240072 - Electronics

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 7,5   Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: EMILIO JOSE LUPON ROSES
Others: JUAN ANTONIO CARRASCO LOPEZ - 20
EMILIO JOSE LUPON ROSES - 10, 30

Opening hours
Timetable: JUAN ANTONIO CARRASCO LOPEZ : Monday and Friday from 3 to 5 PM.
EMILIO JOSE LUPON ROSES : Tuesday and Friday from 12 to 2 PM.

Degree competences to which the subject contributes
Specific:
1. Knowledge of electronics fundamentals.
240072 - Electronics

Teaching methodology

This course has an assigned load of 7.5 ECTS credits, which is equivalent to 187.5 student's working hours. 74.5 of these hours correspond to face-to-face activities (57 of theory and problem lectures, 10 of laboratory experiments, and 7.5 of assessments). The remaining 113 hours correspond to non-classroom activities (13.5 for reading certain documents, 10 for simulations of circuits, and 89.5 hours of general study, which includes problem solving and laboratory work preparation).

The course is structured in two parts: a theory part (44 topics dealing with theory and problems) and a laboratory part (10 sessions dealing with circuits that must be simulated or mounted and experimented). Each of these parts involves attending activities, non-attending activities, and assessment activities. Each part will follow the program indicated in the contents.

The attending activities of the theory part will consist in theory and problems lectures (minimum of 57 hours, including one hour for the course presentation). Some topics will not be explained in the lecture sessions. Instead, some material will be given to students in order to be studied by their own (theory non-attending directed learning, 13.5 hours).

The attending activities of the laboratory part will consist of 5 laboratory sessions (odd sessions) of two hours in teams of two students. Session 1 (simulation) will be held at the Laboratory of Electronics III, located on the 9th floor, door 45. The other attending sessions will be held at the Laboratory of Electronics I, located in the 9th floor, door 35. The remaining sessions (even sessions) will be directed non-attending simulation experiments.

Each experiment, whether attending or non-attending, has an associated set of tasks to be performed as a preparation for the experiment. It is advisable to carefully prepare the experiments, as this significantly facilitates their understanding and improves the work made in the laboratory. In order to properly perform and verify the preparation of the experiments, a booklet will be published for this purpose, in which the student should reflect the development of these preparation tasks. This booklet must be presented to the teacher at the beginning of each attending laboratory session, and will be returned to the student with a visa in case of a proper preparation. This booklet must also be presented to the teacher in the laboratory assessment exams. The number of visas will be considered in the course grading.

In order to help with study of the course contents, all kinds of useful material, such as textbooks, collections of problems, collection of exam questions, material used in class, etc., will be provided to students. Part of this material will be available on the Digital Campus.

Learning objectives of the subject

General objectives:
Introduce the different types of electronic systems, their signals, their components, and their applicability in the industrial world.

Specific objectives:
Introduce the essence of electronic systems and characterize the different types of electronic systems: analog systems, digital systems, power electronics systems, and electronic instrumentation systems.
Introduce the main components and devices used in the electronic systems, as well as their functionality.
Introduce the behavior models used for modeling the main electronic components.
Introduce some analysis techniques used for analyzing electronic circuits.
Introduce the main analog circuits and systems, and their most significant applications.
Introduce the main digital circuits and systems, and their most significant applications.
Introduce the electronic instrumentation systems, and their most significant applications.
Introduce the main power electronics systems, and their most significant applications.
Familiarize students with the use of electronic CAD tools.
Familiarize students with the use of the instruments present in an electronics laboratory.
Familiarize students with the interpretation of the data sheets of the electronic components.
Provide students with a common language that facilitates communication with electronic engineers.
Enable students to specify electronic systems.
Enable students to analyze simple electronic systems.
Introduce the basic aspects of the electronic systems manufacturing process.
# Study load

<table>
<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time</strong></td>
<td>187h 30m</td>
<td>65h</td>
<td>10h</td>
<td>0h</td>
<td>112h 30m</td>
</tr>
<tr>
<td></td>
<td>34.67%</td>
<td>0.00%</td>
<td>5.33%</td>
<td>0.00%</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
# 240072 - Electronics

## Content

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Learning time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module 0:</strong></td>
<td>Course presentation (1 h + 0 h)</td>
<td><strong>Learning time:</strong> 1h</td>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td><strong>Module 1:</strong></td>
<td>Introduction to Electronics (4.5 h + 1.5 h)</td>
<td><strong>Learning time:</strong> 12h</td>
<td>Practical classes: 4h 30m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Guided activities: 1h 30m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self study: 6h</td>
</tr>
<tr>
<td><strong>Module 2:</strong></td>
<td>Basic devices and circuits (14 h + 3 h)</td>
<td><strong>Learning time:</strong> 34h</td>
<td>Practical classes: 14h</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Guided activities: 3h</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self study: 17h</td>
</tr>
</tbody>
</table>

### Description:
- Module 0: Course presentation
  - **Description:** Presentation of objectives, methodology and assessment of the course.

### Module 1: Introduction to Electronics
- **T1.** Introduction to electronic systems (2.5 h + 0 h)
- **T2.** Introduction to the design of electronic systems (1 h + 1.5 h)
- **T3.** Introduction to semiconductors (1 h + 0 h)

### Module 2: Basic devices and circuits
- **T4.** Introduction to the electronic devices and to the analysis of electronic circuits (2 h + 1.5 h)
- **T5.** Diodes (2.5 h + 0.5 h)
- **T6.** Field effect transistors (MOSFETs) (2.5 h + 0 h)
- **T7.** Bipolar junction transistors (BJTs) (2.5 h + 0 h)
- **T8.** Transistors (MOSFETs and BJTs) as amplifiers (1 h + 0.5 h)
- **T9.** Transistors (MOSFETs, BJTs and IGBTs) as switches (1 h + 0.5 h)
- **T10.** Other controlled switches: SCR and TRIAC (1 h + 0 h)
- **T11.** Photo-electronic devices (1.5 h + 0 h)
## Module 3: Analog systems (6.5 h + 1 h)

**Description:**
- T12. Introduction to analog systems (1 h + 0 h)
- T13. The ideal operational amplifier (0.5 h + 0 h)
- T14. Linear processing using operational amplifiers (1 h + 0 h)
- T15. Active filters (1.5 h + 0 h)
- T16. Non-linear processing using operational amplifiers (1.5 h + 0 h)
- T17. Other applications based on operational amplifiers (1 h + 1 h)

**Learning time:** 15h
- Practical classes: 6h 30m
- Guided activities: 1h
- Self study: 7h 30m

## Module 4: Digital systems (16.5 h + 3.5 h)

**Description:**
- T18. Introduction to digital systems (1 h + 0 h)
- T19. Binary coding systems (1.5 h + 1 h)
- T20. Boolean and switching algebras. Logic functions (2.5 h + 0.5 h)
- T21. Logic gates and digital technologies (1.5 h + 0.5 h)
- T22. Gate based implementation of logic functions (1.5 h + 0 h)
- T23. Natural binary arithmetic operators (0.5 h + 0.5 h)
- T24. Data paths (1 h + 0 h)
- T25. Read-only memories (ROM) (1 h + 0.5 h)
- T26. Introduction to sequential systems (0.5 h + 0 h)
- T27. Bistables (latches and flip-flops) and parallel registers (1 h + 0 h)
- T28. Canonical structure and graphic representation of synchronous automata (1 h + 0 h)
- T29. Counters and shift registers (1.5 h + 0 h)
- T30. Analysis and synthesis of synchronous automata using flip-flops (2 h + 0 h)
- T31. Random access memories (RAM) (0 h + 0.5 h)

**Learning time:** 40h
- Practical classes: 16h 30m
- Guided activities: 3h 30m
- Self study: 20h
### Module 5: Electronic instrumentation systems
**Learning time:** 13h
- Practical classes: 4h 30m
- Guided activities: 2h
- Self study: 6h 30m

**Description:**
- T32. Introduction to electronic instrumentation systems (0.5 h + 1 h)
- T33. The acquisition chain (2.5 h + 1 h)
- T34. The actuation chain (1.5 h + 0 h)

### Module 6: Power electronics systems
**Learning time:** 14h
- Practical classes: 5h 30m
- Guided activities: 1h 30m
- Self study: 7h

**Description:**
- T35. Introduction to power electronics systems (1 h + 0.5 h)
- T36. DC-DC direct converters (1 h + 0.5 h)
- T37. DC-AC direct converters (1 h + 0 h)
- T38. AC-DC direct converters (1 h + 0 h)
- T39. AC-AC direct converters (1 h + 0 h)
- T40. Application examples of power electronics (0.5 h + 0.5 h)

### Laboratory experiments
**Learning time:** 40h
- Laboratory classes: 10h
- Guided activities: 10h
- Self study: 20h

**Description:**
- Experiment 1: Introduction to the simulation of electronic systems (2 h + 0 h)
- Experiment 2: Simulation of circuits based on discrete devices (0 h + 2 h)
- Experiment 3: Experimentation of circuits based on discrete devices (2 h + 0 h)
- Experiment 4: Simulation of analog circuits and systems (0 h + 1.5 h)
- Experiment 5: Experimentation of analog circuits and systems (2 h + 0 h)
- Experiment 6: Simulation of digital circuits and systems (0 h + 3 h)
- Experiment 7: Experimentation of digital circuits and systems (2 h + 0 h)
- Experiment 8: Simulation of power electronics circuits and systems (0 h + 1.5 h)
- Experiment 9: Experimentation of power electronics circuits and systems (2 h + 0 h)
- Experiment 10: Simulation of electronic instrumentation systems (0 h + 2 h)
<table>
<thead>
<tr>
<th>Module 7: Digital systems for data processing (4.5 h + 1 h)</th>
<th>Learning time: 11h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 4h 30m</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 1h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h 30m</td>
</tr>
</tbody>
</table>

**Description:**
- T41. Digital data processing (1 h + 0 h)
- T42. Introduction to processors and computers (2 h + 0.5 h)
- T43. Information transmission and communication systems (1.5 h + 0.5 h)

<table>
<thead>
<tr>
<th>Course assessment (7.5 h + 0 h)</th>
<th>Learning time: 7h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 5h 30m</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>

**Description:**
- Three partial theory + problems exams.
- Two laboratory exams (simulation and experimentation).
- An extraordinary global theory + problems exam.
The theory part will be assessed through three individual exams: a first partial test at the middle of the course, a second partial test at a quarter to the end of the course, and a third partial test after finishing the course. The theory part will be globally re-assessed through an extraordinary unique exam, which will be held after the end of the ordinary exams period of the spring semester.

The laboratory part will be assessed through two individual exams at the end of the course, one focused in simulation and the other focused in assembly. The laboratory part will not be re-assessed after the end of the ordinary exams period of the spring semester. The last laboratory grades obtained in the semester or semesters allowing the re-assessment of the theory part will be used to calculate the grade appearing in the extraordinary academic record of students attending re-assessment.

The ordinary final course grade will be equal to the maximum of the following first to third possible final grades, rounded to the nearest tenth of a point, while the extraordinary final course grade will be equal to the following fourth possible final grade, rounded to the nearest tenth of a point:

\[
N_{\text{final1}} = 0.20 N_{\text{pp1}} + 0.26 N_{\text{pp2}} + 0.34 N_{\text{pp3}} + 0.10 N_{\text{labs}} + 0.10 N_{\text{labm}} \\
N_{\text{final2}} = \text{PE}[N_{\text{final1}} + 0.03 N_{\text{vpp}}] \times \text{MINIM}[1, \text{PE}[N_{\text{pp3}}/4]] \\
N_{\text{final3}} = \text{PE}[N_{\text{final1}} + 0.03 N_{\text{vpp}}] \times \text{MINIM}[1, \text{PE}[N_{\text{pp1}}/3], \text{PE}[N_{\text{pp2}}/3], \text{PE}[N_{\text{pp3}}/3]] \\
N_{\text{final4}} = 0.80 N_{\text{exr}} + 0.10 N_{\text{labs}} + 0.10 N_{\text{labm}}
\]

where:

- \(N_{\text{pp1}}\): Grade of first partial exam (test)
- \(N_{\text{pp2}}\): Grade of second partial exam (test)
- \(N_{\text{pp3}}\): Grade of third partial exam (test)
- \(N_{\text{labs}}\): Grade of laboratory simulation exam
- \(N_{\text{labm}}\): Grade of laboratory assembly exam
- \(\text{IP}[x]\): Integer part of "x" (truncation)
- \(N_{\text{vpp}}\): Number of experiment preparation visas
- \(N_{\text{exr}}\): Grade of extraordinary exam (test)

\(N_{\text{final1}}\), \(N_{\text{final2}}\), \(N_{\text{final3}}\), and \(N_{\text{final4}}\) represent the first, second, third, and fourth possible final grades, respectively.

The first possible final grade is the basic formula and considers a continuous assessment of the course. The second final grade provides a possible more generous rounding up for students with a third partial exam grade equal to or greater than 4. The third possible final grade provides a possible more generous rounding up for students with a grade equal to or greater than 3 in each of the three partial exams. The fourth possible final grade corresponds to the extraordinary assessment of the course.

"Not presented" will appear only in the academic record of students which have not attended any of the above-mentioned exams. The final course grade for those students that have attended at least one exam, but not all exams, will be calculated considering as zeroes the grades of the unattended exams. No grades will be kept on record for future semesters. No exams can be validated from the academic record of previous semesters.
Regulations for carrying out activities

The first partial exam of the theory part will last one hour and fifteen minutes and will consist of a series of multiple choice questions related to chapters T1 to T9 of the contents. It will be held on the date and time set by Studies Planning for the partial exam of the course.

The second partial exam of the theory part will last for one hour and forty-five minutes and will consist of a series of multiple choice questions related to chapters T10 to T25 of the contents. It will be held on Thursday of the 11th week of the semester (May 12th), from 7:15 to 9:00 PM.

The third partial exam of the theory part will last two hours and thirty minutes and will consist of a series of multiple choice questions related to chapters T26 to T43 of the contents. It will be held on the date and time set by Studies Planning for the final exam of the course.

The laboratory assembly exam will take place during the 12th and 13th weeks of the semester and its duration will be one hour. It will mainly consist in carrying out one or some of the assemblies of experiments 3, 5, 7 or 9 and some questions about their preparation. It will take place at the Laboratory of Electronics I.

The laboratory simulation exam will take place during the 13th and 14th weeks of the semester and its duration will be of one hour. It will mainly consist in simulating one or some of the circuits in experiments 1, 2, 4, 6, 8 or 10 and some questions about their preparation. It will take place at the Laboratory of Electronics III.

The announcement of the two laboratory exams will be published with sufficient advance, specifying the date and time of the exam for each student. The schedule for the exams will be the usual laboratory schedule of each laboratory group, but half of the group will be convened to the first hour of the session and the other half to the second hour of the session.

The extraordinary exam of the theory part will last three hours and will consist of a series of multiple choice questions related to chapters T1 to T44 of the contents. It will be held on the date and time set by Studies Planning for the extraordinary exam of the course.

The partial exams of the theory part, of multiple choice questions, shall be composed of two subtests with weights P1 and P2, which will be indicated in the exam instructions. The first subtest will consist of a series of N1 true or false statements. This subtest will add one point for each correct answer and one point will be deducted for each wrong answer, resulting in a score Q1 comprised between ?N1 and N1. The other subtest will consist of a series of N2 questions with five alternative answers. This subtest will add one point for each correct answer and a quarter point will be deducted for each wrong answer, resulting in a score Q2 comprised between -N2 / 4 and N2. The exam grade will be given by the formula P1 Q1 + P2 Q2. The values of P1, P2, N1 and N2 may be different from one test to another, but must always verify the equality P1 N1 + P2 N2 = 10. The exam grade will be considered to be 0 if negative.

Students may not bring any documentation, calculator, mass storage device information (floppy, CD, DVD, memory stick, etc.), nor communication device (cell phone, etc.) in any of the exams. Students must bring their identity card, passport or other official identification. Students violating these rules will be forced to leave the exam.

The grades of the exams will be published in the Digital Campus indicating the associated claim period. The claim period of the laboratory exams grades will end the day before the third partial exam of the theory part. No further claims on such grades will be accepted after this period.
Bibliography

Basic:


Complementary:


Others resources:

Computer material

OrCAD 16.2 o posterior

Demonstration version of the OrCAD 16.2 or later electronic CAD package (the last version, available at the OrCAD web, is 16.6).