Geodesy and Localization Systems

Code: 104533
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500001 Management of Smart and Sustainable Cities	OB	2

Contact

Name: Alaitz Zabala Torres

Email: alaitz.zabala@uab.cat

Teachers

Miquel Garcia Fernandez

Lluis Pesquer Mayos

Teaching groups languages

You can view this information at the end of this document.

Prerequisites

Although there are no strict prerequisites, it is recommended to have some knowledge about math, computer science and geoinformation.

Objectives and Contextualisation

The general goals of this subject are:

- To know the different models of the earth's surface and its components.
- To identify the types, properties and distortions of the main cartographic projections.
- To know the basics and the applications of the main existing localization systems.

The specific goals of this subject are:

- To introduce the student in the tools for the analysis of georeferenced data.
- To Correctly identify the map projection and datum of a georeferenced base.
- To calculate measures of distance, perimeter and area accurately.
- To know the methods and tools for map projection changes.
- To know the operating principles of location systems based on terrestrial signals and their advantages / disadvantages.
- To know the operating principles of satellite location systems and their advantages / disadvantages.

- To be able to decide which location system is the most appropriate according to the user requirements, the work scenario and the associated complexity / cost.

Competences

- Analyse and model urban and regional dynamics using methodological instruments for qualitative and quantitative analysis.
- Critically analyse work carried out and demonstrate a desire to improve.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

Learning Outcomes

1. Critically analyse work carried out and demonstrate a desire to improve.
2. Georeference alphanumeric databases of diverse types.
3. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
4. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
5. Work with databases having different reference systems or projections.

Content

Part I. Geodesy and projections

G-1. Earth surface modeling

- Geoid
- Ellipsoid / sphere
- Measures, distortions, uncertainties

G-2. Reference systems

- Composed reference systems
- Horizontal reference systems
- Vertical reference systems and altimetry
- Frameworks
- Components of a cartographic reference system
- Non-cartographic systems

G-3. Datums and ellipsoids

- Datums and global ellipsoids
- Datums and local ellipsoids
- Transformations between datums

G-4. Standards and geoservices

- Introduction
- Visualization (WMS) and download (WCS, WFS) standards
- Positional Accuracy and Quality

G-5. Cartographic projections

- Types of projections
- Properties of the projections
- Distortions in projections (area, distance, shape)
- Methods of cartographic reprojection

Part II. Location systems

SL-1. Introduction to localization systems

- Motivations and applications
- Types of location systems
- Location technologies (satellite and terrestrial)

SL-2. Fundamentals and principles of operation

- Location techniques based on time of arrival measurements (TOA)
- Location techniques based on time difference of arrival measurements (TDOA)
- Location techniques based on angle of arrival measurements (AOA)
- Location techniques based on received signal strength measurements (RSS)

SL-3. Satellite location systems

- Introduction to global satellite positioning systems (GNSS)
- Architecture of GNSS systems
- Characteristics of GNSS signals
- Architecture of GNSS receivers
- Performance and sources of errors
- Fundamentals of differential systems
- Integration with inertial sensors

SL-4. Location systems with terrestrial signals

- Location with cellular network signals (4G and 5G)
- Location with broadcast signals (DVB-T, DAB, FM)
- Location with proximity signals (RFID, Bluetooth)

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory sessions	10.5	0.42	3, 4
Problem-solving lectures	10	0.4	2, 5
Theory lectures	24	0.96	3
Type: Autonomous			
Individual work of the student	88	3.52	1, 2, 5

Classroom activities

- Theory lectures (TE): presentation of the theoretical contents of the subject.
- Problem-solving lectures (PAUL): solving practical exercises related to theory, with student participation.
- Laboratory sessions (PLAB): application of the theoretical concepts presented in theory and exercices to real practical cases and contact with planning, analysis and simulation software.

Autonomous activities

- Study of the theoretical and practical contents of the subject. Preparation of exercices, laboratory practices and exams.
- Practical works: realization and deepening of laboratory practices. Preparation of the final report of each practice.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam Part I	25	2	0.08	1, 3, 4
Exam Part II	25	2	0.08	1, 3, 4
Laboratory reports	35	12	0.48	1, 2, 3, 5
Practical sessions	15	1.5	0.06	1, 2, 3, 5

Evaluation activities

The evaluation activities are the following:

- [50%] Partial exams [ExP]
  [25%] Exam Part I (Geodesy) [ExP1] (individual)
  [25%] Exam Part II (Location Systems) [ExP2] (individual)

- [35%] Laboratory practices [Lab]: delivery of reports and/or knowledge tests of the practices carried out at the laboratory
  [20%] Reports/Tests Part I (Geodesy) [Lab1] (in pairs)
  [15%] Reports/Tests Part II (Location Systems) [Lab2] (in pairs)

- [15%] Practical sessions [Pr]: development of practical sessions to evaluate the knowledge acquired
  [5%] Sessions Part I (Geodesy) [Pr1] (individual)
  [10%] Sessions Part II (Location Systems) [Pr2] (in pairs)

Grades computation

The Final Grade (NF) of the subject will be calculated according to the activities indicated above, applying the next equation:

NF = (0.5 x NF1) + (0.5 x NF2)

Where:

- NF1 = (0.5 x ExP1) + (0.4 x Lab1) + (0.1 x Pr1)
- NF2 = (0.5 x ExP2) + (0.3 x Lab2) + (0.2 x Pr2)

Each activity will be evaluated under the scale of 0 to 10.

To pass the subject, the final grade must be equal to or greater than 5 (NF > = 5.0) and fullfil all the following conditions:

- ExP1 >=3
- ExP2 >=3
- NF1 >=3
- NF2 >=3

If any of the prerequisites are not met (and the "average grade cannot not be computed"),the student will be assigned a "fail" with a maximum grade of 4.5.

Synthesis examination

In accordance with the academicregulations, students who donot pass the subject but who have been evaluated for more than two thirds of this, can be submitted to a synthesis examination.

This exam will allow to recover the part of evaluation corresponding to the partial exams (50% of the final grade), but not the part corresponding to the laboratory activities. The latter, due to their eminently practical nature, can not be recovered.

Repeating students

The repeating students need to be re-evaluated of all the evaluation activities planned for the subject. The note of tests carried out in past courses will not be maintained.

Consideration of "Not Evaluable"

Students who do not attend either of the two exams, or the final synthesis test, will be considered "Not Evaluable".

Consideration in case of copy or plagiarism

Without prejudice to other disciplinary measures deemed appropriate, and in accordance with the regulations in force, the irregularities committed by the student that may lead to a variation of the grade of an evaluation act will be graded with a zero. Therefore, copying or allowing to copy a practice or any other evaluation activity will involve suspending it with a zero and can not be recovered in the same academic year.

Honor grades

Granting an Honor qualification is a decision of the faculty responsible for the subject. Honors will be awarded only to students who have shown a great level of excellence in the subject, and not by default to those who have removed the highest marks. The regulations of the UAB indicate that Honors can only be awarded to students who have obtained a final grade of 9.00 or more. It can be granted up to 5% of MH of the total number of students enrolled.

Communication

The Virtual Campus will be the preferred communication platform with the students. After publishing the grades for each evaluable activity, the review mechanism will be communicated through the virtual campus.

Single evaluation

A single global exam will be offered for both parts of the subject (G and SL) which will add questions related to the practices (PAUL and PLAB). The same recovery system will be applied as for the continuous assessment.

Bibliography

Part I

- D. Fenna, *Cartographic Science: A Compendium of Map Projections, with Derivations*. CRC Press. 2006. [https://cataleg.uab.cat/iii/encore/record/C__Rb2033394]
- J. Grau, E. Bosch, "Canvi de sistema de referencia ED50 a ETRS89", Revista Catalana de Geografia IV epoca / volum XIV / num. 36, 2009.
- J. González-Matesanz, A. Dalda, J. A. Malpica, "A range of ED50-ETRS89 datum transformation models tested on the Spanish geodetic network". Survey Review, 38 (302), pp. 654-667, 2006. [https://cataleg.uab.cat/iii/encore/plus/C__SA%20range%20of%20ED50-ETRS89%20datum%20transforma]
- J. P. Snyder, *Map Projections, A Working Manual*, U.S. Geological Survey professional paper 1395, 1997. [https://cataleg.uab.cat/iii/encore/record/C__Rb2038409]
- J. Nogueras-Iso, F.J. Zarazaga-Soria i P.R. Muro-Medrano, *Geographic Information Metadata for Spatial Data Infrastructures: Resources, Interoperability and Information Retrieval,* Ed. Springer. 264 pp., 2005. [https://cataleg.uab.cat/iii/encore/record/C__Rb1845430]
- D.F. Maune, *Digital Elevation Model Technologies and Applications: The DEM Users Manual*, American Society for Photogrammetry and Remote Sensing. Bethesda, 2007. [https://cataleg.uab.cat/iii/encore/record/C__Rb1611686]

Part II

- C. Gentile, N. Alsindi, R. Raulefs, C. Teolis, *Geolocation techniques. Principles and applications*, Springer, 2013.[https://cataleg.uab.cat/iii/encore/record/C__Rb2024208]
- S. A. Zekavat, R. M. Buehrer (Eds.), *Handbook of position location. Theory, practice and advances,* IEEE Press Series, John Wiley & Sons, 2012. [https://cataleg.uab.cat/iii/encore/record/C__Rb2083164]
- P. J.G. Teunissen, O. Montenbruck (Eds.), *Handbook of Global Navigation Satellite Systems*, Springer, 2017. [https://cataleg.uab.cat/iii/encore/plus/C__SHandbook%20of%20Global%20Navigation%20Satellite%20Sy]

Software

During the practical sessions, next software could be used: MiraMon, ArcGIS, ArcGisPro, QGIS, Web apps and MATLAB.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	611	Catalan	second semester	afternoon
(PAUL) Classroom practices	612	Catalan	second semester	afternoon
(PLAB) Practical laboratories	611	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	612	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	613	Catalan	second semester	morning-mixed
(TE) Theory	61	Catalan	second semester	afternoon