DEGREE CURRICULUM

SYSTEMS INTEGRATION II

Coordination: TRESÁNCHEZ RIBES, MARCEL

Academic year 2019-20

SYSTEMS INTEGRATION II 2019-20

Subject's general information

<table>
<tr><td>Subject name</td><td>SYSTEMS INTEGRATION II</td></tr>
<tr><td>Code</td><td>102131</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Automation and Industrial Electronic Engineering</td><td>4</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>3</td><td>3</td></tr>
<tr><td>Number of groups</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>TRESÁNCHEZ RIBES, MARCEL</td></tr>
<tr><td>Department</td><td>COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>Total load: 150h
- 60h of lectures (40%)
- 90h of independent student work (60%)</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Speaking: As required (Catalan, Spanish or English).
Materials and resources: English.
Student workload: English.</td></tr>
<tr><td>Distribution of credits</td><td>Theoretical sessions: 2 ECTS
Experimental training sessions: 2 ECTS
Practical sessions: 2 ECTS</td></tr>
<tr><td>Office and hour of attention</td><td>Robotics Lab (2.04-EPS building). Monday 10:00-11:00 AM.</td></tr>
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Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
TRESÁNCHEZ RIBES, MARCEL	marcel.tresanchez@udl.cat	7,2	

Subject's extra information

It is **COMPULSORY** to have completed or be attending the previous subject (Systems Integration I) relating to this optional module.

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Blue laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos
Centre the Cultures i Cooperació Transfronterera

http://www.publicacions.udl.cat/

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student cannot access to the laboratories or have to go out of them. The no realization of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realization of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.
- Long hair needs to be tied.
- Keep the laboratory gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lenses and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following document of the *Servei de Prevenció de Riscos Laborals de la UdL*: http://www.sprl.udl.cat/alumnes/index.html

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Learning objectives

Learning the internal working of a high-performance microcontroller of 32 bits.

Being able to program any peripheral of a 32-bit microcontroller for an automated specific task.

Knowing the ARM Cortex-M architecture and its application in microcontrollers of 32 bits.

Understanding the operation with sensors, MEMS sensors and actuators systems by means of low cost microcontrollers.

Learning the use of the main intra-board communication busses for integrated circuits.

Acquire necessary knowledge to be able to design and program a intelligent integrated system.

Competences

Strategic Competences of the UdL

UdL2. Command of a foreign language.

UdL3. Mastering ICT's.

Cross-disciplinary competences

EPS4. To have the skills required to undertake new studies or improve the training with self-direction.

EPS9. Capacity for unidisciplinary and multidisciplinary teamwork.

Specific competences

GEEIA21. Knowledge of the basics and applications of the digital electronics and microprocessors.

GEEIA25. Knowledge and capacity for modelling and simulation of systems.

GEEIA27. Knowledge of principles and applications of robotic systems.

Subject contents

1. Introduction to embedded systems
2. Working principles of a microcontroller
3. ARM Cortex-M architecture
4. STM32F4 microcontrollers
5. STM32F407VGT6 MCU
6. STM32F4Discovery kit

7. CMSIS files & libraries

8. Digital I/O

9. Registers and memory managing

10. SWV and ITM Debugging

11. System Clock Configurations

12. System timer (NVIC) and EXTI peripheral

13. System timer (SysTick)

14. USART communication

15. Analog I/O (ADC and DAC peripherals)

16. MCU timers

17. I2C communication

18. SPI communication

Methodology

The subject will be developed by conducting several experimental works to be carried out in the electronics lab 2.05 (2nd floor) of the Polytechnic School (EPS).

Learning systems integration will be carried out by STMicroelectronics development tools, mainly with STM32F4 - Discovery.

Development kits will be provided entirely by the school where each student will work individually.

Practical exercises will be based on microcontroller programming using C language development environments.

The sessions will be divided into three consecutive stages repeated for each of the contents of the subject:

- Sessions of theory (classroom): Preliminary theoretical concepts.
- Experimental training sessions (electronics lab): Acquire skills with teacher support.
- Practice sessions (electronics lab) : Individual student work with exercises and activities.

Development plan

Week	Description	Classroom Activity	Classroom Hours	Student workload Hours
1	Presentation	Masterclass	2	0
	Lesson 1: Lecture	Masterclass	2	3
2	Lesson 2: Lecture	Masterclass	2	3
2	Lesson 3: Lecture	Masterclass	2	3
3	Lesson 4: Lecture	Masterclass	2	5
3-4	Lesson 5-6: Lecture/Experimental	Experimentation	4	4

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Week	Description	Classroom Activity	Classroom Hours	Student workload Hours
4	Lesson 7-8: Experimental	Experimentation	2	6
5	Lesson 8: Practices	Practical exercise 1	2	5
5-6	Lesson 9-10: Experimental	Experimentation	4	3
6	Lesson 11: Experimental	Experimentation	2	4
7	Lesson 12-13: Experimental	Experimentation	4	2
8	Lesson 14: Experimental	Experimentation	2	2
8	Lesson 14: Practices	Practical exercise 2	2	8
9	Evaluation exam 1	Practices doubts	2	0
10	Lesson 15: Lecture/Experimental	Experimentation	4	5
11	Lesson 16: Experimental	Experimentation	2	8
11	Lesson 17: Experimental	Experimentation	2	2
12	Lesson 16-17: Practices	Practical exercise 3	2	8
12	Lesson 18: Experimental	Experimentation	2	3
12-14	Proyecto final	Practical exercise 4	8	10
15-16	Evaluation exam 2	Practices doubts	2	0
17	Tutorials	Tutorials	2	0
18	make-up exam	Evaluation	2	6

Evaluation

The course assessment will take place continuously and be based on the weighted evaluation of the reports of the activities undertaken throughout the course.

These experimental exercises should be carried out individually. Each student will have available the electronics devices required to work with the proposed exercises at home and at hours of electronics laboratory.

The practical exercises are composed for three practical tasks and one final project. The difficulty of the activities will be increased as regarding on the punctuation weight of final qualification: 2, 2 and 2.5 points respectively. Finally, there will be a final project that will be focused on the global knowledge acquired. This project will be carried out in workgroups and will have a weight about final qualification of 35% (3.5 points).

Bibliography

STM32 32-bit ARM Cortex MCUs

http://www.st.com/web/en/catalog/mmc/FM141/SC1169

STM32F4Discovery - STMicroelectronics

http://www.st.com/web/catalog/tools/FM116/SC959/SS1532/PF252419

Atollic TrueSTUDIO

http://www.atollic.com/index.php/truestudio

ARM Cortex-M architecture

http://www.arm.com/products/processors/cortex-m/

Adaptations to the methodology due to COVID-19

All content will be online.

The subject will continue to be developed through the implementation of practical work initially planned. Although the purpose of the activities are the same, their content will be adapted so that they can be performed entirely from home.

The scheduled face-to-face sessions will be transformed into recorded virtual sessions which will be available following the initial schedule.

There will be joint live follow-up tutorials through video conferencing on Tuesdays and Thursdays from 6:00 p.m. to 7:00 p.m.

The forum tool, organized by subject stages, will also be available where the students will be able to create topics to discuss each other and with the teacher (as a moderator).

Adaptations to the development plan due to COVID-19

The expected development plan is as following:

Week	***Days***	***Expected online content***
10	14/04 – 19/04	**Practical Exercise 2**. USART communication and analog I/O with AWD.
11	20/04 – 26/04	**Video Lecture 3**. Timers on STM32F4. (Lesson 16)
12	27/04 – 03/05	**Video Lecture 4**. I^2C communication. (Lesson 17) **Practical Exercise 3**. Implementation of a driver to control an audio codec.
13	04/05 – 10/05	**Video Lecture 5**. SPI communication. (Lesson 18) **Practical Exercise 4**. Develop an audio mixing console (DJ mixer).
14	11/05 – 17/05	Time for the active practices and doubts.
15	18/05 – 25/05	Time for the active practices and doubts.
19	16/06	Make-Up exam

Adaptations to the evaluation due to COVID-19

The subject evaluation will continuous in the same way, four practical exercises. Although the topic and punctuation of the upcoming practices will be the same, the content will change as we cannot provide you the necessary additional electronics such as displays or joysticks modules. So, we will take the advantages of the extra embedded features of the STM32F4Discovery, specifically the CS43L22 audio codec module. The focus of the next practices will change to audio processing instead of graphical interfaces and videogames development.