Universidad de Alcalá

TEACHING GUIDE

Radio-communication and radio-determination systems

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:	**Radio-communication and radio-determination systems**
Code:	**201809**
Master in:	**Telecommunication Engineering**
Department and area:	**Teoría de la Señal y Comunicaciones** **Teoría de la Señal y Comunicaciones**
Type:	**Compulsory**
ECTS Credits:	**6.0**
Year and semester:	**1st Year, 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

Students will understand to define the requirements for radio systems and radiodetermination with this course. The views of system design, service planning, and evaluation of performance will be studied. Hardware elements of the transmit and receive chains (antennas, receivers, and transmitters) will be described, as well as radio channel models. The student will study the characteristics of the transmitted signals and techniques to implement in receiving chains to meet the requirements of the different radio services. Then, current and future trends of radio services, surveillance, and radar-based sensors, navigation, and radiolocation systems will be studied. Research activities and innovation will be encouraged. Prerequisites and

Recommendations: The requirements or prior knowledge to be provided by the student are those regarding high frequency technologies (microwave frequencies).

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_CT2 - Ethical commitment to work

en_CT3 - Skill to work in a team

en_CT4 - Working in a pressure environment

en_CT5 - Motivation for quality

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. Formulation of the telecommunications systems development, antennas, equipment, and subsystems design, channel modeling, radio-link calculation, and planning

RA2. Radionavigation and positioning systems design, as well as radar systems.

RA3. Design, in different bands, of communication components, such as routers, switches, hubs, transmitters, and receivers.

3. CONTENTS

Theoretical Contents Blocks	Total number of hours
RADIOCOMMUNICATION BLOCK	
Module 1. Introduction to the design of antenna systems. Antennas characterization. Types of antennas. Antenna Arrays.	4 hours
Module 2. Engineering in radiocommunication systems. Radio-link Budget. Emitters and receivers modeling. Radio-channel modeling. Radar equation. Radar cross-section.	6 hours
Module 3. Quality parameters in radiocommunication equipment and systems. Quality against noise and interferences. Availability and fidelity rate.	6 hours
Module 4. Radio Communication services planning. Terrestrial and spatial fixed radio-service. Wireless networks.	8 hours
RADAR AND RADIODETERMINATION BLOCK	
Module 5. Radar systems. Operating principle. Primary pulse radars. Continuous-wave radars. Automatic detection. Radar signal processing. Secondary radars	12 hours
Module 6. Radio-navigation systems. GNSS: GPS and Galileo.	4 hours
Laboratory Contents Blocks	Total number of hours
RADIOCOMMUNICATION BLOCK	
1. Analysis and synthesis of antenna arrays. 2. Radio-channel simulation 3. Planning of fixed radio-service	8 hours
RADAR AND RADIODETERMINATION BLOCK	
1. Radar system performance evaluation. 2. Implementation and evaluation of radar signal processing techniques. 3. Analysis of a GPS receiver.	8 hpurs

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 working sessions in the laboratory.

Sessions of large group in the classroom:

Working sessions in the classroom, in large groups, will consist of lectures where the main concepts of the theory of circuits will be presented. The aim is to introduce students to the theoretical foundations of circuit analysis in a guided and reflective way. The understanding of these concepts will culminate with the use of them in both the laboratory and the problem solving sessions in small groups.

Teaching materials will be essential to create reflective learning environments, where students and teachers can undertake a critical analysis that allows the student to autonomously relate concepts.

The order of presentation of the contents will evolve from the simple to the complex, in order to avoid a high degree of abstraction that might cause a student lack of interest in the course. In any case, it is very convenient, during the working sessions in the classroom, to establish linkages with other subjects in the curriculum, and to provide possible experience on the contents, which will help to attract students' attention and will encourage their interest in the subject.

Collaborative and work groups:

- **Laboratory sessions:** These sessions are will be carried out in small groups (2-3 students). The objective is that the student explores, with the help of a practice manual
  designed for the subject, the applicability of the theoretical concepts. With the results obtained during the practice, the students will elaborate a memory following the indications of the script of the corresponding practice. Required software and hardware material will be available for the students.
- **Self-learning portfolio:** Each collaborative group will realize a work related to techniques and theoretical concepts of the subject. The objective is that the groups develop skills related to search information, bibliography management, and the generation of a portfolio with results and conclusions.

Individual work:

- Students will individually solve proposed theoretical problems, putting into practice the concepts covered during the classroom sessions. In problem classes, students present,
  to the rest of the classmates, obtained results and solution methods for their correction. The objective pursued is to complement the teaching-learning process of the
  student, bringing him closer to the assimilation of concepts and application of the same, emphasizing that the analytical techniques to be used are tools and not objectives.
  The strategies to adopt in these sessions will be aimed at fostering certain habits in the student when facing the resolution of a problem, to know: initial study, choice of the best resolution strategy, and critical evaluation of the results obtained.

Information Technologies and Communications to support training activities (use of the Internet, forums, wikis, and email, materials available on virtual

platforms, etc.).

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:

1. **Problems (EP).** Solving practical problems individually.
2. **Laboratory Exercises (EL).** Performance of laboratory practices and delivery of the corresponding reports. The evaluation will consider systematic observation, where the teacher will record the main difficulties and skills observed in each student, and the realization of a single memory by practice, by each of the groups of students who have done it. These practices will be evaluated by the professor responsible for the laboratory group, to assess if the objectives indicated in the script of the same have been met.
3. **Assessment Tests (PE)**. Performing written tests focused on both practical and theoretical aspects of the subject.
4. **Portfolio (ET)**. Each laboratory workgroup will develop a work related to an extension of some of the carried-out practices to promote inquiry-based self-study

Students must attend 100% of the laboratory sessions and deliver the corresponding reports to all laboratory practices. Recovery sessions will be enabled for those students who have not attended any of the sessions and justify it documentarily.

The students, as a group, will deliver the reports of the laboratory practices and material of the portfolio following the established schedule.

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:

1. **Laboratory Exercises (EL).** Reports of laboratory practices.
2. **Assessment Tests (PE)**. Performing written tests focused on both practical and theoretical aspects of the subject.

Extraordinary Call

The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call.

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. Capability to design RF antennas, equipment, and subsystems in radiocommunication and radiodetermination systems.

CE2. Capability to design transmitters and receivers in the radiocommunication-services bands.

CE3. Capability to carry out radiocommunication-services planning.

CE4. Capability to design and analyze primary and secondary radar systems

CE5. Capability to design signal radar processing techniques and feature extractor in surveillance and monitoring tasks

CE6. Capability to analyze GNSS and apply in radio-localization systems

CE7. Being able to solve problems with initiative, decision making, and creativity.

CE8. Be able to communicate and transmit knowledge, abilities, and skills, both in writing and in oral form.

CE9. Be able to work in a group and in a multilingual environment.

GRADING TOOLS

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

1. Ordinary call
   a. Continuous assessment, with problem resolution (EP), practices deliverables (EL), portfolio (ET) and two assessment exams (PE1,PE2).
   b. Final assessment, with practices deliverables (EL) and two assessment exams (PE1,PE2).
2. Extraordinary call. Final assessment, with practices deliverables (EL) and two assessment exams (PE1,PE2).

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
CB6-10, CGT1-4, CT1-5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE1-9	EP	10%
CB6-10, CGT1-4, CT1-5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE1-9	EL	10%
CB6, CB8-10, CGT1-5, CT2-3, CT5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE3-9	ET	20%
CB7-9, CGT1-2, CGT4-5, CT1-2, CT4-5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE1-6,CE7-8	PE1, PE2	40+20%

Students must achieve the minimum passing grade (5.0) in each of the thematic blocks. If the student has not passed any of the thematic blocks and the weighted average is equal to or greater than 4.5 points, the final grade will be 4.5 points.

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
CB7-9, CGT1-2, CGT4-5, CT1-2, CT4-5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE1-6, CE7-8	PE1, PE2	50%+35%
CB6, CB8-10, CGT1-4, CT2-5, CTecTel02, CTecTel05, CTecTel13	RA1-3	CE1, CE3, CE4, CE5, CE6-8	EL	15%

Extraordinary call

In the case of the extraordinary call, the same percentages that have been established in the case of the evaluation by means of a final exam will be maintained, giving the option of making the PL or maintaining the mark obtained in the EL (continuous evaluation) or in the PEF (final evaluation), according to the student's decision. In any case, the PL will be made by those students who have not done it in the final exam option in the ordinary call.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

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- Cardama, A.; Jofré, L.; Rius, J.M.; Romeu, J. y Blanch, S.- “Antenas”. Ediciones UPC. 1998.
- Hernando Rábanos, José María. Transmisión por radio. Ed.Centro de Estudios Ramón Areces, Madrid, 1993.
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6.2. Additional Bibliography

- Shibuya. “A Basic Atlas of Radio-Wave Propagation”. Wiley&sons
- Boithias, Lucien. Radiowave propagation . McGraw-Hill, 1987.
- Tri; Ha. Digital Satellite Communications. McGraw-Hill, 1990.
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- Borre, “A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach”, Birkhäuser, 2007.

- IEEE Transactions on Aerospace and Electronic Systems.
- IEE Proceedings on Radar, Sonar and Navigation
- IEEE Transactions on Signal Processing
- IEEE Transactions on Antennas and Propagation

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.