240072 - Electronics

**Coordinating unit:** 240 - ETSEIB - Barcelona School of Industrial Engineering  
**Teaching unit:** 710 - EEL - Department of Electronic Engineering  
**Academic year:** 2019  
**Degree:** BACHELOR’S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)  
**ECTS credits:** 7.5  
**Teaching languages:** Catalan, Spanish

### Teaching staff

**Coordinator:** Busquets Monge, Sergio  
**Others:**  
Busquets Monge, Sergio  
Carrasco Lopez, Juan Antonio  
Gómez Pau, Álvaro  
Moreno Equilaz, Juan Manuel  
Santos Miranda, Jose Antonio

### Degree competences to which the subject contributes

**Specific:**  
1. Knowledge of electronics fundamentals.
Teaching methodology

The course is structured in two parts: a theory part (39 chapters with theory and exercises) and a laboratory part (10 sessions dealing with circuits that must be simulated or assembled and experimentally tested). Each of these parts involves in-class activities, out-of-class activities, and assessment activities. The in-class activities of the theory part will consist in theory and exercise lectures. However, some topics will not be explained in class. The students will have to study them on their own with the aid of the provided documents. The in-class activities of the laboratory part will consist of 5 laboratory sessions (odd sessions) to be performed by two-student teams. Session 1 (simulation) will take place in the Electronics Laboratory III, located on the 9th floor, door 45. The other in-class sessions will take place in the Electronics Laboratory I, located on the 9th floor, door 35. The remaining sessions (even sessions) will be guided out-of-class simulations. Each session, whether in-class or out-of-class, has a set of tasks to be performed as a preliminary preparation for the session. It is important to carefully do these tasks, as they facilitate the understanding of the tasks to be performed during the session and will help speed up the laboratory work. In order to perform and verify the preparation of the sessions, a booklet will be published where the student should reflect the development of these preparation tasks. This booklet must be handed to the professor at the beginning of each in-class laboratory session and the professor will return it to the student with the visas corresponding to the current session and the immediately previous out-of-class session, in case these preparation tasks have been performed. This booklet must also be shown to the professor during the laboratory assessment exams, so that the professor can check the number of visas obtained. This number will be considered in the course grading.

In order to facilitate the study of the course contents, all kinds of useful material, such as textbooks, collections of exercises, collections of exam questions, material used in class, etc., will be provided to the students. Part of this material will be available in Atenea. The course has an assigned load of 7.5 ECTS credits, which is equivalent to 187.5 student's working hours. 74 of these hours correspond to in-class activities (57 of theory and exercise lectures, 10 of laboratory sessions, and 7 of assessments). The remaining 113.5 hours correspond to out-of-class activities (13.5 for reading certain documents, 10 for simulations, and 90 of general study, including solving exercises and preparing laboratory sessions).

Learning objectives of the subject

General objective:
Know the different types of electronic systems, their functionality, their components, and their applicability in the industry.

Specific objectives:
Know the essence of electronic systems and the different types of electronic systems: analog systems, digital systems, power electronics systems, and electronic instrumentation systems.
Know the main components used in electronic systems.
Know the behavior models of the main electronic components.
Know some analysis and synthesis techniques of electronic circuits.
Know the main analog systems and their most significant applications.
Know the main digital systems and their most significant applications.
Know the main power electronics systems and their most significant applications.
Know the electronic instrumentation systems and their most significant applications.
Become familiar with the use of electronic CAD tools.
Become familiar with the use of common instruments found in an electronics laboratory.
Know how to interpret the information from electronic component datasheets.
Know the basic vocabulary to communicate with electronic engineers.
Know how to set the specifications of electronic systems.
Know how to analyze and design simple electronic systems.
## Study Load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group:</th>
<th>65h</th>
<th>34.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>10h</td>
<td>5.33%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>112h 30m</td>
<td>60.00%</td>
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</table>
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## Content

<table>
<thead>
<tr>
<th>Module 0: Course presentation (0.5 h + 0 h)</th>
<th>Learning time: 0h 30m</th>
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<tbody>
<tr>
<td></td>
<td>Practical classes: 0h 30m</td>
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<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>Presentation of objectives, methodology and assessment of the course.</td>
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</table>

<table>
<thead>
<tr>
<th>Module 1: Introduction to electronics (5.5 h + 1.5 h)</th>
<th>Learning time: 14h</th>
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<tbody>
<tr>
<td></td>
<td>Practical classes: 5h 30m</td>
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<tr>
<td></td>
<td>Guided activities: 1h 30m</td>
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<tr>
<td></td>
<td>Self study : 7h</td>
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<tr>
<td><strong>Description:</strong></td>
<td></td>
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<tr>
<td>T1. Definition, classification, and characteristics of electronic systems (2.5 h + 0 h)</td>
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<tr>
<td>T2. Design of electronic systems (1.5 h + 1.5 h)</td>
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<tr>
<td>T3. Semiconductors (1.5 h + 0 h)</td>
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<thead>
<tr>
<th>Module 2: Devices and basic circuits (15 h + 3.5 h)</th>
<th>Learning time: 37h</th>
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<tbody>
<tr>
<td></td>
<td>Practical classes: 15h</td>
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<tr>
<td></td>
<td>Guided activities: 3h 30m</td>
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<tr>
<td></td>
<td>Self study : 18h 30m</td>
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<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>T4. Introduction to electronic devices and to the analysis of electronic circuits (2.5 h + 1.5 h)</td>
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<tr>
<td>T5. Diodes (3 h + 0.5 h)</td>
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<tr>
<td>T6. Field effect transistors (2.5 h + 0 h)</td>
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<tr>
<td>T7. Bipolar junction transistors (2.5 h + 0 h)</td>
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<tr>
<td>T8. Amplifiers with transistors (1 h + 1 h)</td>
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<tr>
<td>T9. Switches with diodes and transistors (1.5 h + 0 h)</td>
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<tr>
<td>T10. Thyristors (1 h + 0 h)</td>
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<tr>
<td>T11. Photoelectronic devices (1 h + 0.5 h)</td>
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<tr>
<td>Module 3: Analog systems (7 h + 1 h)</td>
<td>Learning time: 16h</td>
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<tr>
<td><strong>Description:</strong></td>
<td>Practical classes: 7h</td>
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<tr>
<td>T12. Introduction to analog systems (0.5 h + 0 h)</td>
<td>Guided activities: 1h</td>
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<tr>
<td>T13. Operational amplifier (1 h + 0 h)</td>
<td>Self study: 8h</td>
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<tr>
<td>T14. Basic linear processing (1.5 h + 1 h)</td>
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<td>T15. Advanced linear processing (1.5 h + 0 h)</td>
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<tr>
<td>T16. Nonlinear processing (1.5 h + 0 h)</td>
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<td>T17. Signal generation (1 h + 0 h)</td>
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<tr>
<th>Module 4: Digital systems (19.5 h + 3.5 h)</th>
<th>Learning time: 46h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Practical classes: 19h 30m</td>
</tr>
<tr>
<td>T18. Introduction to digital systems (1 h + 0 h)</td>
<td>Guided activities: 3h 30m</td>
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<tr>
<td>T19. Codes (1.5 h + 1 h)</td>
<td>Self study: 23h</td>
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<tr>
<td>T20. Logic functions (2 h + 1 h)</td>
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<tr>
<td>T21. Implementation of basic logic functions: logic gates (1.5 h + 0 h)</td>
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<tr>
<td>T22. Implementation of logic functions with logic gates (2.5 h + 0 h)</td>
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<tr>
<td>T23. Arithmetic operators (1 h + 0.5 h)</td>
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<tr>
<td>T24. Data paths (1 h + 0 h)</td>
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<tr>
<td>T25. ROM memories (1.5 h + 0.5 h)</td>
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<tr>
<td>T26. Structure, classification, and representation of sequential systems (1.5 h + 0 h)</td>
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<tr>
<td>T27. Bistables (1.5 h + 0 h)</td>
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<tr>
<td>T28. Analysis and synthesis of synchronous automata (3 h + 0 h)</td>
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<tr>
<td>T29. Counters and shift registers (1.5 h + 0 h)</td>
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<tr>
<td>T30. RAM memories (0 h + 0.5 h)</td>
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</tbody>
</table>
### Module 5: Power electronics systems (5 h + 2 h)

**Description:**
- T31. Introduction to power electronics systems (1 h + 0.5 h)
- T32. Dc-dc conversion (1 h + 0.5 h)
- T33. Dc-ac conversion (1 h + 0 h)
- T34. Ac-dc conversion (1 h + 0 h)
- T35. Ac-ac conversion (1 h + 0 h)
- T36. Application examples of power electronics (0 h + 1 h)

**Learning time:** 14h
- Practical classes: 5h
- Guided activities: 2h
- Self study: 7h

### Module 6: Electronic instrumentation systems (4.5 h + 2 h)

**Description:**
- T37. Introduction to electronic instrumentation systems (0.5 h + 1 h)
- T38. Acquisition chain (2.5 h + 1 h)
- T39. Actuation chain (1.5 h + 0 h)

**Learning time:** 13h
- Practical classes: 4h 30m
- Guided activities: 2h
- Self study: 6h 30m

### Laboratory sessions (10 h + 10 h)

**Description:**
- Session 1: Introduction to the simulation of electronic systems (2 h + 0 h)
- Session 2: Simulation of circuits based on discrete devices (0 h + 2 h)
- Session 3: Experimentation of circuits based on discrete devices (2 h + 0 h)
- Session 4: Simulation of analog systems (0 h + 1.5 h)
- Session 5: Experimentation of analog systems (2 h + 0 h)
- Session 6: Simulation of digital systems (0 h + 3 h)
- Session 7: Experimentation of digital systems (2 h + 0 h)
- Session 8: Simulation of power electronics systems (0 h + 2 h)
- Session 9: Experimentation of power electronics systems and electronic instrumentation systems (2 h + 0 h)
- Session 10: Simulation of electronic instrumentation systems (0 h + 1.5 h)

**Learning time:** 40h
- Laboratory classes: 10h
- Guided activities: 10h
- Self study: 20h
The theory part will be ordinarily 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 exam period of the spring semester.

The laboratory part will be assessed through two individual exams at the end of the course, one focused on simulation and the other focused on assembly and experimental testing. The laboratory part will not be re-assessed after the end of the ordinary exam period of the spring semester. The last laboratory grades from 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 final course grade will be equal to the maximum of the following four grades:

\[
\begin{align*}
N_{\text{final}1} &= \text{R1d}[0,20 \cdot N_{\text{pp}1} + 0,25 \cdot N_{\text{pp}2} + 0,35 \cdot N_{\text{pp}3} + 0,10 \cdot N_{\text{labs}} + 0,10 \cdot N_{\text{lab}m}] \\
N_{\text{final}2} &= \text{IP}[\text{R1d}[N_{\text{final}1} + 0,03 \cdot N_{\text{vpp}}] ] \\
N_{\text{final}3} &= \text{R1d}[0,80 \cdot N_{\text{rev}} + 0,10 \cdot N_{\text{labs}} + 0,10 \cdot N_{\text{lab}m}] \\
N_{\text{final}4} &= \text{IP}[\text{R1d}[N_{\text{final}3} + 0,03 \cdot N_{\text{vpp}}] ]
\end{align*}
\]

where:

- \(N_{\text{pp}1}\): Grade of partial exam 1 (test)
- \(N_{\text{pp}2}\): Grade of partial exam 2 (test)
- \(N_{\text{pp}3}\): Grade of partial exam 3 (test)
- \(N_{\text{rev}}\): Grade of reevaluation exam (test)
- \(N_{\text{labs}}\): Grade of laboratory simulation exam
- \(N_{\text{lab}m}\): Grade of laboratory assembly exam
- \(N_{\text{vpp}}\): Number of laboratory session preparation visas
- \(\text{R1d}[x]\): Rounding of \(x\) to the nearest tenth of a point
- \(\text{IP}[x]\): Integer part of \(x\) (truncation)

“Not presented” will only be assigned to the academic record of students who 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 the grades of the unattended exams equal to zero. No grades from the theory part can be kept for future semesters. At the student request through an e-mail sent to the coordinator before the beginning of the laboratory exams, the grade of the laboratory exams and the number of laboratory preparation visas can be kept, provided they were obtained during academic year 2018-19 or later. In case the student repeats the laboratory exams, the preparation visas from previous semesters will be valid.

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**Course assessment (7 h + 0 h)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time: 7h</th>
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<tbody>
<tr>
<td>Three partial theory + exercises exams.</td>
<td>Practical classes: 5h</td>
</tr>
<tr>
<td>Two laboratory exams (simulation and experiments).</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>An extraordinary global theory + exercises exam.</td>
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</tbody>
</table>

**Qualification system**

The theory part will be ordinarily 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 exam period of the spring semester.

The laboratory part will be assessed through two individual exams at the end of the course, one focused on simulation and the other focused on assembly and experimental testing. The laboratory part will not be re-assessed after the end of the ordinary exam period of the spring semester. The last laboratory grades from 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 final course grade will be equal to the maximum of the following four grades:

\[
\begin{align*}
N_{\text{final}1} &= \text{R1d}[0,20 \cdot N_{\text{pp}1} + 0,25 \cdot N_{\text{pp}2} + 0,35 \cdot N_{\text{pp}3} + 0,10 \cdot N_{\text{labs}} + 0,10 \cdot N_{\text{lab}m}] \\
N_{\text{final}2} &= \text{IP}[\text{R1d}[N_{\text{final}1} + 0,03 \cdot N_{\text{vpp}}] ] \\
N_{\text{final}3} &= \text{R1d}[0,80 \cdot N_{\text{rev}} + 0,10 \cdot N_{\text{labs}} + 0,10 \cdot N_{\text{lab}m}] \\
N_{\text{final}4} &= \text{IP}[\text{R1d}[N_{\text{final}3} + 0,03 \cdot N_{\text{vpp}}] ]
\end{align*}
\]

where:

- \(N_{\text{pp}1}\): Grade of partial exam 1 (test)
- \(N_{\text{pp}2}\): Grade of partial exam 2 (test)
- \(N_{\text{pp}3}\): Grade of partial exam 3 (test)
- \(N_{\text{rev}}\): Grade of reevaluation exam (test)
- \(N_{\text{labs}}\): Grade of laboratory simulation exam
- \(N_{\text{lab}m}\): Grade of laboratory assembly exam
- \(N_{\text{vpp}}\): Number of laboratory session preparation visas
- \(\text{R1d}[x]\): Rounding of \(x\) to the nearest tenth of a point
- \(\text{IP}[x]\): Integer part of \(x\) (truncation)

“Not presented” will only be assigned to the academic record of students who 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 the grades of the unattended exams equal to zero. No grades from the theory part can be kept for future semesters. At the student request through an e-mail sent to the coordinator before the beginning of the laboratory exams, the grade of the laboratory exams and the number of laboratory preparation visas can be kept, provided they were obtained during academic year 2018-19 or later. In case the student repeats the laboratory exams, the preparation visas from previous semesters will be valid.
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 set of multiple choice questions about a first part of the contents. It will be held on the date and time set by the Studies Planning Office for the course partial exam.

The second partial exam of the theory part will last for one hour and forty-five minutes and will consist of a set of multiple choice questions about a second part of the contents. It will be held on Thursday of the 11th week of the semester, from 7:15 PM to 9:00 PM.

The third partial exam of the theory part will last two hours and fifteen minutes and will consist of a set of multiple choice questions about a third and last part of the contents. It will be held on the date and time set by the Studies Planning Office for the final exam of the course.

The laboratory assembly exam will take place during the 13th week of the semester and it will last one hour. It will mainly consist in carrying out one of the assemblies of sessions 3, 5, 7, or 9 and some questions about it. It will take place in the Electronics Laboratory I.

The laboratory simulation exam will take place during the 14th week of the semester and it will last one hour. It will mainly consist in simulating one or some of the circuits on sessions 1, 2, 4, 6, 8, or 10 and some questions about them. It will take place in the Electronics Laboratory III.

The announcement of the two laboratory exams will be published in 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 asked to attend the first hour of the session and the other half will be asked to attend the second hour of the session.

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

The partial exams and the extraordinary exam of the theory part, will be divided into two subtests with weights $P_1$ and $P_2$, whose value will be indicated in the exam instructions. The first subtest will consist of a set of $N_1$ true or false statements. In this subtest, one point will be added for each correct answer and one point will be subtracted for each wrong answer, resulting in a score $Q_1$ comprised between $-N_1$ and $N_1$. The other subtest will consist of a set of $N_2$ questions with five alternative answers. In this subtest one point will be added for each correct answer and a quarter point will be subtracted for each wrong answer, resulting in a score $Q_2$ comprised between $-N_2/4$ and $N_2$. The exam grade will be given by the formula $P_1 Q_1 + P_2 Q_2$. The values of $P_1$, $P_2$, $N_1$ and $N_2$ may be different from one test to another, but they will always verify that $P_1 N_1 + P_2 N_2 = 10$. The exam grade will be replaced by 0 if it is negative.

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

The grades of the exams will be published in Atenea indicating the corresponding revision period. The revision period of the laboratory exam grades will end the day before the day of the third partial exam of the theory part. No grade revision applications will be attended after the indicated revision periods.
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Bibliography

Basic:


Complementary:


Others resources:

Computer material

OrCAD 17.2

Evaluation version of the electronic CAD package OrCAD 17.2.