



National University of Engineering (UNI)

School of Civil Engineering

Syllabus 2027-I

1. COURSE

CE2T1. Basic Geomatics (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE2T1. Basic Geomatics
2.2 Semester	: 6 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	: None

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Basic Geomatics introduces the civil engineering student to the fundamental ground-based measurement and positioning techniques used to characterize terrain and set out construction works. The course covers measurement theory and error propagation, horizontal measurement and traverse computation (planimetry), the operation of total stations and theodolites, vertical control through differential and trigonometric leveling and its application to profiles, cross-sections, and earthwork volume computation, modern GNSS positioning methods, and the production of topographic maps and digital terrain models, including their use in Building Information Modeling (BIM) workflows. The course closes with construction layout and stakeout surveying. This knowledge constitutes the indispensable field and computational foundation for subsequent courses in Roads and Highways, Hydraulics, and Structural and Geotechnical design, all of which depend on accurate site measurement and representation.

5. GOALS

- Apply measurement theory and error propagation to evaluate the precision of surveying observations.
- Perform planimetric surveys, computing and adjusting traverse closures using total stations and allied field methods.
- Perform differential and trigonometric leveling, deriving elevations, longitudinal profiles, and cross-sections, and use them to compute earthwork volumes.
- Use GNSS (static and RTK) methods for horizontal and vertical positioning on civil engineering projects.
- Produce topographic maps and digital terrain models, including BIM-oriented digital models, and apply surveying techniques to the construction layout and stakeout of civil works.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (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: Surveying Fundamentals and Measurement Theory (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Surveying's role in civil engineering: geodetic vs. plane surveying, and horizontal and vertical control • Sources and types of measurement error; precision, accuracy, and significant figures • Units and coordinate systems used in surveying: UTM, local grids, and datums	• Distinguish between geodetic and plane surveying and identify which applies to a given civil engineering project [Familiarity] • Propagate and evaluate measurement error in a computed surveying quantity [Usage]
Readings : [Ghilani2015]	

Unit 2: Planimetry (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Distance measurement methods: taping and electronic distance measurement, and reduction to horizontal • Horizontal and vertical angle measurement and angular adjustment • Traverse computation: latitudes, departures, closure, and coordinate adjustment	• Compute traverse closure and adjust traverse coordinates using an accepted method (e.g. the compass rule) [Usage] • Determine the coordinates of unknown points from field angle and distance observations [Assessment]
Readings : [Ghilani2015]	

Unit 3: Total Stations and Theodolites (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Total station and theodolite setup, orientation, and field operation • Electronic distance measurement (EDM) principles and error sources	• Operate a total station to collect horizontal and vertical field measurements [Usage] • Explain the sources of instrumental error in total station measurements and how to minimize them [Familiarity]
Readings : [Ghilani2015], [Kavanagh2019]	

Unit 4: Leveling and Vertical Control (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Differential leveling: benchmarks, back-sight/foresight readings, and level circuits • Trigonometric leveling for indirect elevation determination • Profile and cross-section leveling for linear infrastructure design	• Perform a differential leveling circuit and compute elevations with error closure within tolerance [Usage] • Generate a longitudinal profile and cross-sections from field leveling data [Usage]
Readings : [Ghilani2015]	

Unit 5: Earthwork Volume Computations (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Cut and fill volume computation methods: average end area and prismatic • Mass-haul diagrams for earthwork balance and haul distance planning	• Calculate cut and fill volumes for a linear earthwork project from cross-section data [Usage] • Construct a mass-haul diagram to plan earthwork balance and haul distances [Usage]
Readings : [Uren2010]	

Unit 6: GNSS Surveying (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• GNSS positioning principles: satellite constellations, signals, and error sources • Static and Real-Time Kinematic (RTK) GNSS surveying methods • Coordinate reference systems and datum transformations for GNSS data	• Compare static and RTK GNSS surveying methods and identify which fits a given accuracy requirement [Familiarity] • Transform GNSS-derived coordinates between reference datums for use in a local project [Usage]
Readings : [VanSickle2015]	

Unit 7: Topographic Mapping and Digital Terrain Models (18 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Contour representation and interpretation of terrain relief • Digital Terrain Model (DTM) generation from field or GNSS survey data • Topographic map production and cartographic conventions	• Generate a contour map from field survey data [Usage] • Build a digital terrain model (DTM) from a point-based topographic survey [Assessment]
Readings : [Ghilani2015], [Kavanagh2019]	

Unit 8: Construction Layout and Stakeout Surveying (6 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• Stakeout methods for horizontal and vertical alignment of civil works • As-built survey verification against design geometry	• Stake out a horizontal alignment (e.g. a road centerline or building corner) from design coordinates [Usage] • Verify as-built construction geometry against design specifications using survey data [Assessment]
Readings : [Kavanagh2019]	

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