

Program	09TT- Engineering in Telecommunication Technologies and Services
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Course number and name	
Number	95000065
Name	Electronic Systems Engineering Ingeniería de Sistemas Electrónicos
Semester	Y4-S8

Credits and contact hours	
ECTS Credits	4.5
Contact hours	49

Coordinator's name	José Manuel Moya Fernández
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Specific course information		
Description of course content		
<p>This course introduces theoretical foundations for modern embedded system design, with special emphasis in embedded software for systems under tight timing, memory, and energy constraints. It covers modeling techniques that are often used for design specifications, and formal verification techniques facilitating design correctness. The students will practically apply those concepts in developing and validating several small but realistic group projects of embedded control systems on Raspberry-Pi.</p>		
List of topics to be covered		
<p>1. Introduction to cyber-physical systems; 2. Microprocessors and embedded system platforms, toolchains for native and cross-development; 3. Programming embedded systems under tight timing, memory, and energy constraints, real-time system analysis and design, low-power system design; 4. Techniques for system design and optimization, security considerations; 5. Distributed embedded systems.</p>		
Prerequisites or co-requisites		
<p>There is no formal prerequisite. Recommended prior knowledge on: Programming (95000010), Digital Systems I (95000026), and Digital Systems II (95000033). Basic C programming skills would also help to get the most out of the course.</p>		
Course category in the program		
<input type="checkbox"/> R (required)	<input checked="" type="checkbox"/> E (elective)	<input type="checkbox"/> SE (selective elective)

Specific goals for the course
Specific outcomes of instruction
RA70: Knowledge about devices, circuits, and electronic systems.

RA71: Knowledge about design techniques for electronics.
 RA73: Knowledge about electronic instrumentation and measurements techniques.
 RA75: Ability to specify, implement, document, and use electronic equipment and systems.
 RA77: Ability to design interface devices, data acquisition and storage, and terminals for telecommunication services and systems.
 RA333: Knowledge about embedded systems, cyber-physical systems, their characteristics, and their design process.
 RA335: Knowledge about models of computation and supporting tools for embedded software development. Ability to design and analyze programs optimizing memory size, energy consumption, or performance. Ability to validate and test embedded systems.
 RA336: Knowledge about concurrent systems, real-time systems, and multi-tasking operating systems. Ability to analyze the scheduling of real-time embedded systems.
 RA327: Ability to analyze factors affecting energy consumption and performance of microprocessor-based embedded systems.
 RA338: Knowledge about techniques to verify formal properties. Ability to analyze the worst-case execution time.

Student outcomes addressed by the course

CE-SE1, CE-SE2, CE-SE3, CE-SE4, CE-SE7, CE-SE8, CG1, CG2, CG3, CG4, CG6, CG7, CG8, CG9, CG10, CG11, CG12

Bibliography and supplemental materials

- M. Wolf , Computers as components, 3rd edition, Morgan Kaufman, .
- E. A. Lee & S. A. Seshia, Introduction to Embedded Systems. A Cyber-Physical Systems Approach, 1st edition, <http://LeeSeshia.org>, 2011
- Web page in UPM moodle:
<https://moodle.upm.es/titulaciones/oficiales/course/view.php?id=5644>

Teaching methodology

<u> X </u> lectures	<u> X </u> problem solving sessions	<u> X </u> collaborative actions	<u> — </u> laboratory sessions
Other:			