ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

615001060 - Embedded Systems Modelling

DEGREE PROGRAMME

61CI - Grado En Ingenieria De Computadores

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 2

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	615001060 - Embedded Systems Modelling
No of credits	6 ECTS
Type	Optional
Academic year ot the programme	Third year
Semester of tuition	Semester 6
Tuition period	February-June
Tuition languages	English
Degree programme	61CI - Grado en Ingenieria de Computadores
Centre	61 - Escuela Tecnica Superior De Ingenieria De Sistemas Informaticos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Gustavo Adolfo Hernandez Peñaloza (Subject coordinator)	4408	gustavo.hernandez.penaloza@upm.es	Sin horario. Schedule not defined yet. Mentoring schedule will be published at the beginning of the semester according to the needs.

Jose Carlos Gamazo Real	4308	josecarlos.gamazo@upm.es	Sin horario. Schedule not defined yet. Mentoring schedule will be published at the beginning of the semester according to the needs.
Javier Garcia Martin	4419	javier.garciam@upm.es	Sin horario. Schedule not defined yet. Mentoring schedule will be published at the beginning of the semester according to the needs.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Fundamentos De Ingenieria Del Software

3.2. Other recommended learning outcomes

The subject - other recommended learning outcomes, are not defined.

4. Skills and learning outcomes *

4.1. Skills to be learned

CE2 - Capacidad de desarrollar procesadores específicos y sistemas empotrados, así como desarrollar y optimizar el software de dichos sistemas.

CE3 - Capacidad de analizar y evaluar arquitecturas de computadores, incluyendo plataformas paralelas y distribuidas, así como desarrollar y optimizar software para las mismas

CE5 - Capacidad de analizar, evaluar y seleccionar las plataformas hardware y software más adecuadas para el soporte de aplicaciones empotradas y de tiempo real.

CT12 - Uso de tecnologías de la información y las comunicaciones : Usar las tecnologías de la información y las comunicaciones en el ámbito de la ingeniería.

OB09 - Capacidad para resolver problemas con iniciativa, toma de decisiones, autonomía y creatividad. Capacidad para saber comunicar y transmitir los conocimientos, habilidades y destrezas de la profesión de Ingeniero Técnico en Informática.

4.2. Learning outcomes

RA557 - Utiliza la programación concurrente en el contexto de los sistemas empotrados.

RA559 - Utiliza las herramientas de programación adecuadas para Implementar sistemas multitarea que siguen la estructura de un sistema empotrado

RA461 - Desarrolla todas las etapas del ciclo de vida de un sistema empotrado

RA556 - Selecciona los diagramas más adecuados para modelar un sistema empotrado, integrando la parte Hardware y la parte Software.

RA558 - Utiliza lenguajes de modelado para especificar y diseñar un sistema empotrado

RA562 - Identifica los requisitos y las soluciones tecnológicas que permiten desarrollar sistemas empotrados.

RA132 - Desarrolla los componentes HW y SW de un sistema empotrado

RA563 - Utiliza herramientas de desarrollo para la integración de todos los elementos requeridos para un sistema embebido

RA10 - Recopila y sintetiza información de fuentes bibliográficas y de clases magistrales en inglés

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Embedded Systems Modelling is aimed at endowing students with the background to select the appropriate diagrams to develop a model for an embedded system according to its characteristics and needs.

The students will develop in an appropriate manner a complete lifecycle for an embedded system including the use of model language to create diagrams, with special attention to the requirements for systems that interact with hardware and sensors (embedded systems, real-time systems, etc).

The students will obtain the knowledge to apply appropriate validation techniques for the diverse diagrams' model. Furthermore, students will learn the methods to develop code enabled for the implementation of the system modelled with the diagrams.

5.2. Syllabus

1. Introduction to Embedded System Modelling
   1.1. Goals and principles of modelling languages
   1.2. Introduction to Modelling Languages
   1.3. Characteristics of embedding system programming
   1.4. Tools to develop system modelling
2. System Requirement Diagrams
   2.1. Introduction (scope, concepts and goals)
   2.2. Systems engineering
   2.3. Features and requirements specification
   2.4. Relationships between requirements and other components

7.2. Validation and Verification of embedded systems

7.3. High Integrity Systems: concepts and standards

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**T1: Introduction to Embedded System Modelling** Duration: 02:00 Lecture	**W1: Introduction to modelio (Or other tool for laboratory works)** Duration: 02:00 Laboratory assignments	**Group questionnaire** Duration: 00:15 Additional activities	
2	**T2: System Requirements Diagrams (I)** Duration: 01:00 Lecture **Case study Presentation** Duration: 01:00 Additional activities	**Coding basis for the case study** Duration: 02:00 Laboratory assignments		
3	**T2: System Requirements Diagrams (II)** Duration: 02:00 Lecture	**Coding basis for the case study** Duration: 02:00 Laboratory assignments		
4	**T3: Modelling the system Architecture (I)** Duration: 02:00 Lecture	**W2: Programming a system defined by Block Diagrams** Duration: 02:00 Laboratory assignments		**Moodle Questionnaire: T1 & T2 (RA10, RA132).** Other assessment Continuous assessment Presential Duration: 00:15
5	**T3: Modelling the system Architecture (II)** Duration: 02:00 Lecture	**W2: Programming a system defined by Block Diagrams** Duration: 02:00 Laboratory assignments		
6	**T4: Modelling the system behaviour (I)** Duration: 02:00 Lecture	**W2: Programming a system defined by Block Diagrams** Duration: 02:00 Laboratory assignments		
7	**T4: Modelling the system behaviour (II)** Duration: 02:00 Lecture	**W3: Programming a system specified by State Machine Diagrams** Duration: 02:00 Laboratory assignments		**Moodle Questionnaire: T3 & T4 (RA10,RA132).** Other assessment Continuous assessment Presential Duration: 00:15
8				**Midterm Exam 1: T1, T2, T3 & T4. (RA10,RA556,RA558)** Written test Continuous assessment Presential Duration: 01:30
9	**T5: Architecture and conceptual modelling (I)** Duration: 02:00 Lecture	**W3: Programming a system specified by State Machine Diagrams** Duration: 02:00 Additional activities		

10	**T5: Architecture and conceptual modelling (II)** Duration: 02:00 Lecture	**W3: Programming a system specified by State Machine Diagrams** Duration: 02:00 Additional activities		
11	**T6: Model-Driven Development (MDD) Engineering for embedded systems (I)** Duration: 02:00 Lecture	**W4: Modelling a complete embedded system: Selection of the appropriate diagrams and developing and validating the model.** Duration: 02:00 Laboratory assignments		
12	**T6: Model-Driven Development (MDD) Engineering for embedded systems (II)** Duration: 02:00 Lecture	**W4: Modelling a complete embedded system: Selection of the appropriate diagrams and developing and validating the model.** Duration: 02:00 Laboratory assignments		
13	**T7: Reliability and fault tolerance (I)** Duration: 02:00 Lecture	**W4: Modelling a complete embedded system: Selection of the appropriate diagrams and developing and validating the model.** Duration: 02:00 Additional activities		
14	**T7: Reliability and fault tolerance (II)** Duration: 02:00 Lecture	**W4: Modelling a complete embedded system: Selection of the appropriate diagrams and developing and validating the model.** Duration: 02:00 Additional activities		**Moodle Questionnaire: T5, T6 & T7 (RA10,RA132).** Other assessment Continuous assessment Presential Duration: 00:15
15			**Seminar (Optional)** Duration: 01:00 Additional activities	**Case study presentation: Final report. (RA10,RA132,RA461,RA556,RA557,RA558, RA559,RA562,RA653)** Group presentation Continuous assessment Presential Duration: 00:20 **Exam2: T5, T6 & T7. (RA: All)** Written test Continuous assessment Presential Duration: 01:30
16				
17				**Final Exam (only for students who did not manage to pass the continuous assessment.) (RA: All)** Written test Final examination Not Presential Duration: 03:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
4	Moodle Questionnaire: T1 & T2 (RA10, RA132).	Other assessment	Face-to-face	00:15	3%	0 / 10	CE3 CE5
7	Moodle Questionnaire: T3 & T4 (RA10,RA132).	Other assessment	Face-to-face	00:15	3%	0 / 10	CT12 CE3
8	Midterm Exam 1: T1, T2, T3 & T4. (RA10,RA556,RA558)	Written test	Face-to-face	01:30	25%	4 / 10	CT12 CE5 OB09
14	Moodle Questionnaire: T5, T6 & T7 (RA10,RA132).	Other assessment	Face-to-face	00:15	4%	0 / 10	CT12 CE3
15	Case study presentation: Final report. (RA10,RA132,RA461,RA556,RA557,RA558,RA559,RA562,RA653)	Group presentation	Face-to-face	00:20	35%	5 / 10	CT12 CE2 CE3 CE5 OB09
15	Exam2: T5, T6 & T7. (RA: All)	Written test	Face-to-face	01:30	30%	4 / 10	CT12 CE2 CE3 CE5

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Exam (only for students who did not manage to pass the continuous assessment.) (RA: All)	Written test	No Presential	03:00	100%	5 / 10	CT12 CE2 CE3 CE5 OB09

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final Exam: All syllabus and practical case (RA: All).	Written test	Face-to-face	02:00	100%	5 / 10	CT12 CE2 CE3 CE5 OB09

7.2. Assessment criteria

The student reaching a mark equal or larger than 5 via the continuous evaluation will be exempt of the final exam.

Students who do not pass the progressive assessment will have the opportunity to pass the course by means of the final exam, which will count for 100% of their mark. To do so, they must request this possibility to the teachers of the subject within 2 months from the beginning of the term in which the subject is taught.

EXTRAORDINARY EXAM

The extra-(July) exam will consist of a Final exam that will count for 100% of the final grade.

In these final exams (June and July) the student must demonstrate the same skills as those required in the progressive assessment, both in theory and in practice. It means that practical part will be composed of questions related to the case study. Students must reach a mark equal or larger than 5 in the final exam to pass.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Lenny Delligatti. 2013. SysML Distilled: A brief Guide to the Systems Modelling Language (1st ed) Addison-Wesley Professional	Bibliography	
Designing Concurrent, Distributed, and Real-Time Applications with UML. Hassan Gomaa. Addison-Wesley.	Bibliography	
Sanford Friedenthal, Alan Moore, and Rick Steiner. 2008. A Practical Guide to SysML: Systems Modeling Language. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.	Bibliography	
Beydeda, S., Book, M. & Gruhn V., Model- Driven Software Development, Springer, 2005.	Bibliography	

9. Other information

9.1. Other information about the subject

TRANSLATIONS:

RA10 - Recopila y sintetiza información de fuentes bibliográficas y de clases magistrales en inglés / Gathers and and synthesises information from bibliographic sources and lectures in English

RA132 - Desarrolla los componentes HW y SW de un sistema empotrado // Develops the HW and SW components of an embedded system.

RA461 - Desarrolla todas las etapas del ciclo de vida de un sistema empotrado // Develops all lifecycle stages of an embedded system.

RA557 - Utiliza la programación concurrente en el contexto de los sistemas empotrados. // Uses concurrent programming in the context of embedded systems.

RA558 - Utiliza lenguajes de modelado para especificar y diseñar un sistema empotrado // Uses modelling languages to specify and design an embedded system.

RA559 - Utiliza las herramientas de programación adecuadas para Implementar sistemas multitarea que siguen la estructura de un sistema empotrado // Uses appropriate programming tools for implementing multitask systems that follows the structure of an embedded system.

RA562 - Identifica los requisitos y las soluciones tecnológicas que permiten desarrollar sistemas empotrados //

Identifies the requirements and the technological solutions allowing to develop embedded systems.

RA563 - Utiliza herramientas de desarrollo para la integración de todos los elementos requeridos para un sistema embebido // Uses development tools for the integration of al required elements for an embedded system.

CT12 Uso de tecnologías de la información y las comunicaciones : Usar las tecnologías de la información y las comunicaciones en el ámbito de la ingeniería. // Use of ICT in the engineering field.

CE2 Capacidad de desarrollar procesadores específicos y sistemas empotrados, así como desarrollar y optimizar el software de dichos sistemas. // Ability to develop specific processors and embedded systems as well as to develop and optimise software for such systems

CE5 Capacidad de analizar, evaluar y seleccionar las plataformas hardware y software más adecuadas para el soporte de aplicaciones empotradas. Ability to analyse, assess and select the HW platforms and SW more appropriated for the support of embedded applications

OB09 - Capacidad para resolver problemas con iniciativa, toma de decisiones, autonomía y creatividad. Capacidad para saber comunicar y transmitir los conocimientos, habilidades y destrezas de la profesión de Ingeniero Técnico en Informática. // Ability to solve problems with initiative, decision-making, autonomy and creativity. Ability to communicate and transmit knowledge, skills and abilities of Engineers.

TRANSVERSAL COMPETENCES:

This subject, aims at covering the aforementioned competences by combining the theoretical knowledge with it's

application in practice settings. The students are actively working in the case study where they have the opportunity to apply the techniques for close-to-market problems. In order to cope with these competences, the " Resultados de aprendizaje /Learning Results (RA)" were defined: The interrelation between the concurrent programming applied to embedded systems and real-time systems for optimal performance. For the competences training, the following activities are foreseen:

1) Release of the subject contents including, slides presentation, bibliography and references with the ambition of making the links between engineering, environment and social responsibilities.

2) A talk about the social impact and environmental of the case study implemented in the subject will allow them to create consciousnesses of the impact while aligning with the United Nations Sustainable Development Goals SDG.

The results will be evaluated in the "Project presentation", where studies will have to incorporate in the report an analysis and an essay about the impact that the developed system will have for some of the society fields including economy, social wellbeing, human rights, environment). This part counts for a 20% of the project mark.