cemented/bonded soils. To understand how the mechanisms are related with the stress-strain response. To establish the way that constitutive models can be modified to incorporate the effect of soil bonding, starting from basic models usually applied in geotechnique. Failure of some geotechnical structures can only be explained by means of progressive failure. For this, models that incorporate a stress-strain curve with a residual strength after the peak-strength can be used.</p>	
<p>Theme 6. Small strain nonlinear behaviour</p>	<p>Learning time: 9h 36m Theory classes: 2h Practical classes: 2h Self study : 5h 36m</p>
<p>Description: Behaviour of soils at small strains. Nonlinear elasticity. Characterization by means of geofisical testing and laboratory resonant column. Application of small strain elasticity theory for the analysis of history cases such as tunnels in urban areas. Instrumentation systems.</p> <p>Specific objectives: To introduce the deviations that occur on the elastic response of the geomaterials at zones that undergo small strain, for instance, because these are far from the zone of larger influence. To understand, based on applications, the effects that may induce the variable stiffness of the ground depending the solicitation level, on the movements of geotechnical constructions, mainly on the underground constructions.</p>	

250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

Evaluation	Learning time: 9h 36m Laboratory classes: 4h Self study : 5h 36m
Description: Global Evaluation	

Theme 7. Other aspects on the real behaviour of geomaterials	Learning time: 19h 12m Theory classes: 8h Self study : 11h 12m
<p>Description:</p> <p>Structural anisotropy in soils and soft rocks. Induced anisotropy. Mechanical and hydraulic anisotropy. Static liquefaction and liquefaction under cyclic loading. Models for geomaterials including dynamic effects. Thermal behaviour of soils. Frozen soils. Vapour in soils. Thermo-hidro-mecanical problems. Creep in soils and rocks. Physical processes that explain creep of geomaterials. Secondary consolidation.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> To understand the causes for mechanical and hydraulic anisotropy that occur in geomaterials. To understand the liquefaction phenomenon, and to learn the engineering aspects that are involved. To understand and apply non-isothermal conditions to geomaterials. To understand and apply processes associated to delayed response of geomaterials. 	

Theme 8. Geotechnical analysis using numerical methods.	Learning time: 14h 23m Theory classes: 2h Practical classes: 4h Self study : 8h 23m
<p>Description:</p> <p>Particular aspects of geotechnical analysis using finite element method. Coupled and uncoupled analysis. History cases, modelling methodology, assumptions to develop a geotechnical model from a real case.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> To be able to determine the added value that a numerical analysis may bring to the study of a geotechnical problem and to be able to determine the level of complexity required in the model (processes, dimensionality, constitutive models). To be able to transform a real problem into a model. Process of model verification and validation. 	

Qualification system

Two exams will be done, one of them as global. The mark will be calculated as the maximum between the arithmetic average of the two exams and the mark of the global. In addition, a maximum of one point will be added to the final mark corresponding to practical part.



250407 - GEOMENGTER - Geomechanical and Geotechnical Engineering

Regulations for carrying out activities

Failure to perform a practical exercise or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Bibliography

Basic:

Wood, D.M... Soil behaviour and critical state soil mechanics.. Cambridge.: Ed. Cambridge University Press, 1990. ISBN ISBN 0-521-33782-8..

David M. Potts, Lidija Zdravkovic. Finite Element Analysis in Geotechnical Engineering. Londres: Thomas Thelford, 1999.

Atkinson, J.. The mechanics of soils and foundations.. Oxford, UK: Taylor & Francis., 2007. ISBN ISBN 978-0-415-36255-9..