COURSE OUTLINE

(1) GENERAL

SCHOOL	**UNIVERSITY OF THESSALY**		
ACADEMIC UNIT	DEPARTMENT OF CIVIL ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**ΓΕ0600**	**SEMESTER**	9ο
COURSE TITLE	TUNNELS AND UNDERGROUND WORKS		

INDEPENDENT TEACHING ACTIVITIES *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*	**WEEKLY TEACHING HOURS**	**CREDITS**
	4	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Specialized general knowledge
PREREQUISITE COURSES:	Soil Mechanics I, Soil Mechanics II Geology for Engineers, Rock Mechanics Foundation and Retaining Structures Computation Geotechnical Engineering
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	-

(2) LEARNING OUTCOMES

Learning outcomes

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.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Understanding the specific requirements and methodologies for the preliminary design of tunnels.
Application of preliminary design methodologies for assessing the stress state and plastic zones caused by tunnel excavation.
Determination of immediate support measures using simplified methods.
Interaction of elastoplastic response curves of the surrounding rock mass with immediate support measures.
Tunnel excavation in urban environments – methods for mitigating impacts on adjacent structures.
Use of numerical methods for the analysis and design of tunnels in two and three dimensions.

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 thinking Working in an interdisciplinary environment*
Production of new research ideas	*……*
	Others…
	…….

The students acquire the following general competences:

1. Search for, analysis and synthesis of data and information
2. Decision-making
3. Project planning

(3) SYLLABUS

1. Tunnel types, description of construction methods in soil and rock formations.
2. Evaluation of in-situ geological and geotechnical conditions. Requisite site tests and measurements and laboratory tests to define design parameters of soil materials and domain topology.
3. Initial stress field definition. Anticipated kinematic and stress field due to excavation. Yielding zones and general pathology due to excavation.
4. Tunnel stability. Typical shapes of instability. Reaction curves of surrounding rock mass in relation to excavation step. Linear elastic and elastoplastic approach.
5. Elastoplastic response curves of surrounding rock mass in relation to excavation size and immediate support measures.
6. Description of primary support measures. Variation associated with placement convenience, partial and full activation time and installation cost.
7. Preliminary design of primary support measures, according to custom geotechnical rating systems (Bieniawski rock mass rating system application).
8. Preliminary design of primary support measures, according to custom geotechnical rating systems (Q rock mass rating system application).
9. Dependence of primary support measures' selection and implementation sequence on construction method.
10. Preliminary tunnel design example. Definition of strength parameters and deformation modules, application of geotechnical rating systems, adequacy control using pressure-convergence curves.
11. Application of numerical methods in tunnel designing. Reference to simplified numerical approaches.
12. Finite Element Method application to simulate tunnel construction as a multistage problem, with variable boundaries and capability of primary support activation and deactivation.
13. Modification of constitutive materials' stiffness during various stages. Interaction of surrounding rock mass and final lining elements.
14. Simulation, analysis, solution framework allowing for load combinations, final design. Representative examples of tunneling.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY ***Face-to-face, Distance learning, etc.***	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of ICT in teaching, communication with students
TEACHING METHODS *The manner and methods of teaching are described in detail.* *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.* *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*	
STUDENT PERFORMANCE EVALUATION ***Description of the evaluation procedure*** *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* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	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.

Activity	*Semester workload*
Lectures	56
Study	32
Educational visits or videos of construction methods	6
Preparation for examinations	24
Project	60
Examinations	2
Course total	*180*

(5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

1. Bouvard-Lecoanet, A, Colombet, G. et Esteulle, F. (1988). Ouvrages Souterrains – Conception – Realisation – Entretien. Presses Ponts et Chaussées, Paris.
2. Hoek, E., Kaiser, P.K. and Bawden, W.F. (1995). Support of Underground Excavations in Hard Rock. A. A. Balkema, Brookfield, VT 05036, USA.
3. Wyllie, D. C. (1992). Foundation on Rock. Chapman & Hall, London, pp. 333.
4. Panet, M., (1995). Calcul des Tunnels par la méthode convergence-confinement. Département Edition de l'Association Amicale des Ingénieurs Anciens Elèves, Paris: Press de *l'Ecole Nationale des Ponts et Chaussées.*

- Related academic journals:

1. Geotechnique
2. Journal of Geotechnical and Geoenvironmental Engineering, ASCE
3. International Journal for Numerical and Analytical Methods in Geomechanics
4. Canadian Geotechnical Journal

5. Computers & Geotechnics Acta Geotechnica
6. Soils and Foundations
7. Geotechnical and Geological Engineering