270003 - F - Physics

Coordinating unit: 270 - FIB - Barcelona School of Informatics  
Teaching unit: 748 - FIS - Department of Physics  
Academic year: 2018  
Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)  
ECTS credits: 7,5  
Teaching languages: Catalan

Teaching staff

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- Raul Bombín Escudero (raul.bombin@upc.edu)  
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- Rosendo Rey Oriol (rosendo.rey@upc.edu)

Prior skills

Students are expected to have taken physics at upper secondary level and have basic notions of mathematical analysis. As far as skills are concerned, they should know how to learn, solve problems, search for information, make abstractions and use mathematical language.

Degree competences to which the subject contributes

Specific:
CT1.2B. To interpret, select and value concepts, theories, uses and technological developments related to computer science and its application derived from the needed fundamentals of mathematics, statistics and physics. Capacity to understand and dominate the physical and technological fundamentals of computer science: electromagnetism, waves, circuit theory, electronics and photonics and its application to solve engineering problems.
CT8.4. To elaborate the list of technical conditions for a computers installation fulfilling all the current standards and normative.

Generical:
G4. EFFECTIVE ORAL AND WRITTEN communication: To communicate with other people knowledge, procedures, results and ideas orally and in a written way. To participate in discussions about topics related to the activity of a technical informatics engineer.
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Teaching methodology

Theoretical concepts will be covered in either theory classes followed up with problem-solving sessions or theory/problem-solving classes (at the lecturer’s discretion).
Practical exercises will be completed in the laboratory sessions, preferably in pairs.

Learning objectives of the subject

1. Students should be able to apply Kirchhoff’s laws to the calculation of intensity and voltage in a direct current circuit in one or more grids.
2. Students should be able to calculate the Thévenin-equivalent voltage between two points in a given direct current circuit.
3. Students should be able to calculate the power in any component in a direct current circuit.
4. Students should be able to identify the amplitude, frequency, phase and effective value of a sine wave.
5. Students should be able to determine the response of the different passive elements affected by the action of periodic signals.
6. Students should be able to apply the phasor concept and determine the steady state response of an alternating current circuit.
7. Students should be able to calculate the power of different elements in an alternating current circuit and to correct the power factor for a given circuit.
8. Students should be able to calculate the effect of different types of filters on signals composed of superimposed frequencies.
9. Students should be able to define waves and classify them according to different criteria.
10. Students should be able to determine the function of a one-dimensional harmonic wave and a harmonic electromagnetic plane wave.
11. Students should be able to describe the basic characteristics of the electromagnetic spectrum.
12. Students should be able to calculate the intensity of the energy carried by a beam of light and the energy of its photons.
13. Students should be able to determine the interference patterns for two coherent waves.
14. Students should be able to determine the directions of light beams reflected and refracted in a changing environment.
15. Students should be able to describe the fundamentals of conduction theory, particularly for semiconductors.
16. Students should be able to determine the intensities and voltages of simple circuits containing diodes.
17. Students should be able to describe basic current rectifiers.
18. Students should be able to determine the intensities and voltages of simple circuits containing transistors.
19. Students should be able to describe how digital information is represented and manipulated in electronic circuits.
20. Students should be able to determine the logic gates that implement given basic circuits.
21. Students should be able to properly and safely use the laboratory’s electrical equipment.
22. Students should be able to properly and safely use the laboratory’s basic electronic equipment: multimeter, oscilloscope, voltage sources, function generators.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Theory classes: 30h</th>
<th>16.00%</th>
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</thead>
<tbody>
<tr>
<td>Practical classes: 30h</td>
<td></td>
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<tr>
<td>Laboratory classes: 15h</td>
<td></td>
<td></td>
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<tr>
<td>Guided activities: 7h 30m</td>
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<tr>
<td>Self study: 105h</td>
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Content

Direct Current

Degree competences to which the content contributes:

Description:
1.1 Electrical load. 1.2 Electrical current. 1.3 Voltage. 1.4 Power. 1.5 Resistance. Ohm's law. Joule effect. 1.6 Voltage sources. 1.7 Kirchhoff's laws. 1.8 Series and parallel resistors. 1.9 Measurement devices. 1.10 Thévenin's theorem. 1.11 Capacitors.

Alternating Current (AC)

Degree competences to which the content contributes:

Description:
2.1 Transients: RC and RL circuits. 2.2 RLC circuits: steady state response. 2.3 Complex numbers. 2.4 Impedance. Ohm's law. 2.5 Alternating current circuits. 2.6 Power. 2.7 Signal superposition. Bandwidth. 2.8 Resonance. 2.9 Filters.

Electronics and logic gates

Degree competences to which the content contributes:

Description:
3.1 Electronic structure of atoms. 3.2 Conduction theory: metals, insulators, semiconductors. 3.3 The p-n junction diode: current rectifier and logic gates. 3.4 Light-emitting diodes (LED). 3.5 Zener diode: voltage regulators. 3.6 Enhancement MOSFET. Logic gates. 3.7 CMOS inversor. 3.8 Power and delay in digital circuits. 3.9 CMOS logic.

Waves

Degree competences to which the content contributes:

Description:
4.1 Wave types. Wave functions. 4.2 Harmonic waves. 4.3 Electromagnetic waves Energy density. Intensity. 4.4 Electromagnetic spectrum. 4.5 Polarisation. Liquid crystal displays. 4.6 Reflection and refraction. Optical fibres. 4.7 Interference. 4.8 Lasers.
## Planning of activities

| SUBJECT 1 | **Hours:** 44h 30m  
Theory classes: 7h  
Practical classes: 7h  
Laboratory classes: 4h  
Guided activities: 2h  
Self study: 24h 30m |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Topic 1 development</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3</td>
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</tbody>
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| P1 | **Hours:** 1h 12m  
Guided activities: 1h 12m  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory/problem-solving test to assess topic 1 (Direct Current)</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3</td>
</tr>
</tbody>
</table>

| SUBJECT 2 | **Hours:** 44h 30m  
Theory classes: 7h  
Practical classes: 7h  
Laboratory classes: 4h  
Guided activities: 2h  
Self study: 24h 30m |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Topic 2 development</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>15, 16, 17, 18, 19, 20</td>
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</table>

| P2 | **Hours:** 1h 12m  
Guided activities: 1h 12m  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory/problem-solving test to assess topic 2 (Electronics and Logic Gates)</td>
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<td><strong>Specific objectives:</strong></td>
<td>15, 16, 17, 18, 19, 20</td>
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### SUBJECT 3

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<th><strong>Description:</strong></th>
<th>Topic 3 development</th>
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</thead>
<tbody>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>4, 5, 6, 7, 8</td>
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<table>
<thead>
<tr>
<th><strong>Hours:</strong></th>
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<tbody>
<tr>
<td>Theory classes:</td>
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<tr>
<td>Practical classes:</td>
<td>7h</td>
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<tr>
<td>Laboratory classes:</td>
<td>3h</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
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### P3

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<tr>
<th><strong>Description:</strong></th>
<th>Theory/problem-solving test to assess topic 3 (Alternating Current)</th>
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<tbody>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>4, 5, 6, 7, 8</td>
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</tbody>
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<table>
<thead>
<tr>
<th><strong>Hours:</strong></th>
<th>1h 12m</th>
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</thead>
<tbody>
<tr>
<td>Guided activities:</td>
<td>1h 12m</td>
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<tr>
<td>Self study:</td>
<td>0h</td>
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### SUBJECT 4

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<th><strong>Description:</strong></th>
<th>Topic 4 development</th>
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</thead>
<tbody>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>9, 10, 11, 12, 13, 14</td>
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<table>
<thead>
<tr>
<th><strong>Hours:</strong></th>
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<tbody>
<tr>
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<td>3h</td>
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<tr>
<td>Guided activities:</td>
<td>2h</td>
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<tr>
<td>Self study:</td>
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### P4

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<tr>
<th><strong>Description:</strong></th>
<th>Theory/problem-solving test to assess topic 4 (Waves)</th>
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<tbody>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>9, 10, 11, 12, 13, 14</td>
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<table>
<thead>
<tr>
<th><strong>Hours:</strong></th>
<th>1h 12m</th>
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<tbody>
<tr>
<td>Guided activities:</td>
<td>1h 12m</td>
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<tr>
<td>Self study:</td>
<td>0h</td>
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</table>
| **F** | **Hours:** 2h 30m  
Guided activities: 2h 30m  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Final theory/problem-solving test for students who failed continuous assessment or who wish to improve their mark (students should apply to sit the test 10 days previously). All four topics and their associated content will be assessed.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20</td>
</tr>
</tbody>
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| **L1** | **Hours:** 0h  
Guided activities: 0h  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Laboratory session 1 will provide a basic grounding in handling experimental data. Assessment will be in the form of practical exercises to be completed by the end of the session. The learning objectives for the laboratory sessions will be assessed along with the written part of the transferable competency in effective verbal and written communication.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>21, 22</td>
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</tbody>
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| **L2** | **Hours:** 0h  
Guided activities: 0h  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Practical 1 will be assessed by means of a final report and an exercise to be handed in at the start of laboratory session 2. The learning objectives for topic 1 and the laboratory sessions will be assessed along with the written part of the effective verbal and written communication transferable competency.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3, 21, 22</td>
</tr>
</tbody>
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| **L3** | **Hours:** 0h  
Guided activities: 0h  
Self study: 0h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Practical 2 will be assessed by means of a final report and an exercise to be handed in at the start of laboratory session 3. The learning objectives for topic 2 and the laboratory sessions will be assessed along with the written part of the effective verbal and written communication transferable competency.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>16, 17, 18, 19, 21, 22</td>
</tr>
</tbody>
</table>
Practical 3 will be assessed by means of a final report and an exercise to be handed in at the start of laboratory session 4. The learning objectives for topic 3 and the laboratory sessions will be assessed along with the written part of the effective verbal and written communication transferable competency.

**Specific objectives:**
4, 5, 6, 7, 8, 21, 22

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Practical 4 will be assessed by means of an exercise and a final report to be handed in at the start of laboratory session 5. The learning objectives for topic 4 and the laboratory sessions will be assessed along with the written part of the effective verbal and written communication transferable competency.

**Specific objectives:**
9, 10, 11, 12, 13, 14, 21, 22

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In laboratory session 6, students will make individual oral presentations (maximum 8 minutes) describing the objectives and results of a practical exercise performed in a previous session (assigned beforehand). These presentations will be followed up by questions. The learning objectives for the topic to which the exercise refers will be assessed along with the written part of the effective verbal and written communication transferable competency.

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
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Qualification system

The technical competency mark will be based on two marks:
- a theory mark (90%).
- a laboratory or practical mark (10%).

During the course four tests (each with the same weight) will be issued, corresponding to the four topics. The average of the four tests yields the continuous assessment (AC) mark for the theory part of the course.
Students who wish to improve their mark can sit a final exam (EF).
The final mark for the course is calculated as:
Final mark = 0.1*Lab + 0.9*max(AC,EF).

The laboratory (Lab) mark is calculated as:
(1) the average of five practical session marks (75% of the laboratory mark).
(2) an individual test taken after the fifth practical (25% of the laboratory mark), consisting of an oral presentation on a previous practical (maximum 8 minutes) followed by questions.

The oral and written expression mark is graded as A (excellent), B (good), C (satisfactory) or D (fail). The written part will be assessed on the basis of the average of the marks obtained for the summary reports provided at the end of each practical. The oral part will be assessed during the 8-minute individual presentation. The oral and written parts have equal weighting in the final competency mark.
Students will have guidelines specifying the aspects to be assessed in the oral and written parts.

Bibliography

Basic:

Complementary: