



Universidad  
de Alcalá

# TEACHING GUIDE

## Telecommunication systems and technologies

**Master in  
Telecommunication Engineering**

**Universidad de Alcalá**

---

**Academic Year 2022/2023**

2º Curso - 1<sup>er</sup> Cuatrimestre

# TEACHING GUIDE

|                      |  |
|----------------------|--|
| Course Name:         | <b>Telecommunication systems and technologies</b>                                  |
| Code:                | <b>201818</b>  |
| Master in:           | <b>Telecommunication Engineering</b>   |
| Department and area: | <b>Teoría de la Señal y Comunicaciones<br/>Teoría de la Señal y Comunicaciones</b> |
| Type:                | <b>Compulsory</b>  |
| ECTS Credits:        | <b>4.5</b>   |
| Year and semester:   | <b>2º Curso, 1º Cuatrimestre</b>   |
| Teachers:            | To be determined at the beginning of the term.                                     |
| Tutoring schedule:   | To be determined at the beginning of the term.                                     |
| Language:            | English  |

## 1. COURSE SUMMARY

The main purpose of this course is to provide the student with a global knowledge of telecommunications systems (terminals and networks) and that of the different telecommunications technologies used to put them into practice. With this aim, the functional and the structural models (access network, aggregation network and core network) are explained, focusing on the transmission system and, more specifically, on the physical layer.

This course analyzes the main systems, with special emphasis on very high speed and low latency access systems (FTTH, HFC, 4G, 5G), their topological characteristics, equipment used and cost. The success of a certain technology does not only depend on its technical features, but also on some economic and regulatory factors. This is the reason why the student will learn each specific market system and regulation.

After completing this course, the student will be able to design a complete telecommunications system, considering not only the technological facets but also the regulatory and economic factors, optimizing the system under certain restrictions.

It is necessary for the student to have acquired the skills studied in communication subjects. These skills are studied in all the degrees that provide access to this master.

## 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\_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\_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\_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\_CGT6** - Commitment to Human Rights, democratic principles, equality between women and men, solidarity, environmental protection and with the promotion of a culture of peace

**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:

After completing this subject, the students will be able to:

- **RA1.** Identify, assess and argue about the complex situation in the telecommunication hyper-sector: interconnection of access networks (over a variety of technologies) to a unified network core (IP/MPLS), integration of services (fixed, mobile, Internet, TV), competition for retain and/or attract customers (by means of service packages, acquisition of content companies, etc.)
- **RA2.** Identify, assess and argue about the need for regulation that protects citizens and promotes competition against anti-competitive practices against interconnection or interoperability.
- **RA3.** Design a complete broadband access system so that, in this effort, students: 1) Select the most appropriate technology taking into account not only customer needs but also current regulations and possible economic and regulatory restrictions; and 2) Design (in a reasoned way and with precision in calculations) a system that meets the requirements.
- **RA4.** Integrate optimization processes in the design of telecommunication technologies and systems (or in critical sections of these) for their subsequent application not only in access and trunk systems, but also in broader contexts such as Smart City, Smart Grid, etc.

### 3. CONTENTS

| Contents Blocks   | Total number of hours |
|---|-----------------------|
| <p><b>Module 1. Introduction: Telecommunication Systems and Technologies</b></p> <ul style="list-style-type: none"> <li>• Current state of access, aggregation and transport systems.</li> <li>• Economic and regulatory considerations.</li> <li>• Telecommunication services.</li> </ul>  | 7 hours               |
| <p><b>Module 2. Design and dimensioning of telecommunication systems</b></p> <ul style="list-style-type: none"> <li>• Broadband access systems and technologies: FTTH, HFC, 4G, 5G.</li> <li>• Normative and regulatory criteria for broadband networks.</li> <li>• Design and dimensioning of broadband access systems.</li> <li>• Practical study cases.</li> </ul> | 21.5 hours            |
| <p><b>Module 3. Optimization of telecommunication systems</b></p> <ul style="list-style-type: none"> <li>• The need for optimization in the current telecommunication environment.</li> <li>• Specific optimization techniques for telecommunication systems.</li> <li>• Application to the optimization of access, aggregation and/or transport systems.</li> </ul>  | 15 hours              |

## 4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

### 4.1. Credits Distribution

|                                  |  |
|----------------------------------|--|
| Number of on-site hours:         | 45 hours.  |
| Number of hours of student work: | 68 hours.<br>These include those for studying, elaboration of activities, preparation of classes and evaluation tests. |
| Total hours                      | 113 hours.   |

### 4.2. Methodological strategies, teaching materials and resources

|   |   |
|---|---|
| Theoretical classes   | <ul style="list-style-type: none"> <li>• Presentation and/or review of concepts based on lectures</li> <li>• Seminars and other activities</li> <li>• Active learning activities</li> <li>• Flipped Teaching/Learning experiences.</li> </ul> |
| Individual and group work   | <ul style="list-style-type: none"> <li>• Practical case studies</li> <li>• Exhibition of works: oral presentations</li> <li>• Generation of documentation associated to practical work.</li> </ul>  |
| Individual, group and online tutorials (synchronous and asynchronous tools) | <ul style="list-style-type: none"> <li>• Solve problems that arise from concepts not well understood enough</li> <li>• Support for autonomous learning.</li> </ul>  |

## 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 Assessment 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 Assessment 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.

The main evaluation or grading tools will be:

- **Deliverables (En):** Specific works on different parts of the subject or laboratory practices. They can be individual or in a group.
- **Evaluation Exams (PE):** Exams that will be carried out individually and in writing. It will consist of solving problems and questions that involve the topics of the complete subject.

## 5.2. EVALUATION

### EVALUATION CRITERIA

The evaluation process aims to assess to what extent the student has acquired the skills that are necessary to complete the course. Consequently, the evaluation criteria that are applied in the various tests (evaluation tools) will guarantee that the student has the appropriate level in the following knowledge and skills:

- **CE1.** The student correctly assesses and argues the relationship between the service requirements, the technology (or technologies) to be used and the regulation that applies to it (them). (CB6, CB7 and CB10; CGT1-CGT5; CT1, CT5; CTecTel9, CGestion1)
- **CE2.** The student, based on certain imposed service requirements, knows how to design (in a reasoned way and with precision in the calculations) an access network of a telecommunication system. (CB7, CB8 and CB10; CGT1-CGT6; CT1-CT3, CT5, CT6; CTecTel3, CTecTel4, CTecTel9, CGestion1)
- **CE3.** The student is able to develop software optimization tools, either for the design or the deployment of a telecommunication system (or just a segment of it), based on the elements considered at CE1 and CE2. (CB6-CB8 and CB10; CGT1-CGT5; CT1- CT3, CT5, CT6; CTecTel9; CGestion1).

### GRADING TOOLS

The tests and evaluation or grading procedures are detailed below, as well as the qualification criteria corresponding to the ordinary and extraordinary calls. Given that the skills developed in this subject have a marked practical nature, with a strong component of abilities and skills for carrying out algorithms, the completion of the practical work will be mandatory for all students and in all calls.

#### Ordinary Call

##### *Continuous evaluation system*

For those students who follow the continuous evaluation system, the assessment instruments described above will be considered:

- 60% of the qualification corresponds to practical work (En).
- The remaining 40% is given by a final evaluation test (PEF).  
Anyone who does not present any of the deliverables is considered as not presented in the ordinary call.

### ***Evaluation by means of a final exam***

For those students who have the right to the final evaluation system, the following evaluation instruments will be considered:

- 30% of the qualification corresponds to practical work (En).
- The remaining 70% is given by a final evaluation test (PEF).

### **Extraordinary call**

The procedure will be the same as that described for the evaluation by final exam in the ordinary call.



## GRADING CRITERIA

Deliverables (En) are considered as the practical part of the academic course. Thus, passing them satisfactory is mandatory, as determined in section 6.4 of the assessment regulations.

### Ordinary Call

#### *Continuous Evaluation*

| Skill  | Learning Outcomes | Evaluation criteria | Grading Tool | Contribution to the final mark |
|--|-------------------|---------------------|--------------|--------------------------------|
| CB7, CB8 y CB10; CGT1-CGT6; CT1-CT3, CT5, CT6; CTecTel3, CTecTel4, CTecTel9, CGestion1 | RA2–RA4           | CE1, CE2            | En_1         | 30%                            |
| CB6-CB8 y CB10; CGT1-CGT5; CT1-CT3, CT5, CT6; CTecTel9                                 | RA1, RA4          | CE2, CE3            | En_2         | 30%                            |
| CB6-CB8 y CB10; CGT1-CGT6; CT1, CT5; CTecTel3, CTecTel4, CTecTel9, CGestion1           | RA1–RA4           | CE1–CE3             | PEF          | 40%                            |

#### *Final Evaluation*

| Skill   | Learning Outcomes | Evaluation criteria | Grading Tool | Contribution to the final mark |
|---|-------------------|---------------------|--------------|--------------------------------|
| CB6-CB8 y CB10; CGT1-CGT5; CT1-CT3, CT5, CT6; CTecTel3, CTecTel4, CTecTel9, CGestion1 | RA1, RA4          | CE2, CE3            | En           | 30%                            |
| CB6-CB8 y CB10; CGT1-CGT6; CT1, CT5; CTecTel3, CTecTel4, CTecTel9, CGestion1          | RA1–RA4           | CE1–CE3             | PEF          | 70%                            |

### Extraordinary Call

In the case of the extraordinary call, the same instruments and percentages that have been established in the case of the evaluation by final exam will be maintained.

## 6. BIBLIOGRAPHY

### 6.1. Basic Bibliography

- Wenhong Tian, *Analytical Models and Efficient Dimensioning Algorithms: for Communication Systems in Randomly Changing Traffic Environments*, LAP Lambert Academic Publishing (July 10, 2009).
- Arie Koster (Editor), Xavier Muñoz (Editor), *Graphs and Algorithms in Communication Networks: Studies in Broadband, Optical, Wireless and Ad Hoc Networks*, Springer; 2010 edition (November 30, 2009).
- Learning material provided by the professors (on Blackboard).
- Recommendations of the Telecommunications Market Commission, on <http://www.cmt.es/>
- Selected recommendations International Telecommunication Union (on Blackboard).
- Reports and data from Comisión Nacional de los Mercados y la Competencia (CNMC), on the web <http://www.cnmc.es>

### 6.2. Additional Bibliography

- Scientific-technical journals: IEEE Communications Magazine, IEEE Journal on Selected Areas in Communications, IEEE Transactions of Communications, etc.
- Whitepapers of companies in the sector.
- Recommendations International Telecommunication Union, on <http://www.itu.int/home/index-en.html>

## **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.