



National University of Engineering (UNI)

School of Civil Engineering

Syllabus 2027-I

1. COURSE

CE2T3. Geodesy (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE2T3. Geodesy
2.2 Semester	: 7 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	: CE2T1. Basic Geomatics. (6 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Geodesy extends the ground-survey fundamentals established in Basic Geomatics (Surveying I) into the science of determining the Earth's exact size, shape, orientation, and gravity field, and of establishing the precise reference systems that every other survey, map, and GNSS position ultimately depends on. The course opens with classical geodesy – the reference ellipsoid and geoid, horizontal and vertical geodetic datums, global reference frames (ITRF, WGS84), and the relationship between geodetic/geocentric coordinates and the projected (UTM) coordinates used in ordinary topographic work. It then develops the design, least-squares adjustment, and accuracy classification of geodetic control networks, including Peru's national geodetic network maintained by the IGN and its densification for project-level surveys. The course turns next to satellite geodesy: satellite orbit fundamentals, static GNSS baseline processing and Precise Point Positioning (PPP), and the planning and execution of a geodetic-grade GNSS observation campaign. It closes with physical geodesy and applied geodesy – the Earth's gravity field, gravimetric surveying, geoid models, and the conversion between orthometric and ellipsoidal height systems that a civil engineer needs to apply geodetic results correctly in practice. This foundation underlies every subsequent geospatial and construction-layout course in the Vialidad, Geomática y Transporte track that depends on a consistent, accurate geodetic reference.

5. GOALS

- Distinguish Earth shape models (the reference ellipsoid and the geoid) and select horizontal and vertical geodetic datums and global reference frames, converting coordinates between geodetic, geocentric, and projected (UTM) systems.
- Design a geodetic control network and adjust it by least squares, and classify its control points against national (IGN) geodetic accuracy standards.
- Plan and process a geodetic-grade GNSS observation campaign using static baseline processing and Precise Point Positioning (PPP), and mitigate its error sources.
- Apply gravity field and geoid models to convert between orthometric and ellipsoidal heights, and conduct a gravimetric survey.

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: Geodetic Fundamentals and Reference Systems (22 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Earth shape models: the reference ellipsoid and the geoid • Horizontal geodetic datums and their realization • Vertical geodetic datums and height reference surfaces • Global reference frames (ITRF, WGS84) and their realization and maintenance • Geodetic, geocentric, and projected coordinate systems and conversions between them	• Distinguish the reference ellipsoid from the geoid and explain their respective roles [Familiarity] • Select an appropriate horizontal and vertical datum for a given project [Usage] • Transform coordinates between global reference frames (e.g. ITRF realizations) [Assessment] • Convert coordinates between geodetic, geocentric, and projected coordinate systems [Usage] • Explain how a geodetic datum is realized and maintained over time [Familiarity]
Readings : [VanicekKrakiwsky1986], [TorgeMueller2012]	

Unit 2: Geodetic Control Networks (13 hours)	
Competences Expected: ABET-2,ABET-6	
Topics	Learning Outcomes
• Geodetic control network design: configuration, redundancy, and point selection • Least-squares network adjustment and error ellipse interpretation • National geodetic control networks and their institutional maintenance (e.g. Peru's IGN network) • Control network densification for local and project-level surveys • Geodetic accuracy standards and classification of control points	• Design a geodetic control network with appropriate configuration and redundancy [Usage] • Adjust a geodetic network by least squares and interpret the resulting error ellipses [Assessment] • Describe the structure and maintenance of a national geodetic control network [Familiarity] • Densify a national control network for a local or project-level survey [Usage] • Classify a control point against its applicable geodetic accuracy standard [Assessment]
Readings : [VanicekKrakiwsky1986], [GhilaniWolf2015]	

Unit 3: Satellite Geodesy and Precise Positioning (25 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
• GNSS geodetic positioning: static baseline processing for control-quality accuracy • Satellite orbit fundamentals and broadcast versus precise ephemerides • Precise Point Positioning (PPP) principles and applications • Planning and execution of a geodetic-grade GNSS observation campaign • GNSS error sources affecting geodetic-grade positioning and their mitigation	• Process static GNSS baselines to achieve control-quality positioning accuracy [Usage] • Explain satellite orbit fundamentals and the difference between broadcast and precise ephemerides [Familiarity] • Apply Precise Point Positioning to a geodetic observation [Assessment] • Plan a geodetic-grade GNSS observation campaign [Usage] • Mitigate GNSS error sources affecting geodetic-grade positioning [Assessment]
Readings : [HofmannWellenhofLichteneggerWasle2008], [LeickRapoportTatarnikov2015]	

Unit 4: Physical Geodesy and the Gravity Field (10 hours)	
Competences Expected: ABET-1,ABET-6	
Topics	Learning Outcomes
• Gravity field fundamentals and normal gravity formulas • Geoid models and geoid undulation determination • Gravimetric surveying methods and instrumentation • Orthometric versus ellipsoidal height systems and the role of the geoid in converting between them • Application of geoid undulation to obtain orthometric heights from GNSS data	• Explain the Earth's gravity field and the normal gravity formula [Familiarity] • Apply a geoid model to determine geoid undulation at a point [Usage] • Conduct a gravimetric survey and process the resulting data [Assessment] • Distinguish orthometric from ellipsoidal heights and explain when each is used [Familiarity] • Convert ellipsoidal heights from GNSS to orthometric heights using a geoid model [Usage]
Readings : [HeiskanenMoritz1967], [TorgeMueller2012]	

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