

Course guide

230926 - RT - Real-Time Systems

Last modified: 24/05/2024

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 701 - DAC - Department of Computer Architecture.

Degree: BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018).
(Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: JUAN JOSÉ COSTA PRATS

Others: Segon quadrimestre:
JUAN JOSÉ COSTA PRATS - 11, 12, 13
MANUEL ALEJANDRO PAJUELO GONZALEZ - 11, 13

PRIOR SKILLS

From a theoretical point of view, it is assumed that the student has a basic knowledge of Operating Systems.
From a laboratory point of view it is good to have prior knowledge of the C programming language.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE2. (ENG) GREELC: coneixements bàsics sobre l'ús i programació dels ordinadors, sistemes operatius, bases de dades i programes informàtics amb aplicació a l'enginyeria. (Mòdul de formació bàsica).

Generical:

CG9. (ENG) GREELEC: Capacitat de treballar en un grup multidisciplinari i en un entorn multilingüe, i de comunicar tant per escrit com de forma oral, coneixements, procediments, resultats i idees relacionades amb les telecomunicacions i l'electrònica.

Transversal:

CT5. (ENG) GREELEC: ÚS SOLVENT DELS RECURSOS DE LA INFORMACIÓ. Gestionar l'adquisició, l'estructuració, l'anàlisi i la visualització de dades i informació en l'àmbit de l'especialitat i valorar de forma crítica els resultats d'aquesta gestió.

TEACHING METHODOLOGY

Lectures 3hs / week
Laboratory classes 2hs / week
Group work (non-presential): 1
Short answer test (Control): 1
Long answer test (Final Exam): 1

LEARNING OBJECTIVES OF THE SUBJECT

To know the need for a real system as well as to list the different types of real systems that exist.

To know the need for task planning in a real time system.

Be able to build correct simple concurrent programs avoiding deadlocks, starvation, as well as to solve by means of different strategies the potential problems of synchronization between concurrent tasks when the system has shared memory and that fulfills the requirements to be a time system real.

That the student be able to design a task schedule based on the time control assigned to each task in a minimally efficient way for a real-time system.

That the student be able to design a task planning based on priorities per task in a minimally efficient way for a real-time system.

That the student is able to build correct concurrent programs when their tasks are communicated through the passage of messages on distributed memory and that it meets the requirements of a system in real time.

STUDY LOAD

Type	Hours	Percentage
Hours small group	26,0	17.33
Hours large group	39,0	26.00
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

Introducció i conceptes bàsics

Description:

What is a real-time system?

Why RT?

What does RT involve?

RTOSs

Characteristics of a real-time system: determinism, reliability, control, response time (deadline)

Classification of real-time systems according to:

Time limit to complete a task: hard, soft, firm

Time scale:

clock-based: periodic tasks

event-based: aperiodic tasks

interactive: sporadic tasks

Data processing: centralized systems and distributed systems

Planning strategy: static and dynamic systems

Design of the environment to run the system: embedded (dedicated machine) and non-embedded (general purpose machine)

Full-or-part-time: 8h

Theory classes: 3h

Laboratory classes: 2h

Self study : 3h



Task management

Description:

Basic concepts
Processes and threads
Need for scheduling
Concurrency, process states, multiprogramming, multiprocessing, scheduling
Basic management services (creation, destruction)
Internal management
Overview of scheduling algorithms

Full-or-part-time: 16h

Theory classes: 6h
Laboratory classes: 4h
Self study : 6h

Communication and synchronization of tasks in shared memory

Description:

Need for synchronization and potential problems (deadlock, starvation, ...)
Critical regions
Busy wait
Mutual Exclusion
Semaphores

Full-or-part-time: 11h

Theory classes: 3h
Laboratory classes: 2h
Self study : 6h

Communication and synchronization of tasks in distributed memory

Description:

Signals
Message passing
Pipes
Sockets
Message queues

Full-or-part-time: 27h

Theory classes: 9h
Laboratory classes: 6h
Self study : 12h

Time-based scheduling algorithms

Description:

Definition and assumptions
Static and cyclical planning
Slack stealing
Sporadic planning
Advantages and disadvantages of time-based planning

Full-or-part-time: 14h

Theory classes: 6h
Self study : 8h

Priority-based scheduling algorithms

Description:

Static assumption
Fixed priorities (rate-monotonic and deadline-monotonic)
Dynamic priorities
Earliest-Deadline-First algorithm
Overloaded systems
Advantages and disadvantages of priority-based planning

Full-or-part-time: 23h

Theory classes: 9h
Self study : 14h

GRADING SYSTEM

Continuous assessment (EC) = 50% Control + 50% Final exam
Laboratory (Lab): evaluable exercises

Final mark (F): $F = 0.6 \times EC + 0.4 \times Lab$

In the reevaluation exam (ReAval) only the theoretical content will be reevaluated,
therefore, the resulting final mark will be:
 $F = 0.6 \times ReAval + 0.4 \times Lab$

BIBLIOGRAPHY

Basic:

- Burns, Alan; Wellings, Andrew J. Real-time systems and programming languages : Ada, Real-Time Java and C/Real-Time POSIX. 4th ed. Harlow [etc.]: Addison-Wesley, 2009. ISBN 9780321417459.

Complementary:

- Harder, D.W.; Zarnett, J.; Montaghani, V.; Giannikouris, A. A practical introduction to real-time systems for undergraduate engineering [on line]. Versió 0.2018.07.31. Canada: The authors, 2014 [Consultation: 19/02/2021]. Available on: https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture_materials/A_practical_introduction_to_real-time_systems_for_undergraduate_engineering.pdf.
- Buttazzo, Giorgio C. Hard real-time computing systems : predictable scheduling algorithms and applications [on line]. 3rd ed. New York: Springer, 2011 [Consultation: 18/02/2021]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3067230>. ISBN 9781461406754.