Universidad de Alcalá

TEACHING GUIDE

Real Time Systems

Degree in
Computer Engineering (GIC)

Universidad de Alcalá

Academic Year 2025/2026

3rd Year - 2nd Semester (GIC)

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

TEACHING GUIDE

Course Name:	**Real Time Systems**
Code:	**590008 (GIC)**
Degree in:	**Computer Engineering (GIC)**
Department and area:	**Automática** **Systems Engineering and Automation**
Type:	**Compulsory (GIC)**
ECTS Credits:	**6.0**
Year and semester:	**3rd Year - 2nd Semester (GIC)**
Teachers:	Augusto Luis Ballardini
Tutoring schedule:	Consult at the beginning of the course.
Language:	Spanish/English Friendly

1. COURSE SUMMARY

Increase in speed and reliability of personal computers, along with size and prize reduction, has put them on almost every area of our daylife, from mobile phones to air traffic control. One of the areas with the highest expansion is embeeded and real time systems. These kind of systems process information to control processes. Real time systems account for about 90% of global microprocessors production. The specific haracteristics of these kind of systems require the use of programming languages specifically designed to this end. This course studies real time systems and their implementation aspects. It poses the problem of modeling this kind of systems with strong limitations on timing and reliability. In addition, this course studies the possibilities of different languages oriented to these kind of systems.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

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

en_CG3 - Ability to design, develop, evaluate and ensure accessibility, ergonomics, usability and security of computer systems, services and applications, as well as the information they manage.

en_CG4 - Ability to define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications, in accordance with the knowledge acquired as set out in section 5, annex 2, of resolution BOE-A-2009 -12977.

en_CG5 - Ability to conceive, develop and maintain computer systems, services and applications using software engineering methods as an instrument for quality assurance, in accordance with the knowledge acquired as established in section 5, annex 2, of the resolution BOE-A-2009-12977.

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_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_CIC2 - Ability to develop specific processors and embedded systems, as well as develop and optimize the software of these systems.

en_CIC5 - Ability to analyze, evaluate and select the most suitable hardware and software platforms for the support of embedded and real-time applications.

Learning Outcomes

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

RA1. Understand how to program an embeeded system. Understand the importance of low power consumption. Identify failures and applying the strategies to minimize problems. CE-ESY4, CE-ESY5.
RA2. Being able to differentiate between real time operative systems and desktop and server systems. Understand how to use tools to design real time systems. CE-ESY3, CE-ESY7.
RA3. Capacity to use planning methods for real time systems, both basic and advanced to ensure the temporal restrictions.
RA4. Capacity to design and implement code for a real time system applied to a control system with shared resources.

3. CONTENTS

Contents Blocks	Total number of hours
Real time systems modelling	10 T + 8 P hours
Concurrent Implementation of real time systems	10 T + 8 P hours
Reliability on real time systems	6 T + 6 P hours
Design methodologies for real time systems	4 T + 4 P hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours (56 hours on-site +4 exams hours)
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Lectures	Master classes with theory and practical examples.
Practical exercises resolution	Master classes and team work on practical exercises resolution. Small groups problem discussion. Oral and writen exposition.
Laboratory	Work in up to 2 people groups with the laboratory equipement. Exposition and discussion of practical examplesCommon resolution/approach to the problem. Group implementation and defence in a presentation.

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

Continuous Assessment:

In the ordinary call, all the students will be evaluated in continuous evaluation. This will consist of two partial tests and the evaluation of the laboratory. Students following continuous evaluation that fail, can not attend to the final evaluation of the ordinary call. Students not attending to any of the partial tests or not delivering two or more of the proposed laboratory practices will be considered as Not Presented (NP).

Assessment through final exam:

Students (granted with this type of assessment) will be evaluated in a final exam that will include theorical and practical exercises.

Extraordinary Call

Those students that failed on the ordinary call, will be evaluated in a final exam that will include theorical and practical exercises. Students not attending will be considered as Not Presented (NP).

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 shows capacity and initiative to resolve practical problems in the area of control systems design for real time systems.
CE2: The student is able to implement a real time system ensuring the time constraints.
CE3: The student is able to implement a real time system analyzing errors.
CE4: The student has acquired the different concepts about design, analysis and implementation of real time systems.

GRADING TOOLS

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

1. Intermediate Evaluation Test (IET): Practical exercises resolution about control systems implementation.
2. Laboratory works (LW): Practical problems resolution in the laboratory.
3. Final Evaluation Test (FET): Practical exercises resolution about control systems implementation.

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
CG3-5, CG9, CIC2, CIC5	RA2, RA3	CE1, CE2, CE4	IET	30%
CG3-5, CG9, CIC2, CIC5	RA1, RA4	CE1, CE3	LW	30%
CG3-5, CG9, CIC2, CIC5	RA2, RA3	CE1, CE2, CE4	FET	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
CG3-5, CG9, CIC2, CIC5	RA1-RA4	CE2-CE4	FET	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, 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.

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

- A. Burns y A. Wellings. Sistemas de Tiempo Real y Lenguajes de Programación. 3a edición. Pearson Educación. 2003
- ISO/IEC 862:1995(E) - RM95;6.0 Ada Reference Manual.

6.2. Additional Bibliography

- T. Murata. Petri Nets: Properties, Analysys and Applications. Proceeding of the IEEE 77(4). 1989.

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.