



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2027-I

1. COURSE

CE3T3. Geographic Information Systems (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: CE3T3. Geographic Information Systems
2.2 Semester	: 8 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	: CE2T3. Geodesy. (7 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

Geographic Information Systems is the geospatial-data-analysis course of the Vialidad, Geomática y Transporte (Roads, Geomatics, and Transportation) track, building on the measurement and positioning fundamentals established in Basic Geomatics and the planning concepts introduced in Transportation Engineering to address the capture, management, analysis, and engineering application of spatial data. The course first develops the data models, spatial database structure, and coordinate reference system handling that underlie a GIS, then covers the spatial analysis and geoprocessing operations (overlay, proximity, network, and terrain analysis, and spatial interpolation) used to derive engineering information from spatial datasets, the methods for acquiring and integrating field, GNSS, and remote-sensing data into a GIS together with the data quality and metadata practices that make that data reliable, and closes with the application of GIS to civil engineering decision-making: infrastructure asset mapping, land use and environmental analysis, web GIS and spatial data infrastructure, and GIS-based decision support, illustrated through tsunami hazard analysis, geotechnical-seismic microzonation mapping, and seismic risk calculation.

5. GOALS

- Distinguish vector from raster spatial data models and build a topologically correct, well-structured GIS database, including coordinate reference system management.
- Design a spatial database schema and manage attribute data joins for a GIS project.
- Perform overlay, proximity, network, and terrain analysis geoprocessing operations, and interpolate continuous surfaces from sample data.
- Capture and integrate field, GNSS, and remote-sensing data into a GIS, and evaluate and document spatial datasets against recognized data quality and metadata standards.
- Build infrastructure asset inventories and analyze land use and environmental conditions using GIS, and publish datasets through a web GIS or spatial data infrastructure.
- Support GIS-based decision-making for civil engineering hazard and risk problems – such as tsunami hazard analysis, geotechnical-seismic microzonation mapping, and seismic risk calculation – by designing an end-to-end GIS project workflow.

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: GIS Fundamentals and Data Models (16 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Vector data model: points, lines, and polygons, and topology • Raster data model: cell size, resolution, and raster-vector tradeoffs • Spatial database structure and spatial indexing • Coordinate reference system handling and on-the-fly reprojection in a GIS • Attribute data management and relational joins	• Distinguish vector from raster data models and select the appropriate one for a given dataset [Familiarity] • Build a topologically correct vector dataset in a GIS [Usage] • Design a spatial database schema for a GIS project [Assessment] • Manage coordinate reference systems and reprojection within a GIS project [Usage] • Join attribute data to spatial features using relational joins [Usage]
Readings : [Longley2015]	

Unit 2: Spatial Analysis and Geoprocessing (17 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
• Overlay analysis: intersection, union, and spatial join operations • Buffer and proximity analysis • Network analysis: shortest path, service areas, and allocation • Terrain analysis from a raster DEM: slope, aspect, and watershed delineation • Spatial interpolation methods for generating continuous surfaces from sample data	• Perform overlay analysis to combine multiple spatial datasets [Usage] • Conduct a buffer/proximity analysis for a siting or impact study [Assessment] • Solve a network analysis problem (shortest path, service area, or allocation) [Usage] • Derive slope, aspect, and watershed boundaries from a raster DEM [Assessment] • Interpolate a continuous surface from point sample data [Usage]
Readings : [Longley2015], [Burrough2015]	

Unit 3: GIS Data Acquisition and Integration (17 hours)	
Competences Expected: ABET-6	
Topics	Learning Outcomes
- Field data capture methods: digitizing, heads-up capture, and mobile GIS - Integration of GNSS-collected data into a GIS - Integration of remote sensing imagery and derived products into a GIS - Data quality standards: positional accuracy, completeness, and lineage - Spatial data metadata documentation standards	- Capture field data into a GIS using digitizing or mobile GIS tools [Usage] - Integrate GNSS-collected data into a GIS dataset [Assessment] - Integrate remote sensing-derived products into a GIS analysis [Usage] - Evaluate a spatial dataset against applicable data quality standards [Assessment] - Document a spatial dataset's metadata following a recognized standard [Familiarity]
Readings : [Longley2015], [Lillesand2015]	

Unit 4: GIS Applications in Civil Engineering (20 hours)	
Competences Expected: ABET-2	
Topics	Learning Outcomes
- Infrastructure asset mapping and inventory in a GIS - Land use and environmental analysis using GIS - Web GIS and spatial data infrastructure (SDI) for data sharing - GIS-based decision support and multi-criteria site selection - Design of a GIS project workflow from data acquisition to final product	- Build an infrastructure asset inventory in a GIS [Usage] - Analyze land use or environmental conditions using GIS layers [Assessment] - Publish a dataset through a web GIS or spatial data infrastructure [Usage] - Support a site-selection decision using GIS-based multi-criteria analysis [Assessment] - Design an end-to-end GIS project workflow for a civil engineering application [Assessment]
Readings : [Longley2015], [Chang2019]	

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