COURSE OUTLINE

1.GENERAL

SCHOOL	ENVIROMENT AND AGRICULTURAL ENGINEERING		
ACADEMIC UNIT	NATURAL RESOURCES & AGRICULTURAL ENGINEERING		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	248	**SEMESTER**	7th
COURSE TITLE	HYDROGEOLOGY		

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**
Lectures	2	
Laboratory Exercises	1	
		3
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, specialised general knowledge, skills development*	Special background Skills development
PREREQUISITE COURSES:	Geology - Geomorphology
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	NO

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*

The scope of the course is to provide the fundamental knowledge in the subject of Hydrogeology with emphasis on the importance of groundwater and its correlation with the bedrock, regarding its quality and quantity, its exploitation through boreholes and the planning measures against water degradation.

In Hydrogeology, students will gain an in-depth understanding regarding the hydrological and hydrogeological basin difference. Moreover, they will be familiar with concepts such as groundwater watershed and the importance of the dip and dip direction of geological layers in the groundwater flow. The course will synthesize new knowledge on hydrogeological behavior of geological formations using previous knowledge gained on courses like Geology-Mineralogy (1st semester) and Geology-Geomorphology (4th semester).

Boreholes will be discussed and analysed as major agricultural infrastructures focusing on pumping techniques and selecting suitable drilling points based on geological mapping and geophysical investigations.

It is a principal matter for students to understand how geology determines both the quantitative reserves and the quality of groundwater and how anthropogenic interventions create a negative impact due to incorrect groundwater use standards. There are important problems resulting from anthropogenic activity including salinization of coastal aquifers, movement and accumulation of pollutants such as nitrates, heavy minerals and lately microplastics. These issues, which are of great importance for the sustainability of water resources, will be discussed with the students in order to consolidate the pollutants pathways in groundwater systems, the ways of dealing with such matters, as well as protecting them.

Thermometallic-thermal waters due to the beneficial properties for human health and geotourism, will also be

presented, emphasing on the geothermal energy and the geological processes.

A key pillar of environmental planning is groundwater movement therefore, students will be trained in the basic principles of Hydrogeological Modeling using the open source MODFLOW code developed by the USGS (United States Geological Survey) while in terms of laboratory exercise they will work with ModelMuse software to build a hydrogeological model of groundwater flow. In addition, other software will be shown regarding the analysis of spatial distribution of geochemical parameters and the evaluation of groundwater data extracted from pumping.

In conclusion, the Hydrogeology course is designed for the implementation of knowledge regarding research methods, exploitation and protection of groundwater systems. It aims to introduce students to the basic concepts of the hydrogeological environment and equip graduates with the necessary tools to be able to respond to hydrogeological matters.

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…*
	…….

- Respect for the natural environment
- Search, analysis and synthesis of data and information, using necessary technologies
- Working in an interdisciplinary environment
- Project planning and management

3.SYLLABUS

1. Subject of hydrogeology-Water Cycle-Water balance.
2. Hydrogeological behavior of geological formations-Vertical distribution of groundwater-Aquifers-Springs and classification of springs.
3. Groundwater movement. Pumping tests and calculation of hydraulic parameters.
4. Water Drilling techniques. Locating aquifers. Geophysical exploration.
5. Hydrogeological environments, Granular formations, Karstic systems, Fissured rocks.
6. Groundwater reserves. Artificial recharge.
7. Environmental effects on aquifer water level fluctuations.
8. Salinization of coastal aquifers.
9. Qualitative characteristics of groundwater-Pollution-Contamination-Protection measures against water abstraction projects.
10. Thermometallic-Thermal waters

1st Lab Exercise	Piezometric map design
2nd Lab Exercise	Piezometry evaluation in consolidated and non-consolidated geological formations, geohydraulic parameters estimation
3rd Lab Exercise	Data evaluation of a karstic system: Karst aquifer capacity, Artificial Recharge, Hydrochemical analysis evaluation, Karstic leaching action
4th Lab Exercise	Geohydraulic parameters estimation via grading analysis, pumping test characteristic curve evaluation

5th Lab Exercise	Hydrochemical analysis evaluation using PIPER and DUROV diagrams
6th Lab Exercise	Geohydraulic parameters and capacity estimation of an aquifer,
7th Lab Exercise	Geohydraulic parameters estimation using DUPUIT method
8th Lab Exercise	Geohydraulic parameters estimation using THEIS method
9th Lab Exercise	Hydrochemical analyses evaluation from an artificially recharged area to the aquifer's discharge area, using standards of groundwater
10th Lab Exercise	Groundwater tracing evaluation, geohydraulic parameters estimation
11th Lab Exercise	Data evaluation of pumping tests in unconfined and confined aquifers, THEIS-COOPER-JACOB method analysis
12th Lab Exercise	Hydrogeological simulation of subsurface flow through the use of open access software MODFLOW (USGS) and simulation of Cl and conductivity values for mapping the salinization front.

4.TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Classroom, Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td></td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>24</td></tr>
<tr><td>Laboratory Practice</td><td>12</td></tr>
<tr><td>Individual study</td><td>39</td></tr>
<tr><td>Course total</td><td>75</td></tr>
</table>
</td></tr>
<tr><td>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.</td><td>I. Written final exam on the lectures (50%) including short-answer questions.

II. Written final exam on a laboratory exercise (50%)</td></tr>
</table>

5.ATTACHED BIBLIOGRAPHY

- *Suggested bibliography:*
- Investigating Groundwater, Ian Acworth, CRC Press, 2019.
- Groundwater, R. Allan Freezy, J Cherry, Prentice Hall, 1979.

- *Related academic journals:*
- Hydrogeology Journal, International Association of Hydrogeologists, Springer.
- Proceedings of the International Hydrogeological Congresses.