DEGREE CURRICULUM

SYSTEMS INTEGRATION III

Coordination: TRESÁNCHEZ RIBES, MARCEL

Academic year 2021-22

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>
<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>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>
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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	6	

Subject's extra information

This course is part of the elective module in Systems Integration of the Degree in Automation and Industrial Electronic Engineering offered by the Polytechnic School at the University of Lleida.

A **Joint Project** is developed together with other subjects of the Systems Integration module:

- SYSTEMS INTEGRATION II *
- SYSTEMS INTEGRATION III *

(*) These two subjects must be enrolled simultaneously because they work together on a Joint Project. The only exception is if any of them is approved.

Each subject focuses on the corresponding aspects of project development. In the case of this subject, electronic design, manufacturing and assembly of embedded systems. The aim of this Joint Project is to bring the students with what would be a real-world project of embedded electronic systems development and at the same time, bring into a real context the aspects studied in previous courses.

It is **COMPULSORY** to have completed or be attending the previous subject related to this elective module, SYSTEMS INTEGRATION I and II.

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

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. Electrical compatibility and battery power

    2.2. Power electronics management

    2.3. Data storage systems

    2.4. Visual screens and touch panels

    2.5. Sensors, actuators and wireless communication

    2.6. Image processing with CMOS sensors

    2.7. Audio signal processing

    2.8. Mobile robotics with microcontrollers

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 electronics development for embedded systems.

The subject includes three session types:

- Theory sessions (classroom): Preliminary theoretical concepts before laboratoy experimentation.
- Experimental training sessions (electronics lab): Acquire skills by experimenting with practical examples with teacher support.
- Practical sessions (electronics lab): Student work related to deliverable practical tasks (individual) and the joint project (in group).

In group work sessions, the project-based learning methodology will be used. The students will put into practice the techniques proposed in the subject within the framework of a project common to the two second-semester fourth-year System Integration elective subjects.

The tools used in the practical work for design, manufacture and assembly of printed circuit boards (PCB) will be Autodesk CAD/CAM Eagle and Fusion 360.

Mid-range SMD soldering machines will be used to carry out the device manufacturing and assembly requirements of the joint project.

Development plan

Week	Methodology	Content	Joint Project work	Individual work	HTP (3)	HTNP (3)
1, 2	Masterclass	Lesson 1.1, 1.2			6	2
2	Experimental Sessions	Lesson 1.3			2	3
3	Practical Sessions	Lesson 1.2, 1.3	WP1	Practical Task 1	2	8
3	Experimental Sessions	Lesson 1.2, 1.3	WP1		2	3
4	Experimental Sessions	Lesson 1.4, 1.5	WP1		2	2
4	Practical Sessions	Lesson 1.1-1.4	WP1		2	6
5	Practical Sessions	Lesson 1.5	WP3	Practical Task 2	4	12
6	Masterclass	Lesson 2.1-2.8	WP3		4	8
7, 8	Experimental Sessions	Lesson 2.1-2.8	WP3		6	6
8	Practical Sessions	Lesson 3.1, 3.2	WP4		2	6
9	Practices doubts(1)	Lesson 3.1, 3.2			2	4
10	Practical Sessions	Lesson 3.3, 3.4	WP4		4	4
11	Practical Sessions	Lesson 3.3, 3.4	WP4		4	4
12, 13	Practical Sessions	All	WP6		8	14
14	Practical Sessions	All	WP7		4	8
15	Project presentation	All	All		4	0
16, 17	Practices doubts(1)	All			2	0
18	Tutorials	All			0	0
19	Make-up Exams: Evaluation	All			0	0
				TOTAL	**60**	**90**

(1) Week for exams. As there are no written tests, they are dedicated to classes of practical questions.
(2) HTP = Face-to-face Hours
(3) HTNP = Homework Hours

Evaluation

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

The practical exercises are made up of two practical tasks (20%) and a joint project (80%) distributed within seven work packages (WPx). Each work package involves one or both subjects, Systems Integration II (SI2) and Systems Integration III (SI3), with specific evaluation weight.

The work packages of the joint project (**JP**) to be carried out are the following:

Project Work Packages (WPx)	SI2 Rate	SI3 Rate	Minimum mark	Group activity	Mandatory
WP1: Device proposal.	15%	15%	NO	2 to 3	YES
WP2. Proof of concept.	40%	0%	5	2 to 3	YES
WP3. Electronics design of the initial prototype.	0%	30%	5	2 to 3	YES
WP4: Manufacture and assembly of the prototype.	0%	15%	NO	2 to 3	YES
WP5. Initial prototype firmware.	20%	0%	NO	2 to 3	YES
WP6: Device test and refinements.	5%	20%	NO	2 to 3	YES
WP7: Product presentation and demonstration.	20%	20%	5	2 to 3	YES

The practical tasks (**PT**) to be carried out are the following:

Practical Tasks (PTx)	SI2 Rate	SI3 Rate	Minimum mark	Group activity	Mandatory
PT1: Design electronic parts with 3D model.	0%	50%	5	NO	YES
PT2: PCB Power bank design.	0%	50%	5	NO	YES

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

NC = JP*0.8 + PT*0.2

If **NC** is lower than 5.0 there will be an optional make-up exam (**NR**) of full course content. Then, the final mark (**NF**) will be computed as:

NF = **NR*0.8** + **NC*0.2**

Bibliography

- 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.

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

- STM32 MCU evaluation tools from STMicroelectronics
https://www.st.com/en/evaluation-tools/mcu-mpu-eval-tools.html