



National University of Engineering (UNI)

School of Civil Engineering

Syllabus 2026-II

1. COURSE

CE3G6. Earth Dams (Mandatory)

2. GENERAL INFORMATION

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|----------------------------|---|---|
| 2.1 Course | : | CE3G6. Earth Dams |
| 2.2 Semester | : | 9 th Semester. |
| 2.3 Credits | : | 4 |
| 2.4 Hours | : | 4 HT; |
| 2.5 Duration of the period | : | 16 weeks |
| 2.6 Type of course | : | Mandatory |
| 2.7 Learning modality | : | Face to face |
| 2.8 Prerequisites | : | <ul style="list-style-type: none">• CE2G2. Soil Mechanics II. (8th Sem)• CE2H1. Fluid Mechanics I. (7th Sem) |

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Earth Dams is a Geotechnical Engineering track specialization elective that applies the shear strength, seepage, and slope stability framework developed in Soil Mechanics II, together with the open-channel and hydraulic-structures framework developed in Fluid Mechanics II, to the analysis, design, construction, and operational safety of embankment (earth and rockfill) dams. The course begins with the definition and typology of earth dams and the geotechnical characterization of foundation and borrow materials specific to dam projects, then develops the dam-specific investigation program – building on the general subsurface investigation techniques introduced in Soil Mechanics I – that supports embankment design. It then addresses the geotechnical design of the embankment itself: seepage control through cores, cutoffs, and grout curtains; slope stability of the dam faces under steady-state, rapid-drawdown, and seismic conditions; and filter/drain design against internal erosion. The course closes with the instrumentation and monitoring systems used to verify embankment performance, the constructive aspects of foundation treatment and fill placement, and the operational management and safety practices – surveillance, risk assessment, and emergency action planning – required over a dam's service life.

5. GOALS

- Classify earth and rockfill dam typologies and describe the zoning of an embankment dam.
- Characterize foundation and borrow materials for embankment dam design.
- Plan and interpret geotechnical investigation programs specific to dam projects, including foundation permeability testing and borrow area evaluation.
- Design seepage control measures and filter/drain systems, and evaluate the slope stability of embankment dam faces.
- Design an instrumentation and monitoring program to track dam performance throughout construction and operation.
- Apply construction quality-control practices for foundation treatment and fill placement in embankment dams.
- Evaluate dam safety management practices, including risk assessment and emergency action planning, for dam operation.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Usage)

ABET-2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (Usage)

ABET-6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (Usage)

7. TOPICS

Unit 1: Earth Dams (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Definition, function, and role of earth dams within water resources infrastructure • Typology of embankment dams: homogeneous and zoned earthfill/rockfill dams, and selection criteria • Dam zoning: core, shell, filters, drains, and transition zones • Site selection factors and reservoir/dam-site feasibility considerations	• Explain the function of earth dams and their role within water resources infrastructure [Familiarity] • Classify embankment dams by type and select an appropriate typology for given site and material conditions [Assessment] • Describe the zoning of an earth dam and the function of each zone (core, shell, filters, drains) [Familiarity] • Evaluate site selection factors governing dam type and location choice [Usage]
Readings : [Fel+15], [US 87]	

Unit 2: Geotechnical Characterization for Earth Dams (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Foundation geotechnical characterization: rock and soil foundation conditions for embankment dams • Characterization of borrow materials for core, shell, and filter zones • Compaction and shear strength properties of compacted fill materials • Permeability characterization of foundation and embankment materials • Dispersive soil identification and erodibility assessment for core materials	• Characterize foundation soil and rock conditions relevant to embankment dam design [Assessment] • Evaluate borrow material sources for suitability as core, shell, or filter material [Usage] • Determine compaction and shear strength properties of compacted embankment materials [Assessment] • Assess dispersive soil potential and erodibility of candidate core materials [Usage]
Readings : [Fel+15], [US 87]	

Unit 3: Site Investigation and In-Situ Testing (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Investigation planning and scope determination • Boring methods and subsurface exploration techniques • Sampling methods for disturbed and undisturbed samples • Standard Penetration Test and correlations • Laboratory testing program and test selection • Cone Penetration Test and piezocone testing • Vane shear test and pressuremeter testing • Geophysical methods including seismic and resistivity surveys • Groundwater monitoring and piezometer installation • Report preparation and geotechnical data presentation • In-situ permeability (Lugeon/packer) testing for foundation grouting and seepage assessment • Borrow area investigation for embankment fill material quantity and quality	• Develop appropriate site investigation programs based on project requirements [Assessment] • Select appropriate boring and exploration methods for different soil conditions [Familiarity] • Specify sampling techniques to obtain quality samples for testing [Usage] • Interpret SPT data and apply empirical correlations for design parameters [Assessment] • Design laboratory testing programs for geotechnical projects [Usage] • Analyze CPT and piezocone data for soil profiling and parameter evaluation [Assessment] • Apply vane shear and pressuremeter tests for soft clay characterization [Usage] • Utilize geophysical methods to complement traditional investigation techniques [Assessment] • Monitor groundwater conditions and interpret piezometric data [Usage] • Prepare comprehensive geotechnical investigation reports [Assessment] • Perform packer (Lugeon) testing and interpret results for foundation grouting curtain design [Usage] • Characterize borrow areas for embankment fill material quantity and quality [Assessment]
Readings : [Das19], [Fel+15]	

Unit 4: Geotechnical Design of Embankment Dams (12 hours)	
Competences Expected: ABET-1,ABET-2	
Topics	Learning Outcomes
• Seepage analysis through the embankment and foundation using flow nets and numerical methods • Seepage control measures: core design, cutoff walls, and grout curtains • Filter and drain design criteria to prevent internal erosion and piping • Slope stability analysis of upstream and downstream dam faces under static and rapid drawdown conditions • Seismic design considerations and deformation analysis for embankment dams • Freeboard determination and settlement/camber allowance in embankment design	• Analyze seepage through the embankment and foundation using flow nets or numerical seepage models [Assessment] • Design seepage control measures including impervious cores, cutoff walls, and grout curtains [Usage] • Design filter and drain zones according to piping and internal erosion criteria [Assessment] • Evaluate slope stability of dam faces under steady-state seepage, rapid drawdown, and end-of-construction conditions [Usage] • Incorporate seismic loading and deformation analysis into embankment dam design [Assessment] • Determine freeboard and settlement allowances for embankment design [Usage]
Readings : [Fel+15], [She+63], [US 03]	

Unit 5: Dam Instrumentation and Monitoring (12 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Instrumentation planning: objectives, parameters to monitor, and instrument selection • Piezometers and pore pressure measurement systems • Settlement and deformation monitoring: surface markers, inclinometers, and extensometers • Seepage flow monitoring using weirs and flow measurement devices • Data acquisition, automation, and interpretation of monitoring records • Threshold (alert/alarm) values and performance evaluation criteria	• Plan an instrumentation program defining monitoring objectives and parameters [Usage] • Select and locate piezometers to monitor pore pressure within the embankment and foundation [Assessment] • Specify deformation monitoring instruments (markers, inclinometers, extensometers) for an embankment dam [Usage] • Monitor seepage flow and interpret trends against baseline conditions [Assessment] • Interpret monitoring data and establish threshold values for dam safety alerts [Usage]
Readings : [Dun93], [Fel+15]	

Unit 6: Construction of Earth Dams (8 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
- Foundation preparation and treatment: stripping, grouting, and cutoff trench excavation - Placement and compaction of core, filter, and shell fill materials - Field compaction quality control and acceptance testing - Construction sequencing, staged construction, and river diversion during construction - Construction-phase monitoring and as-built verification	- Specify foundation treatment methods including cut-off trench excavation and grouting [Usage] - Control fill placement and compaction to meet design specifications [Assessment] - Verify compaction quality through field acceptance testing [Usage] - Sequence embankment construction considering staged construction and river diversion [Assessment]
Readings : [US 87], [Fel+15]	

Unit 7: Operation and Safety Management of Dams (8 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
- Dam surveillance programs: visual inspection and periodic evaluation procedures - Risk assessment and hazard classification of dams - Emergency action plans and downstream hazard/inundation mapping - Regulatory framework and dam safety programs (e.g., Peru's ANA dam safety regulations) - Dam rehabilitation, decommissioning, and aging infrastructure management	- Conduct dam surveillance inspections and evaluate performance indicators [Usage] - Classify dam hazard potential and assess associated risks [Assessment] - Develop an emergency action plan including downstream inundation mapping [Usage] - Apply regulatory dam safety requirements to an operating dam [Assessment] - Propose rehabilitation measures for aging or deficient dam infrastructure [Usage]
Readings : [Fed04], [Fel+15]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

***** EVALUATION MISSING *****

10. BASIC BIBLIOGRAPHY

- [She+63] James L. Sherard et al. *Earth and Earth-Rock Dams: Engineering Problems of Design and Construction*. John Wiley & Sons, 1963.
- [US 87] U.S. Bureau of Reclamation. *Design of Small Dams*. Tech. rep. U.S. Government Printing Office, 1987.

- [Dun93] John Dunncliff. *Geotechnical Instrumentation for Monitoring Field Performance*. John Wiley & Sons, 1993.
- [US 03] U.S. Army Corps of Engineers. *Engineering and Design: Slope Stability*. Tech. rep. EM 1110-2-1902. U.S. Army Corps of Engineers, 2003.
- [Fed04] Federal Emergency Management Agency. *Federal Guidelines for Dam Safety*. Tech. rep. FEMA 93. FEMA, 2004.
- [Fel+15] Robin Fell et al. *Geotechnical Engineering of Dams*. 2nd. CRC Press, 2015.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.