Universidad de Alcalá

TEACHING GUIDE

Telecommunication Systems

Degree in
Telecommunication Technologies Engineering (GITT)
Telecommunication Systems Engineering (GIST)

Universidad de Alcalá

Academic Year 2022/2023

4th Year - 2nd Semester (GITT)

3rd Year - 2nd Semester (GIST)

Approved by the School Board on June 3, 2022

TEACHING GUIDE

Course Name:	**Telecommunication Systems**
Code:	**350036 (GITT)** **390003 (GIST)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Telecommunication Systems Engineering (GIST)**
Department and area:	**Teoría de la Señal y Comunicaciones** **Signal Theory and Communications**
Type:	**Optional (Specialized) (GITT)** **Compulsory (GIST)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year - 2nd Semester (GITT)** **3rd Year - 2nd Semester (GIST)**
Teachers:	Lucas Cuadra Rodríguez Silvia Jiménez Fernández
Tutoring schedule:	To be determined at the beginning of the term.
Language:	Spanish/English friendly

1. COURSE SUMMARY

The main purpose of this course is to show the student how to design and analyze different telecommunication systems, considering them as the terminal device and the different networks involved (access, aggregation and core networks, cellular and fixed networks, etc.). Nowadays, these categorizations are becoming increasingly complex, as the present telecommunication market is no longer vertically integrated exclusively. Currently the market is moving towards a horizontal model, where a client may receive a content generated by the content provider A, delivered by service provider B, using network provider C. This fact promotes competitiveness, thus resulting in a better variety of services provided by different companies, and a better offer to the final clients. This situation has been favored due to the convergence of different events such as:

• New regulation putting an end to monopolies (i.e. Telefonica de España) and enacting a mandate to open their networks to other telcos at regulated wholesale prices.

• TCP/IP network architecture enabling the development of new services and applications.

• Development of new terminal devices (smartphones, tablets, laptops, game consoles, smart TVs, etc.) connected to the network and capable providing new services and applications.

• Evolution from the incumbent's copper network to different broadband access systems (DSL and FTTx) qualified to give access to new high-capacity services.

• Convergence of telecommunication networks to an all-IP core.

• Next Generation Networks (NGN).

In this context, the aim of this course is to provide the student a global knowledge of the design and analysis of the telecommunication systems from a technical, economic and regulatory point of view. Precisely, this global framework requires knowledge of a wide number of important concepts (previously explained in other subjects) that are combined to understand the design and analysis of a complete telecommunication system. Thus, it is highly recommended that the student has taken before the following courses: Communication Theory, Digital Communications, Wave Propagation, Network Architecture or Communication Networks.

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/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TR3 - Aptitude to solve problems with initiative, decision making, creativity, and to communicate and to transmit knowledge, skills and workmanship, comprising the ethical and professional responsibility of the activity of the Technical Engineer of Telecommunication.

en_TR5 - Easy to handle specifications, regulations and mandatory standards.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

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/352/2009:

en_CST1 - Ability to build, operate and manage telecommunications networks, services, processes and applications, understood as systems for capturing, transporting, representing, processing, storing, managing and presenting multimedia information, from the point of view of transmission systems .

en_CST2 - Ability to apply the techniques on which telecommunication networks, services and applications are based, both in fixed and mobile environments, personal, local or at a great distance, with different bandwidths, including telephony, broadcasting, television and data, from the point of view of transmission systems.

Learning Outcomes

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

RA1. Identify, connect and apply techniques and concepts learned in other subjects aiming to design real telecommunication systems.

RA2. Argue, reason and compare pros and cons of different telecommunication systems' technological deployment alternatives and implementations.

RA3. Identify and understand regulation and economical considerations related to the deployment of telecommunications' infrastructures.

RA4. Identify specific telecommunication systems' parameters and design end-to-end systems based on them.

3. CONTENTS

Contents Blocks	Total number of hours
Module 1. Introduction to telecommunication systems. Network, Service, System. Telecommunication systems' types. Telecommunication systems' key concepts. Practice.	8 hours
Module 2. Sources of information. Quantification. Source coding. Digital representation of audio signals. Digital representation of video signals. Data signals. Practice.	14 hours
Module 3. Perturbations in telecommunication systems. Distortion. Crosstalk. Interderence. Noise. Perturbations' addition. Practice.	6 hours
Module 4. Digital Transmission Systems. Digital transmission system model. Modulator and demodulator. Transmission channel. Quality parameters. Practice.	4 hours
Module 5. Assessing digital transmission systems. 5.1. Copper pair access systems: copper pair system infrastructure, parameters that describe signal propagation in the local loop, perturbations that limit the design, the Public Switched Telephone Network, xDSL access systems. 5.2. Optical fiber access systems: parameters that describe signal propagation in optical fiber systems, design of an optical fiber system, design of a basic system over optical fiber, fundamentals of FTTx. Practice	24 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	28 hours in large group 28 hours in small group 2 tests hours
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

The teaching activities that are used to put into practice the teaching-learning processes are:

1. Lectures (in large group)
2. Problem solving class (in small groups)
3. Individual or group work: problem-based learning, reading selected papers
4. Individual and group tutorials.

In the theoretical classes (3.5 ECTS), the professor will select, motivate and explain the essential concepts via the blackboard or computer presentations, which will be complemented with examples that illustrate the main concepts explained.

In these classes, the student will learn the fundamental knowledge of the subject. It is convenient for the student to elaborate his/her own work (personal or in group) aiming to reinforce and / or complement the background presented in the class (study of particular cases or especially important aspects suggested by the professor).

For practical problem solving classes (2.5 ECTS), the professor will provide the student with a collection of illustrative problems and / or technical papers. The professor will communicate to his/her students what problems of the collection will be solved in class in order that the student tries to solve them beforehand (autonomous learning). This approach has the double aim of making the learning "meaningful" along with the student acquired the necessary skills.

Aiming at improving learning, it could be convenient that the resolution of some problems on the blackboard be carried out by the students (with the professor's supervision) and not the other way around (except in particularly complex cases). This will assist students in exchanging critical opinions, sharing different strategies to tackle the problem, and discussing the results obtained.

Additionally, the professor may propose readings aiming at expanding or complementing key concepts.

Finally, in the **tutorials**, both individual and in group, the professor can answer questions, or put in common issues related to the subject. Students will have the possibility to establish a more personal communication that allows them for exploring topics that could be unfeasible to discuss in a larger group.

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 (Regulations for the Regulation of Teaching Learning Processes, NRPEA, 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 Regulations for the Evaluation of Apprenticeships (approved by the Governing Council on March 24, 2011 and modified in the Board of Directors). Government of May 5, 2016) 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 continuous evaluation is carried out by means of a set of partial tests (which are carried out throughout the of 4-month course) and by a final exam whose nature is specified in the section "Grading Tools".

Final Assessment

It will consist in passing a final exam whose nature is specified in the section "Grading Tools".

Extraordinary Call

It will consist in passing a final exam whose nature is specified in the section "Grading Tools".

5.2. EVALUATION

EVALUATION CRITERIA

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

CE1. The student knows how to design – in a reasoned way (approach, procedures, approximations) and by means of the appropriate calculations – the telecommunication systems: he/she exhibits capacity of analysis and synthesis.

CE2. The student understands and is able to analyze and specify the fundamental parameters of a telecommunication system.

CE3. The student is able to discuss the advantages and disadvantages of different alternatives (technological, regulatory and economic) to put into practice a telecommunication system.

GRADING TOOLS

The student's work is graded using the following tools:

1. **Mid-term exams (PEIs: "Pruebas de Evaluation Intermedia")**. They will be exams carried out individually and in writing. A PEI consists in the resolution of problems and questions to quantify to what extent the student is progressing in his / her meaningful learning.
2. **Final exam (PEF).** It is an exam carried out individually and in writing. Its purpose is to evaluate to what extent the student has acquired an integrated knowledge of the subject as a whole. It consists in the resolution of problems and questions that involve **all the content blocks** of the

complete course.

GRADING CRITERIA

Ordinary call

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 grade
TR2, TR3, TR5, TRU1-TRU4, CST1-CST2	RA1 - RA3	CE1, CE2, CE3	PEI1	30%
			PEI2	30%
	RA1 - RA4	CE1, CE2, CE3	PEF	40%

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
TR2, TR3, TR5, TRU1-TRU4, CST1-CST2	RA1 - RA4	CE1, CE2, CE3	PEF	100%

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.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Learning material provided by the professors.
- R. L. Freeman. "Telecommunications Transmission Handbook". Cuarta edición. Wiley – Interscience, 1988.
- International Telecommunication Union (ITU-T) recommendations selected in class (https://www.itu.int/es/pages/default.aspx).
- White papers and research papers.

6.2. Additional Bibliography

- L. Goleniewski, "Telecommunications Essentials", Addison-Wesley, 2009; ISBN 0-321-42761-0, Boston, Estados Unidos.
- R. J. Bates. "Broadband Telecommunications Handbook". Segunda edición. McGraw-Hill, 2002.

- A. A. Huurdeman, "Guide to Telecommunications Transmission Systems". Artech House. 1997. ISBN 0-89006-978-6
- W. Stallings, "Comunicaciones y redes de computadores", Pearson-Prentice Hall, Madrid, 2004, ISBN: 84-205-4110-9.
- A. León-García e I. Widjaja, "Redes de comunicación. Conceptos fundamentales y arquitecturas básicas", McGraw-Hill, 2001, ISBN: 84-481-3197-5
- J. M. Hernando Rábanos, "Sistemas de telecomunicación (volumen 1. Transmisión por Línea y Redes)", Universidad Politécnica de Madrid, 1991.

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.