

## COURSE OUTLINE

### 1. GENERAL

<b>SCHOOL</b>	SCHOOL OF ENGINEERING		
<b>ACADEMIC UNIT</b>	DEPARTMENT OF MINERAL RESOURCES ENGINEERING		
<b>LEVEL OF STUDIES</b>	<i>Undergraduate</i>		
<b>COURSE CODE</b>	MRE913	<b>SEMESTER</b>	9th
<b>COURSE TITLE</b>	Reservoir and Tailings Dams		
<b>INDEPENDENT TEACHING ACTIVITIES</b>		<b>WEEKLY TEACHING HOURS</b>	<b>CREDITS</b>
Lectures		2	5
Laboratory or Tutorials		2	
Overall		4	
<b>COURSE TYPE</b>		General knowledge specialization	
<b>PREREQUISITE COURSES:</b>	Mechanics - Structures (MRE204) Geotechnical and Soil Mechanics (MRE401) Rock Mechanics - Engineering Geology (MRE701) Retaining and Support of Surface & Underground Excavations (MRE811)		
<b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>	Greek		
<b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>	NO		
<b>COURSE WEBSITE (URL)</b>			

### 2. LEARNING OUTCOMES

<b>Learning outcomes</b>
<p>The course aims to the understanding of the basic principles of Advanced Geomechanics and Dam and Tailing Dams Design, the consolidation of knowledge regarding the behavior of soil and rock mass in Dam Design and Advanced Geomechanics and the possibility of using computational methods and techniques in Advanced Geoengineering applications. Students study the analysis and design of embankments, earth dams and rock-filled dams. The engineering geological environment, the problems of the foundation, slope stability and the construction materials are investigated. Stability analyses of slopes and groundwater flow nets and paths are performed. Filters, diaphragms, cement injections, jet grouting curtains, are all studied. Quality controls of embankment zones are performed. Methods of analysis of seismic behavior of dams with performance-based design criteria are examined. Extensive historical incidents of good and bad behavior of tailing dams are investigated. Visits are made to real dams and tailing dams with engineering presentations.</p> <p>Upon successful completion of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Designs the basic elements of a dam / tailing dam.</li> <li>• Analyzes slope stability.</li> <li>• Analyzes underground flow nets, and Designs filters, bulkheads, cement injections, jet grouting curtains.</li> <li>• Performs quality control of embankment zones.</li> <li>• Analyzes the seismic behavior of dam / tailing dam with performance-based design criteria.</li> <li>• Understands required dam design background.</li> <li>• Identifies actions/loading on dams / tailing dams projects and Calculates sections of dam / tailing dam.</li> <li>• Forms the structural elements design that compose the dam / tailing dam constructions.</li> </ul> <p>In addition, he will advance his specialized knowledge in the following advanced subjects:</p> <ul style="list-style-type: none"> <li>• Understanding the special requirements &amp; methodologies of preliminary dam / tailing dam design.</li> <li>• Application of preliminary design methodologies for assessment of the stress conditions of dams / tailing dams.</li> <li>• Use of numerical methods for the analysis-design of dams / tailing dams in two &amp; three dimensions.</li> </ul>
<b>General Competences</b>
<p>The course contributes to the acquisition of the following skills:</p> <ul style="list-style-type: none"> <li>• Applying knowledge in practice,</li> <li>• Researching, Analyzing &amp; Synthesizing Data &amp; Information using necessary technologies,</li> </ul>

- Adapting to new situations,
- Working independently & Working in an international environment,
- Working in groups (Teamworking),
- Decision-making and Promoting Free, Creative & Inductive thinking.

### 3. SYLLABUS

General: General - Introduction to dams. Loading and safety factor. Geotechnical site investigation and Characterization. Geological - geotechnical engineering conditions of the foundation ground. Hydrology. Foundation Design of dams / tailing dams. Concrete dams. Embankment type dams / tailing dams. Spillways, Construction of dams / tailing dams. Slopes of dam / tailing dam embankments related to slope stability, Simulation of earth dams / tailing dams, construction and in-filling. Tailings Dam is typically an embankment type dam used to store by-products of mining operations after the ore has been separated from the gangue (the commercially useless material in which the ore is located). Operating waste disposal management: Liquids, Solids or Fine Particle Slurry. Very toxic and possibly radioactive materials that pollute and contaminate the environment. Requirements for very careful design and construction. Mine Dams / Tailing Dams: Characteristics, Failures, Environmental Impacts and their Rehabilitation.

Theory: Introduction. Hydrologic basin morphology. Hydrological elements of the catchment area. Geotechnical / Geological data of the flood hydrologic basin and of the foundation location of the dam / tailing dam. Geotechnical parameters of flood hydrologic basin design and dam foundation location. Ensuring the water-tightness of geological formations of the reservoir. Stability of reservoir slopes and strengthening/supports. Seismicity of the area. Rock Weathering - Corrosion. Ensuring the dam foundation security. Ensuring the water-tightness of the Dam / Tailing Dam foundation zone. Slope stability Analysis and Design. Borrow Pits of construction materials at a short distance from the project. Design of water reservoirs. Leakage control. Dams/ tailing dams typology: classification-design-construction issues.

Tutorial exercises: Dimensioning of typical sections of dams / tailing dams and construction configuration.

Advanced issues:

- Hydrodynamic installations, Spillways, characteristics, classification, layout.
- Reservoirs, features, design.
- Dams/ tailing dams, types, categorization, selection factors. Gravity dams, construction, analysis. Arched dams, Buttress Dams, RCC, design. Earth fill dams / tailing dams, Types, Construction, Design, Flow paths in and under the dam, Flow nets, Stability.
- Spillways, types, design. Water intakes. Other technical projects of hydrodynamic installations.
- Flood protection works. Causes of flooding and actions.
- Stream management and protection works, Reduction of Q-peak flow quantity of discharge, Increase of stream flow capacity, construction of embankments and dams / tailing dams.
- Applications, Analysis and Design.

More details:

Embankments, Earth fill dams and Rockfill dams. Zoning, Choice of embankment type. Common causes of dam failure. The Geological environment (foundation - construction materials). Special geotechnical problems related to the most common Geological formations. Geotechnical Site Investigation and Characterization. Field in-situ methods. Permeability tests. Laboratory tests of construction materials. Geotechnical parameters. Flow nets through the dam and the foundation. Pore water pressures on the embankment. Hydraulic excavation and liquidation. Methods of analysis of embankments and dam / tailing dam stability. Applications of slope stability analyses of embankments and natural slopes. Special problems of fine grained soils and clay soils: internal erosion/piping effects, etc. Design and construction of filters. Specifications and quality control of embankment zones - Proctor tests. Preparation of the foundation, excavations in the abutments and related problems. Diaphragms. Rock cement injections and jet grouting piles. Cut-off Curtains. Construction details of the embankments. Construction stages and related projects (diversion tunnel, spillways, evacuation tunnels, caissons, etc.). Dams with upstream concrete slabs. Comparative advantages. Investigation of historical facts. Visit to a real dam / tailing dam. On-site analysis of the special conditions of geology, foundation, construction materials, design and safety issues. Seismic analysis of dams / tailing dams. Methods of analysis. Permanent slope displacements. Seismic safety. Numerical simulation applications in real dams. Project Security: Dams / tailing dams behavior monitoring instruments (Instrumentation). Safety evaluation, etc..

#### 4. TEACHING and LEARNING METHODS - EVALUATION

<p style="text-align: center;"><b>DELIVERY</b></p>	<p>In the classroom and in the laboratory (Face-to-face). Webinars. Tutorials. Laboratory demonstrations. Possibility of distance lectures if required via Zoom Cloud Meeting.</p>	
<p style="text-align: center;"><b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b></p>	<p>Presentation of lectures using PC (presentations, experimental videos, etc.). Support of learning process through the electronic platform eLearning and electronic communication with students (Online announcements and comments, forum, email etc.). Self-assessment questionnaires in the eLearning environment of the course and asynchronous training platform - eclass. Assistance in completing assignments through result files for each individual student.</p>	
<p style="text-align: center;"><b>TEACHING METHODS</b></p>	<p><b>Activity</b></p>	<p><b>Semester Workload</b></p>
	<p>Lectures</p>	<p>26</p>
	<p><i>Laboratory exercises and processing of results with computational procedures</i></p>	<p>26</p>
	<p><i>Individual assignments on laboratory exercises &amp; theory (Coursework) and application exercises</i></p>	<p>30</p>
	<p><i>Independent Home Study</i></p>	<p>48</p>
	<p><b>Overall Course Set (26 hours of workload per credit unit)</b></p>	<p><b>130</b></p>
<p style="text-align: center;"><b>STUDENT PERFORMANCE EVALUATION</b></p>	<p>Written final theory exam that includes:</p> <ul style="list-style-type: none"> <li>• Theoretical judgment questions in course subjects (short answer questions and multiple choice questions).</li> <li>• Problem solving-exercises.</li> <li>• Solving of laboratory exercises.</li> </ul> <p>Delivery of assignments and oral examination that includes:</p> <ul style="list-style-type: none"> <li>• Laboratory work (processing of results of laboratory exercises).</li> <li>• Solving of application exercises.</li> <li>• Examining the understanding of basic concepts.</li> </ul>	

## 5. SUGGESTED BIBLIOGRAPHY

- Sachpazis, C., "Geotechnical Engineering Lecture-Notes for Tunnels - Dams", 2019.
- Sachpazis, C., (2020) "Geotechnical Engineering of Dams". Academic Book, 455 Pages, Code in Eudoxus: 77120847. ISBN Code: 978-618-83547-0-8. Ch. Tsapraili Publications © 2019.
- Earthworks, Thanopoulos, I., 2012.
- Geotechnical Engineering of Dams, Robin Fell, Patrick MacGregor, David Stapledon, Graeme Bell, Taylor & Francis, 2014.
- Concrete Face Rockfill Dams, Paulo Teixeira da Cruz, Bayardo Materon, Manoel De Souza Freitas Jr., CRC Press, 2015.
- P. Novak, AIB Moffat, C. Nalluri, R. Narayanan. Hydraulic Structures. 4th edition. CRC Press. ISBN 9780415386265. 2006.
- Klohn Leonoff, Design and Construction of Tailings Dams: Proceedings of a Seminar, November 6-7, 1980, Golden, Colorado. David Wilson (Edition).
- Wiley series in geotechnical engineering: Planning, design, and analysis of tailings dams. 369 pages. Publisher: Wiley; 1st Edition (1983) Language: English. ISBN-10: 0471898295 / ISBN-13: 978-0471898290
- ΥΠΕ.ΧΩ.Δ.Ε (2004), Technical specifications of dams.
- PPC Directorate of Education (1995), The Geology and the dams of PPC
- RK Linsley et al. (1992), Water- resources engineering, Mc Graw - Hill Inc.
- US Army Corps of Engineers, Earth and Rock-Fill dams-General Design and Construction considerations
- US Army Corps of Engineers, Arch dam design
- US Army Corps of Engineers (1970) Stability of Earth and Rock-Fill dams, Eng. Manual 1110-2-1902
- US Army Corps of Engineers, Seepage analysis and control for dams
- US Army Corps of Engineers, Gravity dam design
- Div. of Rock Mechanics (1996), Large scale slope stability in open pit mining - A review, Technical Report
- Rickenmann & Chen (eds) (2003), - Flow hazards mitigation: Mechanics, Prediction and Assessment, Millpress
- CCSwn & YKSeo (1999), Slope stability analysis using FE Techniques, 13th Iowa ASCE Geotech. Conf., Williamburg, Iowa
- R.Fell, P.MacGregor, D.Stapledon (1992), Geotechnical engineering of embankment dams, AA Balkema Publishers
- US Dep. Of the Interior (1987), Design of small dams, A Water Resources Technical Publication, 3rd Edition
- US Army Corps of Eng. (1995), Instrumentation of embankment dams and levees, Eng. Manual 1110-2-1908
- US Army Corps of Eng. (2000), Design and construction of levees, Eng. Manual 1110-2-1913
- US Army Corps of Eng. (1995), Construction control for earth and rock-fill dams, Eng. Manual 1110-2-1911.

### Related scientific journals:

- Electronic Journal of Geotechnical Engineering
- Journal of Geotechnical and Geoenvironmental Engineering Geotechnique
- Geotechnical and Geological Engineering Canadian Geotechnical Engineering
- International Journal for Numerical and Analytical Methods in Geomechanics Canadian Geotechnical Journal
- Geotechnics
- Soil Dynamics and Earthquake Engineering
- Computers & Geotechnics
- Geotechnical and Geological Engineering
- Rock Mechanics and Rock Mechanics