

## COURSE OUTLINE

### (1) GENERAL

|                                                                                                                                                                                                                                                                       |                                                                                                                      |                              |                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------------------------|----------------|
| <b>SCHOOL</b>                                                                                                                                                                                                                                                         | UNIVERSITY OF THESSALY                                                                                               |                              |                |
| <b>ACADEMIC UNIT</b>                                                                                                                                                                                                                                                  | DEPARTMENT OF CIVIL ENGINEERING                                                                                      |                              |                |
| <b>LEVEL OF STUDIES</b>                                                                                                                                                                                                                                               | UNDERGRADUATE                                                                                                        |                              |                |
| <b>COURSE CODE</b>                                                                                                                                                                                                                                                    | FE0400                                                                                                               | <b>SEMESTER</b>              | 8 <sup>ο</sup> |
| <b>COURSE TITLE</b>                                                                                                                                                                                                                                                   | COMPUTATIONAL GEOTECHNICAL ENGINEERING II                                                                            |                              |                |
| <b>INDEPENDENT TEACHING ACTIVITIES</b><br><i>if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits</i> |                                                                                                                      | <b>WEEKLY TEACHING HOURS</b> | <b>CREDITS</b> |
|                                                                                                                                                                                                                                                                       |                                                                                                                      | 4                            | 6              |
|                                                                                                                                                                                                                                                                       |                                                                                                                      |                              |                |
|                                                                                                                                                                                                                                                                       |                                                                                                                      |                              |                |
| <i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</i>                                                                                                                                              |                                                                                                                      |                              |                |
| <b>COURSE TYPE</b><br><i>general background, special background, specialized general knowledge, skills development</i>                                                                                                                                                | Specialized general knowledge, skills development                                                                    |                              |                |
| <b>PREREQUISITE COURSES:</b>                                                                                                                                                                                                                                          | Soil Mechanics I, Soil Mechanics II<br>Foundation and Retaining Structures<br>Computational Geotechnical Engineering |                              |                |
| <b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>                                                                                                                                                                                                                      | Greek<br>Greek                                                                                                       |                              |                |
| <b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>                                                                                                                                                                                                                      | Yes                                                                                                                  |                              |                |
| <b>COURSE WEBSITE (URL)</b>                                                                                                                                                                                                                                           | -                                                                                                                    |                              |                |

### (2) LEARNING OUTCOMES

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| <b>Learning outcomes</b><br><i>The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.</i><br><i>Consult Appendix A</i> <ul style="list-style-type: none"> <li>• Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</li> <li>• Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</li> <li>• Guidelines for writing Learning Outcomes</li> </ul> |
| Deepening in the principles and theory of plasticity in continuum mechanics. Analysis of simulation methods for the mechanical behavior of elastoplastic materials. Application of the critical state theory and its introduction into constitutive laws of behavior. Use of numerical analysis programs (FEM, FDM) for the simulation of soil materials after their yielding.                                                                                                                                                                                                                                                                                  |

**General Competences**

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

|                                                                                                      |                                                                                          |
|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Search for, analysis and synthesis of data and information, with the use of the necessary technology | Project planning and management                                                          |
| Adapting to new situations                                                                           | Respect for difference and multiculturalism                                              |
| Decision-making                                                                                      | Respect for the natural environment                                                      |
| Working independently                                                                                | Showing social, professional and ethical responsibility and sensitivity to gender issues |
| Team work                                                                                            | Criticism and self-criticism                                                             |
| Working in an international environment                                                              | Production of free, creative and inductive                                               |
| Working in an interdisciplinary environment                                                          | .....                                                                                    |
| Production of new research ideas                                                                     | Others...                                                                                |
|                                                                                                      | .....                                                                                    |

Successful completion of the course and the development of the assigned project will provide the ability to select appropriate constitutive laws, depending on the type of soil material and the applied loading, as well as to create complex analysis meshes, and analyze problems in multiple construction phases, accounting for the variability of boundaries and dimensions.

Key skills to be acquired include the use of finite element/finite difference software for the study of geotechnical engineering problems (foundations, retaining structures, slope stability, groundwater flow within soils, dams). During the use of these programs, complex constitutive laws of behavior will be applied.

**(3) SYLLABUS**

Presentation of the principles and theory of plasticity combined with the mechanical behavior of the continuum medium. Brief presentation of numerical methods (finite element method and finite difference method). Failure criteria, constitutive models of nonlinear behavior, perfect and hardening elastoplastic behavior. Meshing approaches. Introduction to the use of subroutines for automating the production of meshes and construction phases. Simulation of actions (gravity loads, seismic, initial stress state). Discretization of problems, principles of simulating elements of structures. Methodology for approaching problems. Fundamental principles of discretization and simulation of characteristic soil-structure interaction problems. Simplifying assumptions and conditions for geometry and loading to approach 3D problems in a plane strain or axisymmetric state. Assumptions for simulating soil response, structural elements, boundary and dimension variability, and problems with multiple construction phases. Simulation of piles under axial loading. Methods for determining the response of a single pile and pile groups. Simulation of piles under horizontal loading. Methods for determining the response of a single pile and pile groups. Simulation of stability problems using nonlinear constitutive models. Applications to retaining problems combined with anchorages. Application to tunnel cases with multi-stage analysis, use of direct support means.

**(4) TEACHING and LEARNING METHODS - EVALUATION**

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| <b>DELIVERY</b><br><i>Face-to-face, Distance learning, etc.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Face-to-face                                        |                          |
| <b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b><br><i>Use of ICT in teaching, laboratory education, communication with students</i>                                                                                                                                                                                                                                                                                                                                                                         | Use of ICT in teaching, communication with students |                          |
| <b>TEACHING METHODS</b><br><i>The manner and methods of teaching are described in detail.</i><br><i>Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.</i><br><br><i>The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS</i> | <i>Activity</i>                                     | <i>Semester workload</i> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Lectures                                            | 56                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Study                                               | 48                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Preparation for examinations                        | 15                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Examinations                                        | 2                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                     |                          |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Course total                                        | 121                      |

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| <p><b>STUDENT PERFORMANCE EVALUATION</b></p> <p><i>Description of the evaluation procedure</i></p> <p><i>Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other</i></p> <p><i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i></p> | <p>Assessment is conducted through a semester-project and an oral exam in Greek. Through the exam the student's ability to apply the topics taught in the course is assessed.</p> |
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### (5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

1. Comodromos E. (2009). Computational Geotechnical Engineering – Soil Structure Interaction. Kleidarithmos Ed., Athens (in Greek, distributed)
2. Bathe, K.J. and Wilson, E.L. (1976). Numerical Methods in Finite Element Analysis. Prentice-Hall, Englewood Cliffs, NJ.
3. Chen, W.F. (1982). Plasticity in Reinforced Concrete. McGraw-Hill Book Co., New York, N.Y., 474 pp. Chen, W.F. & Baladi, G.Y. (1986). Soil Plasticity - Theory and Implementation. Elsevier Science Publishing Company, Inc. NY.
5. Desai, C.S. and Abel, F.J. (1972). Introduction to the Finite Element Method. A Numerical Method for Engineering Analysis. Van Nostrand Reinhold Company -N.Y. Desai, C.S. (1977). Soil-Structure Interaction and Simulation Problems. In Finite Element in Geomechanics, ed. Gudehus G., John Wiley & Sons, pp. 209-250.
6. Desai, C.S. & Christian, J.T. (1977). Numerical Methods in Geotechnical Engineering.
7. NAFEMS (1992). Introduction to nonlinear finite element analysis. Glasgow: NAFEMS (edited by E. Hinton).
8. Oden, J.T. (1972). Finite Elements of Continua. McGraw-Hill Co., N.Y.
9. Owen, D.R.J. & Hinton, E., (1980). Finite Elements in Plasticity: Theory and Practice. Salencon, J. (1974). Théorie de la Plasticité pour les Applications à la Mécanique des Sols. Edit. Eyrolles, Paris.
10. Schofield, A.N. & Wroth, C.P. (1968). Critical-State Soil Mechanics. McGraw-Hill Book Co., London.
11. Smith, I. M. & Griffiths, D. V. (1988). Programming the finite element method. 2nd edition, New York, John Wiley & sons Ltd.
12. Zienkiewicz, O.C., (1977). The Finite Element Method. 3rd Edition, McGraw-Hill Book Co., New York.

- Related academic journals:

1. Journal of Geotechnical and Geoenvironmental Engineering, ASCE
2. International Journal for Numerical and Analytical Methods in Geomechanics
3. Canadian Geotechnical Journal
4. Computers & Geotechnics
5. Acta Geotechnica
6. Soils and Foundations
7. Geotechnical and Geological Engineering