Universidad de Alcalá

TEACHING GUIDE

Systems and Communications

Degree in
Computer Engineering (GIC)

Universidad de Alcalá

Academic Year 2025/2026

3rd Year - 1st Semester (GIC)

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Systems and Communications**
Code:	**591001 (GIC)**
Degree in:	**Computer Engineering (GIC)**
Department and area:	**Teoría de la Señal y Comunicaciones** **Signal Theory and Communications**
Type:	**Compulsory (GIC)**
ECTS Credits:	**6.0**
Year and semester:	**3rd Year - 1st Semester (GIC)**
Teachers:	Roberto Javier López Sastre
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

The generation, processing, analysis and exchange of information are becoming one of the foundations of modern society, as a result, the tools to perform information management are subject to continuous development. Ultimately, the information is encoded in the form of signals, and any mechanism that acts on a signal is called a system. To properly manage the information, it is necessary, therefore, to understand from a mathematical point of view the properties of signals and systems.

This course, Systems and Communications, has been designed as an introduction to the basic concepts of signals and systems, emphasizing their descriptions in both time and frequency domains. These two characterizations of the signals and systems play a special role for storage, processing and transmission of information.
In particular, within the Computer Engineering degree, this course is particularly relevant, because it enables students to understand the main methods of signal processing. This way, they can analyze, develop and implement software solutions for IT projects in the field of multimedia signal processing systems (e.g. audio and images) and information and communication systems.

To take this course, it is convenient that students are familiar with the algebra of complex numbers, linear algebra, trigonometry, and mathematical analysis tools, including: integration, derivation and summation of power series.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following basic, generic and cross curricular skills:

en_CG8 - Knowledge of the basic subjects and technologies, which enable them to learn and develop new methods and technologies, as well as those that provide them with great versatility to adapt to new situations.

en_CG9 - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Computer Engineering Engineer.

en_CG10 - Knowledge to perform measurements, calculations, assessments, appraisals, appraisals, studies, reports, task planning and other similar computer work, in accordance with the knowledge acquired as set out in section 5, annex 2, of BOE resolution -A-2009-12977.

en_CB1 - That students have demonstrated to possess and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

en_CB2 - That the students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

en_CB3 - That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

en_CB4 - That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized public.

en_CB5 - That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

en_TRU5 - Team work.

Specific Skills

This course contributes to acquire the following specific skills:

en_CIC4 - Ability to design and implement system and communications software.

Learning Outcomes

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

RA1. Understand and manage the basic mathematical tools for the follow-up of the subject.

RA2: Identify the properties of signals and systems, know and manipulate basic signals. Calculate the response of an LTI system to an input signal. Sum and integral of convolution.

RA3: Know how to analyze signals and systems of continuous time in the frequency domain using the series and Fourier transform.

RA4: Perform the sampling of signals and identify their effects in the frequency domain: Nyquist theorem.

RA5: Understand the fundamental concepts of communications systems: channel models, transmission, and reception.

RA6: Understand the fundamental concepts of digital communications: source coding, channel coding, multiplexing, line coding, types of digital modulation, channel capacity.

3. CONTENTS

Contents Blocks	Total number of hours
Module 1. Review of mathematics. Trigonometry, complex numbers, real functions representation, complex functions representation, and geometric series, and basic integrals and derivatives.	6 hours: 4 theory, 2 practical.
Module 2. Introduction to the basic concepts of signals and communications. Definition of continuous and discrete time signal, Signals transformations. Examples of typical signals and its properties. Characterization of systems in in continuous and discrete time.	8 hours: 4 theory, 4 practical.
Module 3. Characterization of linear and time-invariant systems. Integral and convolution sum. Impulse response. Properties. Systems described by difference equations	8 hours: 4 theory, 4 practical.
Module 4. Fourier analysis of continuous-time signals and systems. System response to a complex exponential. Fourier Series and its properties. The Fourier transform: properties and periodic signals. Frequency response of a LTI system. Introduction to filtering. Introduction to sampling: ideal and real sampling.	17 hours: 9 theory, 8 practical.
Module 5. Introduction to digital communication systems. Introduction to communication systems. Advantages of the digitalization. Structure of digital communication systems. Line coding. Inter-symbol interference. Signal space. Constellations. Modulated digital communication systems (ASK, FSK, QAM, and PSK). Introduction to the detection/demodulation of symbols in digital communications. Types of digital receivers. Theorem of Shannon	16 hours: 8 theory, 8 practical.

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours (55 hours on-site + 5 exams hours)
Number of hours of student work:	90 hours (Includes study hours, activity development, exam preparation)
Total hours	150 hours

4.2. Methodological strategies, teaching materials and resources

The teaching strategy is based on a reflective learning model that facilitates the discovery and critical thinking of concepts, and their application to problems.

To this end, in **large groups, there will be lecture sessions** for summarizing the most important concepts and making out new needs on knowledge from a problem-based learning strategy. In these lectures transparencies or computer presentations will be used to facilitate learning.

In **small groups**, a participative and active strategy is proposed so as to enrich the concepts of the theory. These sessions will help to verify the student evolution in the teaching-learning process. These small groups are used for **problem solving.**

May be used Information and Communications Technologies for supporting some of the training activities (Internet, forums, wikis and email, available materials in e-learning platforms, etc.) and as a mean in the process of teaching-learning.

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:

Since the subject of the course has, mainly, a practical utility in digital communications systems, the evaluation will focus on the development and verification of the practical aspects including the application of the concepts studied in the resolution of problems, and the use of different simulation software related to the subject.

The main assessment tools will be:

1. **Assessment Tests** (PEI). Performing written tests focused on both practical and theoretical aspects of the subject.

A mechanism is established for the recovery of those PEIs that the student has developed during the course before the date corresponding to the exam of the ordinary call. Specifically, the student will be able to repeat those tests he/she wishes, always improving the grade.

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. **Final Assessment Tests** (PF). 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. The student is able to manage all the basic mathematical concepts and tools of the course.

CE2: The student shows ability and disposition to analyze the characteristics of the signals and systems in the time domain.

CE3: The student is able to obtain the response of a LTI system and to understand the effects of the system over an input signal.

CE4: The student shows ability and disposition to analyze the characteristics of the continuous-time systems in the frequency domain.

CE5: The student knows the effects of the conversion from continuous time to discrete time and understands its consequences in the frequency domain.

CE6: The student shows ability and disposition to analyze the model of a communication system, by identifying each of its shaping blocks, and by understanding its operation and performance.

GRADING TOOLS

This section summarizes the grading instruments that will be applied to each of the evaluation criteria:

- Evaluation Test (PE): Short tests to be taken throughout the course. There will be 3 of these tests covering the following distribution of topics: PE1 for modules 1, 2 and 3; PE2 for module 4, and PE3 for module 5.
- Final Evaluation Test (PEF): A single test with the same characteristics as the PEs, but only those students who opt for the final evaluation will have to take it.

The evaluation tests described above will consist of solving theoretical and practical problems on the concepts seen in the course.

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
en_CIC4, en_CG8-en_CG10, en_CB1-en_CB5, en_TRU1-en_TRU4	RA1, RA2	CE1, CE2, CE3	PEI	30%
en_CIC4, en_CG8-en_CG10, en_CB1-en_CB5, en_TRU1-en_TRU4	RA3, RA4	CE4, CE5	PEI	40%
en_CIC4, en_CG8-en_CG10, en_CB1-en_CB5, en_TRU1-en_TRU5	RA5, RA6	CE6	PEI	30%

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
en_CIC4, en_CG8-en_CG10, en_CB1-en_CB5, en_TRU1-en_TRU5	RA1, RA2, RA3, RA4, RA5, RA6	CE1, CE2, CE3, CE4, CE5, CE6	PF	100%

Extraordinary call

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
en_CIC4, en_CG8-en_CG10, en_CB1-en_CB5, en_TRU1-en_TRU5	RA1, RA2, RA3, RA4, RA5, RA6	CE1, CE2, CE3, CE4, CE5, CE6	PF	100%

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Signal and Systems. A.V. Oppenheim, A.S. Willsky y S.H. Nawab. Pearson Educación, 1998.
- Analog and digital communications, . Hwei P. Hsu. Schaum Outline Series. Mcgraw-Hill, 2003.
- Fundamentals of Communication Systems. J. G. Proakis, M. Salehi, Pearson Education Limited, 2014.
- Signals and Systems. Hwei P. Hsu. Schaum Outline Series. Mcgraw-Hill, 1995

6.2. Additional Bibliography

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.