ECTS
ΕΥΡΩΠΑΪΚΟ ΣΥΣΤΗΜΑ ΜΕΤΑΦΟΡΑΣ ΑΚΑΔΗΜΑΪΚΩΝ ΜΟΝΑΔΩΝ
ΣΤΗΝ ΕΥΡΩΠΑΪΚΗ ΕΝΩΣΗ

(B) Course information in English

General course information:

Course title:	Computational Geotechnical Engineering		**Course code:**	CE08-G07	
Credits:	5		**Work load (hours):**	140	
Course level:	Undergraduate	☑	Graduate	☐	
Course type:	Mandatory	☑	Selective	☐	
Course category:	Basic	☐	Orientation	☑	
Semester:	8th		**Hours per week:**	4	
Course objectives (capabilities pursued and learning results):					
Familiarization and implementation of numerical methods in solving geotechnical engineering problems. Comparison to the results derived using conventional methods of limit equilibrium. Comprehension and implementation of fundamental simulation principles.					
Prerequisites:					
Mechanics I, II & III Soil Mechanics I & II Foundations & Retaining Structures					

Instructors' data:

Name:	George Efremidis
Level:	Lecturer
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Other tutors:	50% co-teaching with P. Kallioglou

Name:	Polyxeni Kallioglou
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Specific course information:

Week No.	Course contents	Hours	
		Course attendance	Preparation
1	Introduction to finite element method. Methods of solving simple and complex geotechnical structures and problems. Introduction to numerical geotechnical methods. Introduction to finite element and finite differences methods.	4	1
2	Approximation with finite elements. The notion of master elements. Correspondence and transformation between real and master elements. Example of soil slope stability analysis using analytical methods (GEOSLOPE).	4	2
3	Formation of shape and interpolation functions of master elements. Example of embankment stability analysis using analytical methods (GEOSLOPE).	4	4
4	Matrix equations. Definition of stiffness matrix of a uniform isotropic body. Integration by Gauss. Exercise of stress and deformation analysis of earth structures (SIGMA/W).	4	4
5	Conversion of general loading to nodal loads. Establishment of stress field– initial stress condition. Exercise of water flow for the slope stability analysis of an earth structure (SEEP/W).	4	4
6	Fundamental principles of discretization and simulation of typical geotechnical problems. Stiffness matrix assembly. Stiffness matrix of 1D element. Exercise of air pressure and water flow into a tunnel (AIR/W).	4	4
7	Linear elastic behavior. Constitutive equations of elastic isotropic medium. Applications in Geomechanics. Introduction to FLAC.	4	4
8	Non-linear behavior. Fracture criteria and fracture surfaces. Basic commands of FLAC. Creation of uniform and uninform grids with FLAC.	4	4
9	Fracture criteria: von-Mises, Tresca, Mohr-Coulomb, Drucker-Prager, Lade-Duncan. Example of soil slope stability analysis using FLAC.	4	4
10	Discontinuum analysis. Distinct element method. Introduction to UDEC. Examples of jointed rock block and flexural toppling in discontinuous rock slope with UDEC. Example of soil excavation and backfill with FLAC.	4	6
11	Example of dynamic analysis in discontinuous rock slope with UDEC. Example of retaining wall analysis with FLAC.	4	6
12	Example of couple hydro-mechanical analysis of a slope in jointed rock with UDEC. Exercise of deformation and settlement analysis with FLAC.	4	6
13	Finite element method. Introduction to Phase. Example of tunnel stability with Phase. Example of tunnel stability with FLAC.	4	6
14	Example of an underground circular opening with discontinuity with Phase. Exercise of simulation of direct shear experiment with FLAC	4	6

Additional hours for:			
Class project	**Examinations**	**Preparation for examinations**	**Educational visit**
	3	20	

Suggested literature:

1. Comodromos, M.A. (2009). *Numerical methods in geomechanics – Soil-Structures Interaction*. Klidarithmos ed., Athens (in Greek).
2. Comodromos, M.A. (2003). *Numerical methods in geomechanics – Linear – Non linear analysis*. Ziti ed., Thessaloniki (in Greek).
3. Bathe, K.J. and Wilson, E.L. (1976). *Numerical Methods in Finite Element Analysis*. Prentice-Hall, Englewood Cliffs, NJ.
4. Bull, J.W., (2003), *Numerical Analysis and Modelling in Geomechanics*, Spon Press, Taylor and Francis Group.
5. Chen, W.F, & Baladi,G.Y. (1986). *Soil Plasticity - Theory and Implementation*. Elsevier Science Publishing Company, Inc. NY.
6. 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.
7. Desai, C.S. (1977). Soil-Structure Interaction and Simulation Problems. *In Finite Element in Geomechanics*, ed. Gudehus G., John Wiley & Sons, pp. 209-250.
8. Desai, C.S. & Christian, J.T. (1977). *Numerical Methods in Geotechnical Engineering*.
9. Hinton, E., and Owen, D.R.J., (1978), *Finite Element Programming*, Academic Press, Oxford.
10. NAFEMS (1992). *Introduction to nonlinear finite element analysis*. Glasgow: NAFEMS (edited by E. Hinton).
11. Oden, J.T. (1972). *Finite Elements of Continua*. McGraw-Hill Co., N.Y.
12. Owen, D.R.J. & Hinton, E., (1980). *Finite Elements in Plasticity: Theory and Practice.*
13. Schofield, A.N. & Wroth, C.P. (1968). *Critical-State Soil Mechanics*. McGraw-Hill Book Co., London.
14. Smith, I. M. & Griffiths, D. V. (1988). *Programming the finite element method*. 2nd edition, New York, John Wiley & sons Ltd.
15. Zienkiewicz, O.C., (1977). *The Finite Element Method*. 3rd Edition, McGraw-Hill Book Co., New York.

Teaching method *(select and describe if necessary* - **weight**)*:*		
Teaching	☑	60%
Seminars	☐	…….%
Demonstrations	☐	…….%
Laboratory	☐	…….%
Exercises	☑	40%
Visits at facilities	☐	…….%
Other *(describe):* ……	☐	…….%
Total		100%

Evaluation method *(select)* - **weight:**				
	written	*%*	*Oral*	*%*
Homework	☐		☐	
Class project	☐		☐	
Interim examination	☐		☐	
Final examinations	☑	100	☐	
Other *(describe):* ……	☐		☐	