



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2026-II

1. COURSE

CE3G3. Applied Geology (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3G3. Applied Geology
2.2 Semester	: 9 th Semester.
2.3 Credits	: 4
2.4 Hours	: 3 HT; 2 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: CE2G2. Soil Mechanics II. (8 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Applied Geology extends the descriptive foundations of General Geology, and draws on the field investigation skills introduced in the Geotechnical Engineering sequence, into the practicing engineering geologist's toolkit for civil infrastructure. The course develops rock mass characterization and standard classification systems, engineering geological and geotechnical mapping, and the geological evaluation of soils and rocks as natural resources for construction materials, then applies this framework to the siting and design of two major groups of infrastructure works — roads and canals, and bridges, tunnels, and dams — and closes with the classification, field recognition, and hazard mapping of mass movements and other geological hazards relevant to civil works. As part of the Geotechnical specialization track, it complements the design-oriented Soil Mechanics sequence (Soil Mechanics I-II) with the geological judgment required to characterize sites, select construction materials, choose infrastructure alignments, and anticipate geological hazards.

5. GOALS

- Plan and interpret geotechnical field investigations to characterize subsurface conditions for engineering projects.
- Characterize rock masses in the field and estimate their strength and deformability using standard classification systems (RMR, Q, GSI, and the Hoek-Brown criterion).
- Prepare and interpret engineering geological and geotechnical maps for infrastructure planning and hazard zonation.
- Evaluate soils and rocks as natural resources for construction materials.
- Apply engineering geological criteria to the siting and design of roads and canals.
- Apply engineering geological criteria to the siting and design of bridges, tunnels, and dams.
- Classify, recognize in the field, and map geological hazards and mass movements, and propose appropriate mitigation measures.

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: Site Investigation and In-Situ Testing (5 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]	

Unit 2: Engineering Geological and Geotechnical Mapping (5 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
- Types and purposes of engineering geological and geotechnical maps - Geotechnical zonation and microzonation mapping for urban and infrastructure planning - Specialized symbology and legends for engineering geological maps - Use of GIS and remote sensing tools in geotechnical mapping	- Distinguish the types and purposes of engineering geological and geotechnical maps [Familiarity] - Prepare a basic geotechnical zonation map for a project area [Usage] - Apply GIS tools to compile and present geotechnical mapping information [Usage]
Readings : [Val+02]	

Unit 3: Rock Mass Characterization and Applied Rock and Soil Mechanics (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
- Characterization of rock mass discontinuities: orientation, spacing, persistence, roughness, aperture, and infill - Rock Quality Designation (RQD) and geotechnical core logging - Rock mass classification systems: RMR, Q-system, and GSI - Estimation of rock mass strength and deformability using the Hoek-Brown criterion - Influence of weathering grade on rock mass mechanical behavior - Influence of geological origin -residual versus transported- on soil engineering properties	- Characterize rock mass discontinuities from field or core data [Usage] - Determine RQD and classify rock mass quality using RMR, Q, and GSI systems [Assessment] - Estimate rock mass strength and deformability parameters using the Hoek-Brown criterion [Assessment] - Relate weathering grade to expected rock mass mechanical behavior [Familiarity] - Relate the geological origin of a soil to its expected engineering properties [Usage]
Readings : [Bie89], [HB81], [Val+02]	

Unit 4: Soils and Rocks as Natural Resources for Construction Materials (5 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
- Geological sources and quality evaluation of aggregates for concrete and construction - Site selection and geological evaluation of quarries and borrow pits - Dimension stone and other rock and soil resources used in construction - Basic quality control criteria and tests for construction material sources	- Evaluate geological sources of aggregates and construction materials for quality and suitability [Usage] - Select and assess quarry and borrow-pit sites based on geological criteria [Assessment] - Apply basic quality control criteria to construction material sources [Familiarity]
Readings : [SC01], [Val+02]	

Unit 5: Engineering Geology Applied to Roads and Canals (15 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Geological considerations for highway and road alignment selection • Geological and hydrogeological conditions for canal siting and seepage control • Structural geological controls on cut-slope stability along transportation corridors • Geological and geotechnical conditions for road and canal embankment foundations • Engineering geological mapping and hazard identification along linear infrastructure corridors	• Evaluate geological conditions to support road and canal alignment selection [Assessment] • Assess seepage and foundation conditions for canal design based on geological survey [Usage] • Analyze structural geological controls on cut-slope stability along a transportation corridor [Assessment] • Prepare an engineering geological map identifying hazards along a linear infrastructure corridor [Usage]
Readings : [Fed01], [Val+02]	

Unit 6: Engineering Geology Applied to Bridges, Tunnels, and Dams (20 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Engineering geological studies required at each phase of an infrastructure project: reconnaissance, feasibility, design, and construction • Geological and rock mass considerations for tunnel alignment, excavation method, and support selection • Geological siting and foundation and abutment characterization for dams • Reservoir geology: seepage, landslide-induced impoundment hazards, and sedimentation sources • Geological considerations for bridge site selection and pier and abutment foundation conditions • Comparative geological criteria for selecting sites and alignments among infrastructure alternatives	• Identify the engineering geological studies required at each phase of an infrastructure project [Familiarity] • Evaluate rock mass conditions relevant to tunnel excavation method and support selection [Assessment] • Characterize the geological suitability of a site for dam foundations and abutments [Assessment] • Assess reservoir-related geological hazards including landslide-induced impoundment risk [Usage] • Evaluate geological conditions relevant to bridge foundation siting [Usage]
Readings : [Fed01], [HKB95], [Val+02]	

Unit 7: Geological Hazards and Mass Movements (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Classification of mass movements: falls, topples, slides, flows, and lateral spreads • Triggering and controlling factors of mass movements: geological, hydrological, and seismic • Field recognition of landslide morphology and indicators of active or past instability • Geological hazards from seismic and volcanic activity relevant to civil infrastructure • Geological hazard susceptibility mapping and risk zonation • Overview of structural and non-structural mitigation measures for geological hazards	• Classify mass movements according to their mechanism and material type [Assessment] • Identify triggering and controlling factors of mass movements at a given site [Familiarity] • Recognize field indicators of landslide morphology and slope instability [Usage] • Prepare a geological hazard susceptibility map for a project area [Assessment] • Propose mitigation measures appropriate to a specific type of geological hazard [Usage]
Readings : [CV96], [HB81], [Val+02]	

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

- [HB81] Evert Hoek and John W. Bray. *Rock Slope Engineering*. 3rd. Institution of Mining and Metallurgy, 1981.
- [Bie89] Z. T. Bieniawski. *Engineering Rock Mass Classifications*. 1st. John Wiley & Sons, 1989.
- [HKB95] Evert Hoek, Peter K. Kaiser, and W. F. Bawden. *Support of Underground Excavations in Hard Rock*. 1st. A. A. Balkema, 1995.
- [CV96] David M. Cruden and David J. Varnes. "Landslide Types and Processes". In: *Landslides: Investigation and Mitigation, Transportation Research Board Special Report 247*. National Academy Press, 1996.
- [Fed01] Federal Highway Administration. *Engineering Geology Field Manual, Volumes I-II*. 2nd. U.S. Department of Transportation, FHWA-NHI, 2001.
- [SC01] M. R. Smith and L. Collis. "Aggregates: Sand, Gravel and Crushed Rock Aggregates for Construction Purposes". In: *Geological Society Engineering Geology Special Publication 17*. 3rd. Geological Society of London, 2001.
- [Val+02] Luis I. González de Vallejo et al. *Ingeniería Geológica*. 1st. Pearson Educación, 2002.
- [Das19] Braja M. Das. *Principles of Geotechnical Engineering*. 9th. Cengage Learning, 2019.