



Course guide

250818 - 250818 - Constitutive Equations of Materials

Last modified: 25/01/2024

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: IGNACIO CAROL VILARASAU

Others: IGNACIO CAROL VILARASAU

TEACHING METHODOLOGY

The course consists of 3h/week of classroom classes.

the course content is included in the following chapters:

1. Review of general concepts of tensors and continuum mechanics, notation.
2. Linear elasticity from general anisotropy to isotropy (81 to 2 parameters), non-linear elasticity.
3. Stress-based elasto-plasticity..
- 4, Strain-based elasto-plasticity, and equivalences.
5. Continuum damage theory and multi-surface models.
6. Localization.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
 To characterize the geological environment and its interaction with civil works.
 To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose testing programmes.
 To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.
 To analyze, discriminate and integrate geological and geotechnical information in studies and projects.
 To analyze, from the perspective of an expert, cases of failure in Geotechnical Engineering. To report the evidences, identify the mechanisms responsible for the failure and verify using back- analysis models. Eventually provide solutions to risk reduction. (Specific competence of the specialization in Geotechnical Engineering).
 To use, in a discriminate manner, commercial software for numerical calculations in order to design and eventually monitor geotechnical structures. (Specific competence of the specialization in Geotechnical Engineering).

- * To apply advanced concepts in continuum media and material mechanics to soils and rocks.
- * To use advanced behaviour laws to model the stress-deformation response of soils and rocks.
- * To differentiate the response of laboratory reconstituted soils from that of natural soils.
- * To correctly interpret the response of the latter.
- * To use laws of behaviour that include the effect of environmental variables.
- * To use in a discriminated manner calculation software to model geotechnical engineering problems.

- Introduction. Tensor notation.
- Stress and strain based theory of plasticity.
- Stress and strain-based theory of elastic damage and degradation.
- Theory of multi-surface plasticity / damage. Determination of active surfaces.
- Theory of localization based on the acoustic tensor. Analytical solution from Ottosen & Runesson. Particular solutions for two-dimensional scalar damage and Mohr-Coulomb type models.
- Seminars.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	63.95
Hours large group	25,5	20.38
Hours medium group	9,8	7.83
Hours small group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

Introduction. Tensor notation

Description:

Introduction. Tensorial Notation
 Introduction. Tensor notation. Exercises

Full-or-part-time: 36h

Theory classes: 8h
 Practical classes: 7h
 Self study : 21h



Theory of plasticity based on stress and strain

Description:

Theory of plasticity based on stress and strains

Full-or-part-time: 28h 47m

Theory classes: 12h

Self study : 16h 47m

Theoria of elastic degradation and damage based on stress and strain

Description:

Theory of elastic degradation and damage based on stress and strain

Full-or-part-time: 14h 23m

Theory classes: 6h

Self study : 8h 23m

Theory of plasticity/damage with multiple surfaces

Description:

Theory of plasticity/damage with multiple surfaces

Full-or-part-time: 14h 23m

Theory classes: 6h

Self study : 8h 23m

Theory of localitzation based on acoustic tensor.

Description:

Theory of localitzation based on acoustic tensor.

Full-or-part-time: 14h 23m

Theory classes: 6h

Self study : 8h 23m

GRADING SYSTEM

Project o be developed at home, or exam, complemented by points for active participation during classes.

EXAMINATION RULES.

Final project will be developed individually

BIBLIOGRAPHY

Basic:

- Chen, W.F; Saleeb, A.F. Constitutive equations for engineering materials. John Wiley and Sons, cop. 1982-. ISBN 0471091499.

Complementary:

- Spencer, A.J.M. Continuum mechanics. Mineola: Dover Publications, 2004. ISBN 0486435946.

