Universidad de Alcalá

TEACHING GUIDE

Geolocation

Master in
Telecommunication Engineering

Universidad de Alcalá

Academic Year 2021/2022

1st Year - 2nd Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Geolocation**
Code:	**201833**
Master in:	**Telecommunication Engineering**
Department and area:	**Teoría de la Señal y Comunicaciones** **Teoría de la Señal y Comunicaciones**
Type:	**Optional (Specialized)**
ECTS Credits:	**6.0**
Year and semester:	**1st Year, 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish / English Friendly

1. COURSE SUMMARY

Advances in location systems are applied in many ways around us. Different technologies are needed, because no one can fulfil the requirements for accuracy, cost and coverage for every situation. In these studies, the student will be able to learn the fundamentals of positioning and location technology, including the means to calculate the position with minimal uncertainty, analysing the advantages and shortcomings of different technologies.
Several algorithms, valid for analogous technologies, are studied in order to estimate locations and improve the search for objects.
At last, a variety of applications related with geolocation of objects are studied, opening new opportunities of business and development.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/355/2009:

en_CGT1 - Skill of analysis and synthesis.

en_CGT2 - Skill of organization and planning.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT4 - Skill to make decisions.

en_CGT5 - Skill to adapt to new situations.

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

en_CB8 - That students be able to integrate knowledge and face the complexity of making judgements based on incomplete or limited information that includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements.

en_CB9 - That students be able to communicate their findings and the ultimate knowledge and reasons behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CT1 - Troubleshooting skill

en_CT3 - Skill to work in a team

en_CT4 - Working in a pressure environment

en_CT5 - Motivation for quality

en_CT6 - Ability to integrate knowledge from different scientific areas

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/355/2009:

Learning Outcomes

After succeeding in this subject the students will be able to:

RA1. To understand and describe the functioning of different geolocation systems.

RA2. To analyze the advantages and shortcomings of different geolocation technologies.

RA3. To analyze and design systems and software able to use the capabilities of the general systems of location and positioning.

RA4. To evalute different commercial systems, studying their usability, considering their advantages and problems.

RA5. To be able to study and understand the functioning and utilities of the systems based on different radiolocation techniques.

RA6. To understand different geolocation algorithms and their usefulness.

3. CONTENTS

Contents Blocks	Total number of hours
Module 1. Overview of geolocation. Geolocation systems. Systems requirements. Applications. Study of a general system. Source location. Channel models in geolocation.	0,6 ECTS
Module 2. Location based on time of arrival and angle of arrival. Fundamentals. Propagation effects. TOA based estimation. UWB based location. DOA estimation techniques. Indoor location.	1,4 ECTS
Module 3. Location based on received signal intensity. Fundamentals. Indoor applications: location accuracy, methods and techniques. Other applications.	1 ECTS
Module 4. Location in multipath environments. Identification and location. System model. Multipath effect reduction. Cellular phone location estimation by means of RSS and TOA. Examples.	1 ECTS
Module 5. Mobility and tracing. Estimation problem. Indoor tracing. Tracing in multipath environments. Examples and applications.	1 ECTS
Module 6. Location in communication networks. Overview of the problem. Methods and techniques. Global positioning systems. Systems based on cellular networks. LTE based systems. Other systems.	1 ECTS

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

The teaching strategy of the course is divided into 3 sections: classroom learning, learning in small groups and finally the personal work.

Sessions of large group in the classroom in combination with sessions in the laboratory:

Working sessions in the classroom will consist of lectures where the main concepts of the theory will be presented. The main goal is to introduce the theoretical fundation of Geolocation techniques, its most recent research and applications. Practical cases with real applications are discussed in order to assess the level of understanding of the explained concepts. The work associated with these cases is done during the normal class schedule, so that no additional working hours are demanded from the student. Additional learning materials, like scientific papers, notes, audivisuals, etc, are provided in order to create a critical thinking environment and allow the student to learn in a more autonomous way.

Learning in small groups:

Part of the case studies in the classroom will be done in small groups of less than three students. They will share the results of their study with the other students in order to create a critical thinking environment, very useful from an engineering perspective.

Personal work:

The student will compose a final comprehensive report about a real Geolocation problem in order to test his or her studying abilities, understanding, critical analysis and improvements over existing commercial systems based on radiolocation or other techniques, like inertial or optical ones. The report will follow standard rules explained in every case and an oral presentation will be performed. Both the written and the oral part will be assessed. Personal work is completed by means of a test about the theoretical concepts involved in Geolocation.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of

the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

The main assessment tools will be:

- **Report about discussed practical cases (ICP).** A dossier compiling the practical cases discussed in the classroom.
- **Final written report (TE).** Comprehensive work about a real Geolocation problem revising the main learned concepts.
- **Oral presentation (POT).** Assessment of the student oral presentation abilities.
- **Final assesment test (PEF).**
- **Final analysis of a practical case (ACP).**

Assessment through final exam:

In the case of evaluation by means of a final exam, the evaluation elements to be used will be the following: The critical analysis of a practical case in addition to a test based on the theoretical contents of the subject and finally a written report about a Geolocation topic previously presented to the student by the professor with enough time.

Extraordinary Call

The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call, with the following exceptions:
- If the student has been evaluated by continuous assessment in the ordinary call, the scores of the practical cases and the written report (both written and oral assessments) will be kept with the corresponding percentages.
- If the student opted for the final exam, the scores of the practical case and the written report will be kept with the corresponding percentages.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

CE1. The student knows the basic elements of a Geolocation system.
CE2. The student knows the different techniques of location, positioning and tracing.
CE3. The student is able to select the best location and positioning system for a particular application.
CE4. The student is able to solve practical technological problems related with location, positioning and tracing by his or her own means.
CE5. The student is able to use the best tools and algorithms related with location and positioning problems.
CE6. The student shows critical thinking abilities and a reasonable reasoning about the results, both the obtained and the estimated.
CE7. The student is able to analyze and reason about new Geolocation systems and techniques.
CE8. The student is able to adapt his or her knowledge to new systems.

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

- **Report about discussed practical cases (ICP).** A dossier compiling the practical cases discussed in the classroom.
- **Final written report (TE).** Comprehensive work about a real Geolocation problem revising the main learned concepts.
- **Oral presentation (POT).** Assessment of the student oral presentation abilities.
- **Final assesment test (PEF).**
- **Final analysis of a practical case (ACP).**

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-CB9; CGT1, CGT3-CGT5; CT1, CT3-CT4, CT6	RA1-RA4, RA6	CE2-CE6	ICP	35%
CB6-CB9; CGT2-CGT5; CT3-CT6	RA1-RA2, RA4-RA6	CE1, CE7-CE8	TE	25%
CB6-CB9; CGT2-CGT5; CT3-CT6	RA1-RA2, RA4-RA6	CE1, CE7-CE8	POT	20%
CB6-CB8, CB10; CGT1, CGT4; CT1, CT4, CT6	RA1-RA4, RA6	CE1-CE6	PEF	20%

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-CB9; CGT1, CGT3-CGT5; CT1, CT3-CT4, CT6	RA1-RA4, RA6	CE2-CE6	ACP	35%
CB6-CB9; CGT2-CGT5; CT3-CT6	RA1-RA2, RA4-RA6	CE1, CE7-CE8	TE	45%
CB6-CB8; CB10; CGT1, CGT4; CT1, CT4, CT6	RA1-RA4, RA6	CE1-CE6	PEF	20%

Extraordinary call

In the case of the extraordinary call, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-CB9; CGT1, CGT3-CGT5; CT1, CT3-CT4, CT6	RA1-RA4, RA6	CE2-CE6	ACP or ICP	35%
CB6-CB9; CGT2-CGT5; CT3-CT6	RA1-RA2, RA4-RA6	CE1, CE7-CE8	TE or TE + POT	45%
CB6-CB8; CB10; CGT1, CGT4; CT1, CT4, CT6	RA1-RA4, RA6	CE1-CE6	PEF	20%

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Gentile, C.; Alsindi, N.; raulefs, R. and Teolis, C. Geolocation techniques. Principles and applications. Springer, 2013.
- Hofmann-Wellenhof, B.; Lichtenegger, H. and Wasle, E. GNSS-Global navigation Satellite Systems. GPS, GLONASS, Galileo and more. SpringerWien, 2008.
- Progri, I. Geolocation of RF signals. Principles and simulations. Springer, 2011.
- Nait-Sidi-Moh, A.; Bakhouya, M.; Gaber, J. and Wack, M. (editors). Geopositioning and mobility. Wiley-ISTE, 2013.
- Deblauwe, N. GSM-based positioning: techniques and applications. VubPress, 2008.
- Zekavat, S.A. and Buehrer, M. Handbook of position location. John Wiley and Sons, 2011.
- Xu, G. GPS. Theory, algorithms and applications. Springer, 2007.

6.2. Additional Bibliography

- IEEE Communications Surveys & Tutorials.

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.