DEGREE CURRICULUM

SYSTEMS INTEGRATION III

Coordination: TRESÁNCHEZ RIBES, MARCEL

Academic year 2019-20

SYSTEMS INTEGRATION III 2019-20

Subject's general information

<table>
<tr><td>Subject name</td><td>SYSTEMS INTEGRATION III</td></tr>
<tr><td>Code</td><td>102132</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>
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<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>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: 1 ECTS
Experimental training sessions: 1 ECTS
Practical sessions: 4 ECTS</td></tr>
<tr><td>Office and hour of attention</td><td>Horario a convenir. Lugar: Laboratorio de Robótica (2.04 edificio EPS)</td></tr>
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SYSTEMS INTEGRATION III 2019-20

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 subjects (Systems Integration I and II) 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

SYSTEMS INTEGRATION III 2019-20

Learning objectives

Being able to design, manufacture and assembly of printed circuit boards (PCB).

Learning design techniques of PCB using surface mount devices (SMD).

Acquire knowledge to design integrated solutions with ECAD and MCAD workflow.

Know tools to develop advanced integrated systems based on microcontrollers.

Acquire knowledge to design integrated solutions with screen displays and touch panels.

Know how to develop embedded low-cost integrated systems with battery power charging solutions.

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. Electronic circuits manufacturing with Printed Circuit Boards (PCB)
    - 1.1. Introduction to SMT
    - 1.2. PCB Design
    - 1.3. EDA Software
    - 1.4. PCB Manufacturing
    - 1.5. PCB SMD Component Assembly

2. Advanced solutions for low-cost small-size embedded systems
    - 2.1. Battery power management
    - 2.2. Power electronics control

2.3. MMC and SD card interfaces

2.4. Embedded displays and touch systems

3. Development of an advanced electronic device

3.1. Digital and power electronics design

3.2. Design of the PCB with SMD technology

3.3. Logical MCU programing with advanced peripherals

3.4. Fabrication, assembly and start-up of the device

Methodology

The subject is focused on continuous practical work in the embedded systems integration. All these practical works will be developed distributing tasks in work teams where each project will include part of knowledge acquired in previous work in order to accomplish complex integrated systems.

Learning in systems integration will be divided into three stages. During the first stage, we will work with the design, manufacture and assembly of printed circuit boards (PCB). Autodesk CAD/CAM Eagle Software will be used and will work with Eurocircuits equipment for soldering and assembly. The second stage, dedicated to advanced learning of embedded systems, will be carried out using STMicroelectronics development tools, mainly the STM32F4-Discovery that includes an ARM Cortex-M high performance 32bit microcontroller. Finally, the last stage will focus on a practical full development (HW and SW) of a real embedded electronic device.

The development kits and other materials will be provided entirely by the school.

The practical works will be focused on the application of hardware peripherals managed by microcontrollers where the automation and control will be done using C programming language.

Development plan

Week	Description	Classroom activity	Classroom hours	Student workload hours
1	Presentation	Masterclass	2	0
	Lesson 1.1: Lecture	Masterclass	2	4
2	Lesson 1.2: Lecture/Experimental	Experimentation	2	3
2	Lesson 1.3: Lecture	Experimentation	2	3
3	Lesson 1.3: Practices	Practical Exercise 1	2	8
3	Lesson 1.4: Lecture/Experimental	Experimentation	2	4
4	Lesson 1.3-1.4: Practices	Practical Exercise 2	4	8
5	Lesson 1.5: Lecture/Experimental	Experimentation	4	5
6	Lesson 2: Lecture	Masterclass	2	3
6-7	Lesson 2.1: Lecture/Experimental	Experimentation	4	4

Week	Description	Classroom activity	Classroom hours	Student workload hours
7	Lesson 2.2: Experimental	Experimentation	2	2
8	Lesson 2.1-2.2: Practices	Practical Exercise 2	4	8
9	Evaluation exam 1	Practices doubts	2	0
10	Lesson 2.3: Lecture/Experimental	Experimentation	4	2
11	Lesson 3.1: Practices	Final project	4	8
12-13	Lesson 3.2: Practices	Final project	6	5
13	Lesson 3.3: Practices	Final project	2	8
14	Lesson 3.4: Practices	Final project	4	10
15-16	Evaluation exam 2	Practices doubts	2	0
17	Tutorials	Tutorials	2	0
18	Make-up exam	Evaluation	2	6

Evaluation

The workload assessed consist in the enforcement of three main consistent practical works based on the development of integrated applications using microcontrollers. Specifically, the issues will be:

P1. ECAD design of PCB electronic components

P2. Design of a printed circuit board (PCB) of a prototype using SMT technology

P3. Design of the electronic schematics for a 32-bit microcontroller based PCB

PF. Full development of a smart and portable embedded system based on a microcontroller

At this way, the course qualification (NC) will be calculated as:

NC = P1*0.15 + P2*0.2 + P3*0.2 + PF*0.45

If **NC** is lower than 5.0 there will be an optional exam with a weight of 8 points, the final mark will be computed with:

NF = **NR** + (NC x **0,2**)

Bibliography

- PCB Design & Schematic Autodesk EAGLE Software
http://www.autodesk.com/products/eagle

- Ray P. Prasad (1997) Surface Mount Technology: Principles and Practice. Springer. ISBN: 978-1-4615-4084-7.

- Carmen Capillo (1989) Surface Mount Technology: Materials, Processes and Equipment. McGraw-Hill. ISBN-13: 978-0070097810.

- William Ho (2010) Optimal Production Planning for PCB Assembly. Springer Series in Advanced Manufacturing. ISBN: 978-1-84628-500-4.

- Simon Monk (2014) Make Your Own PCBs with EAGLE: from Schematic Designs to Finished Boards. McGraw-Hill. ISBN-13: 9780071819251.

- Bruce Archambeault (2002) PCB Design for Real-world EMI Control. Springer. ISBN: 978-1-4757-3640-3.

- STM32F4Discovery from STMicroelectronics
http://www.st.com/web/catalog/tools/FM116/SC959/SS1532/PF252419

- STMicroelectronics development boards
http://www.st.com/web/catalog/tools/FM116/SC959/SS1532/PF252419
http://www.st.com/web/catalog/tools/FM146/CL1984/SC720/SS1462/PF255417

- Jonathan W Valvano (2015) Embedded Systems: Introduction to Arm® Cortex(TM)-M Microcontrollers , Fifth Edition. ISBN: 978-1477508992

- Joseph Yiu (2013) The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors. Elseiver. Cambidge, UK.

- Donald Reay (2015) Digital Signal Processing and Applications Using the Arm Cortex M4. Wiley. ISBN: 978-1118859049.

- Warwick A. Smith (2009) C Programming for Embedded Microcontrollers. Publitronic-Elektor. ISBN: 978-0905705804.

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***
14	14/04 – 19/04	**Practical Exercise 3**. Schematics design for 32-bit MCU based PCB.
11	20/04 – 26/04	**Video Lecture 3**. Power ON/OFF and auto shutdown management.
12	27/04 – 03/05	**Video Lecture 4.** Integrating user interfaces on our embedded PCB design. **Video Lecture 5.** Digital audio processing on embedded systems.
13	04/05 – 10/05	**Practical Exercise 4**. Full electronics development of a portable embedded system.
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 be practically the same, four practical exercises. Although the topic of the next practices will be the same, the content and punctuation not. Mainly, it affects in the final project which will be focused only on the design without having to perform an electronics assembly and testing as it was initially planned. So, its punctuation will be reduced and evenly distributed with the other practices as follows:

NC = P1*0.2 + P2*0.25 + P3*0.25 + P4*0.3