820017 - STI - Electronic Systems

Coordinating unit: 820 - EUETIB - Barcelona College of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2015
Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: EDUARD BALLESTER PORTILLO
Others: ROBERT CALATAYUD CAMPS - ALFONSO CONESA ROCA - SPARTACUS GOMARIZ CASTRO - FÉLIX GUTIÉRREZ ESCRIVÁ - MANUEL MANZANARES BROTONS - ROBERT PIQUÉ LÓPEZ - GUILLERMO VELASCO QUESADA - EDUARD BALLESTER PORTILLO

Prior skills
Those of the obligatory subjects of preceding levels (semesters).

Degree competences to which the subject contributes

Specific:
1. Understand the fundamentals of electronics.

Transversal:
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.
The main objective of the course is to introduce students to basic concepts of electronic systems and their basic functions and enable them, if necessary, for subsequent years of Electronic Engineering.

The Electronic Systems course has specific objectives of the overall course, the following:

1. - Describe the essential contents of the syllabus for the course and its justification (Knowledge)
2. - Differentiate the electronic signal processing and the electronics for power conversion. (Comprehension)
3. - Describe the general constitution of an electronic system and distinguish between the basic functions in them. (Knowledge/Understanding)
4. - Describe the basic electronic components. (Knowledge/Understanding)
5. - Solve simple circuits. (Application)
6. - Define the basic elements of digital electronics. (Knowledge)
7. - Distinguish between a combinational and sequential systems. (Knowledge/Understanding)
8. - Describe different combinational blocks. (Understanding/Application)
9. - Describe different sequential blocks. (Understanding/Application)
10. - Define the operational amplifier. (Knowledge)
11. - Define the positive and negative feedback amplifier. (Knowledge)
12. - Describe linear and nonlinear operators. (Understanding/Application)
13. - Describe the main structures of DC-DC conversion and their functional principle. (Knowledge/Understanding)
14. - Describe the main structures of DC-AC conversion and their functional principle. (Knowledge/Understanding)
15. - Describe the main structures of AC-DC conversion and their functional principle. (Knowledge/Understanding)
16. - Describe the main structures of AC-AC conversion and their functional principle. (Knowledge/Understanding)
17. - Describe the scope of the Signal Electronics (digital and analog) and Power Electronics. (Knowledge/Understanding)
### Study load

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<td><strong>Total learning time:</strong></td>
<td>150h</td>
<td>Hours large group:</td>
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1. Introduction to electronic systems.

<table>
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<tr>
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<th>Learning time: 30h</th>
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<tr>
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<td>Theory classes: 9h</td>
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<td>Laboratory classes: 2h</td>
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<td>Self study: 19h</td>
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### Description:

1. Signals and systems.
   1.1.2. Definition of system. Characterization of a system. Analysis and synthesis. Properties of systems. Types of systems according to the signals.
   1.2. Industrial systems.
   1.2.1. Open loop and closed loop systems. General scheme of an industrial system.
   1.2.2. Sensors. Actuators. Processors (information and energy).
   1.2.3. Communications under a CIM perspective.
   1.3. Electronic Systems.
   1.3.1. Definition of Engineering. Definition of Electronics. Timeline of key milestones for the electronics.
   1.3.2. The first electronic system: identification of features, blocks, and signal components and its physical implementation in printed board.
   1.3.3. Layers and subsystems of a complex electronic system.
   1.3.4. Other electronic systems. Identifying blocks and basic functions in the electronic systems.
   1.4. Electronic Instrumentation.
   1.4.3. Equipment under test-instrument interaction. Measurement errors. Representation of measured values. Grounding. Protection instruments and/or its users.

### Related activities:

Practice 1: Instrumentation.
1.1. Description of laboratory equipment.
1.2. Exercises.

### Specific objectives:
Give the student a horizontal view of Electronics, Electronic Systems, Electronic Functions, and some of its components, although defining the feedback systems, and emphasizing the types of typical signals into electronic systems.

At the end of this unit, the student must have achieved the following objectives:

Objective 1: Define a signal. Types of signals. (Knowledge)
Objective 2: Define a system. Types of systems. (Knowledge)
Objective 3: Differentiated the analysis and the synthesis of a system. (Knowledge)
Objective 4: Describe an industrial system in open loop and closed loop. (Knowledge)
Objective 5: Defining the sensors and actuators. (Knowledge)
Objective 6: Differentiate in an industrial system, the electronic signal processing and the electronics conversion energy. (Knowledge)
Objective 7: Identify, in a system, functions, blocks, signals and components. (Knowledge)
Objective 8: Describe the main instruments in an electronics laboratory. (Knowledge)
Objective 9: Describe the interaction between a measuring instrument and equipment under test. (Knowledge)
Objective 10: Describe the measurement errors. (Knowledge)
2. Discreets components.

**Learning time:** 30h
- Theory classes: 9h
- Laboratory classes: 4h
- Self study: 17h

**Description:**
2.1. Circuit elements.
2.2. The semiconductor diode.
2.2.3. Other types of diodes (Zener, Shottky, LED, etc.). Monolithic voltage regulators. Diagram of a linear power supply.
2.3. The transistor.
2.3.1. Brief history of the transistor. Voltage-current characteristic of the bipolar junction transistor. operation modes. Transistor effect.
2.3.3. Other types of transistors: JFET and MOSFET.

**Related activities:**
- Practice 2: Components: Circuits with diodes.
  2.1. Rectifier diode in DC. Static characteristic.
  2.2. Rectifier diode in AC.
  2.3. Zener diode in DC. Static characteristic.
- Practice 3: Components II: circuits with transistors.
  3.1. Bipolar junction transistor in active mode.
  3.2. Bipolar junction transistor in switching mode.

**Specific objectives:**
Give students an overview of detail about the main components of electronic circuits and discrete analysis of the fundamentals of electronic circuits and functions that can be done with them.

At the end of this unit, the student must have achieved the following objectives:

Objective 1: Classify energy sources. Voltage sources, current sources. Independent sources, controlled sources. (Knowledge)
Objective 2: Define the basic components: resistors, inductors and capacitors. (Knowledge)
Objective 3: Generalize the concept of resistor device. Current-voltage characteristic. (Knowledge)
Objective 4: Enunciate and apply Kirchhoff’s laws. (Knowledge, Comprehension, Application)
Objective 5: Enunciate and apply the theorems of Thevenin and Norton. (Knowledge, Comprehension, Application)
Objective 7: Describe the static characteristic (current-voltage characteristic) of a real diode. (Knowledge)
Objective 8: Define different segmental models for the diode. (Knowledge)
Objective 9: Defining the ideal diode. (Knowledge)
Objective 10: Describe the different types of diodes. (Knowledge)
Objective 11: Interpret the characteristics of the diodes datasheets. (Comprehension)
Objective 12: Solve circuits with diodes. (Application)
Objective 13: Describe the static characteristic (current-voltage characteristic) of a transistor. (Knowledge)
Objective 14: Define the linear regime of transistor operation. (Comprehension)
Objective 15: Define the transistor in switching mode. (Comprehension)
Objective 16: Describe the different types of transistors. (Knowledge)
Objective 17: Interpret the characteristics of the BJT and JFET transistors. (Comprehension)
Objective 18: Solve circuits with transistors. (Application)
3. Digital Systems.

**Description:**
3.1. Introduction to Digital Electronics.
3.1.1. Digital encoding of information.
3.2. Combinational systems.
3.2.2. Combinational systems with two gate levels. Analysis. Synthesis.
3.2.3. Commonly used combinational systems: adder, comparator, multiplexer/demultiplexer, encoder/decoder.
3.3. Sequential systems.
3.3.1. Definition of sequential system. General architecture of a clocked sequential system (Huffman model). Concept of internal state.
3.3.3. Some sequential blocks commonly used: shift registers, counters. 3.3.4. Programmable systems.

**Related activities:**
Practice 4: Digital Systems.
4.1. Combinational system: 2-input multiplexer.
4.2. Sequential system: counter module 4.

**Specific objectives:**

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**Learning time:** 30h
Theory classes: 9h
Laboratory classes: 2h
Self study: 19h
Give students an overview of the functions performed by digital processing systems of information and applications with emphasis on the basic differences of combinational and sequential subsystems.

At the end of this unit, the student must have achieved the following objectives:

Objective 1: Define the encoding of information systems. (Knowledge)
Objective 2: Describe and apply the laws and theorems of Boolean algebra. (Knowledge, Comprehension, Application)
Objective 3: Define the logic functions and truth tables. (Knowledge)
Objective 4: Normalize the logical functions. Simplify the logic functions. (Comprehension)
Objective 5: Define the combinational logic. (Knowledge)
Objective 6: Describe combinational blocks (adder, comparator, multiplexer/demultiplexer, encoder/decoder). (Comprehension)
Objective 7: Define the sequential logic. (Knowledge) Goal 8: Define the basic sequential (bistables JK, D and T). (Knowledge)
Objective 9: Describe sequential blocks (registers, counters, advanced devices). (Comprehension)
Objective 10: Set the programmable systems. (Comprehension)

**Description:**

4.1. Introduction to Analog Electronics.
4.2. Voltage-feedback operational amplifier (VFOA).
   4.2.1. VFOA ideal. Gain characteristics, input and output. Equivalent circuit of VFOA. VFOA power supply. Concept of saturation.
   4.2.2. Ideal VFOA in open loop. Analog comparators.
   4.2.3. Ideal VFOA I closed loop. Positive and negative feedback. Feedback factors. Stable and unstable operation. Basic examples.
4.3. Resistive-circuits VFOA applications.
   4.3.1. VFOA in stable operation. Virtual ground model. VFOA circuit analysis under stable operation.
4.4. Other aspects of the operational amplifier.
   4.4.1. Nonlinear operators. Precision rectifiers.
   4.4.2. Logarithmic and antilogarithmic amplifiers. Analog multiplier and divider.

**Related activities:**

Practice 5: Analog Systems.
5.1. The operational amplifier operating in linear mode: voltage follower (buffer), inverting amplifier, inverting adder.
5.2. The operational amplifier in non-linear operation: Noninverting Schmitt trigger.

**Specific objectives:**
Give students an overview of the functions performed by signal processing systems in time continuum and its applications, with emphasis on resistive circuits based on operational amplifier.

At the end of this unit, the student must have achieved the following objectives:

Objective 1:
Defining and classifying amplifiers. (Knowledge)

Objective 2:
Define the operational amplifier. (Knowledge)

Objective 3:
Describe the operation of the operational amplifier in open loop. Application circuits. (Comprehension/Application)

Objective 4:
Describe nonlinear operators with positive feedback. Application circuits. (Comprehension/Application)

Objective 5:
Describe linear operators with negative feedback. Circuit application. (Comprehension/Application)

Objective 6:
Describe nonlinear operators with negative feedback. Circuit application. (Comprehension/Application)
### 5. Power Systems.

**Description:**

5.1. Introduction to Power Electronics.
   5.1.2. Efficient power processing. Concept of the power converter. Components in the static converters.
   Classification of static converters.
   5.2. Switches.
   5.2.2. Resistive-switch modeling. Static characteristics: two, three and four segments. Dynamic characteristics.
   State transition diagram.
   5.2.3. The diode. The transistor. The thyristor SCR.
   5.3. Basic structures of static converters.
   5.3.1. DC-DC converters. Basic functionality and features. Classification. Examples: One quadrant choppers (Buck, Boost).
   5.3.2. DC-AC converters. Basic functionality and features. Classification. Examples: Single-phase Inverters with four switches.
   5.3.3. AC-DC converters. Basic functionality and features. Classification. Examples: Rectifiers P1, P2, PD2, P3.
   5.3.4. AC-AC converters. Basic functionality and features. Classification. Examples: single-phase AC regulators.
   5.3.5. Practical aspects in converters (EMI, Fourier, THD, active power, reactive and distortion).

**Related activities:**

6: Power Systems.
   6.1. Single-phase half-wave (P1) uncontrolled rectifier.
   6.2. Two phases half-wave (P2) uncontrolled rectifier.
   6.3. Two phases (PD2) uncontrolled rectifier.

**Specific objectives:**

**Learning time:** 30h

- Theory classes: 9h
- Laboratory classes: 2h
- Self study: 19h
Give students an overview of the functions performed by the processing systems of electricity and its applications, with emphasis on the concept of switch, and studying some features of the structures of various kinds of static converters.

At the end of this unit, the student must have achieved the following objectives:

Objective 1: Define the concept of "power path". (Knowledge)
Objective 2: Define the concept of the power converter. (Knowledge)
Objective 3: Components used to justify a converter based on the concept of "power path". (Knowledge)
Objective 4: Describe the various switches used in power systems. (Knowledge)
Objective 5: Describe the static characteristic (current-voltage characteristic) of a thyristor. (Knowledge)
Objective 6: Describe the state-transition diagram of a thyristor. (Knowledge)
Objective 7: Interpret the catalog characteristics of the thyristor. (Comprehension)
Objective 8: Sort the converters CC-GG or choppers. (Knowledge)
Objective 9: Describe the operation of one quadrant chopper (buck and boost). (Knowledge)
Objective 10: Formulate tensions and currents in one quadrant chopper, buck and boost. (Knowledge, Comprehension)
Objective 11: Classify DC-AC converters or inverters. (Knowledge)
Objective 12: Describe the operation of four switches single-phase inverter. (Knowledge)
Objective 13: Classify the AC-DC converters or rectifiers. (Knowledge)
Objective 14: Describe the operation of rectifiers P1, P2, P3 and PD2 with ideal components, identifying semiconductors that conduct at all times. (Knowledge)
Objective 15: Classify AC-AC converters. (Knowledge)
Objective 16: Describe the operation of the single-phase AC regulator. (Knowledge)
Evaluation of specific competence:

During the year will be 3 continuous assessment tests (PAC) PAC1, PAC2 and PAC3, each of which will have a rating (NPAC1, NPAC2, NPAC3).

In the PAC1, they are evaluated subjects 1. Introduction to electronic systems and 2. Discret Components, in the PAC2, they are evaluated subjects 3. Analog Systems and 4. Digital Systems and in the PAC3, they are evaluated subjects 5. Power Systems and Practices.

During 6 laboratory sessions it’s evaluated the work done in the laboratory (70%) and the answer sheet (with the previous work) delivered at the end of the practice session (30%), so that the end of the semester students will get a rating of laboratory work, NLAB, grades averaged from each of the laboratory.

At the end of the semester the student will obtain the qualification of specific competence (NOTACOM_ESP) as follows:

\[
\text{NOTACOM}_{\text{ESP}} = 0.25 \cdot \text{NPAC1} + 0.25 \cdot \text{NPAC2} + 0.35 \cdot \text{NPAC3} + 0.15 \cdot \text{NLAB}
\]

Note that there isn’t one last test type “final exam”.

Evaluation of generic competence:

The assessment of generic competence will be based on direct assessment, the teacher and subject heading, generic competence Solvent Use of Information Resources (USRI), level 2, and based on a written work, giving place in the rating NOTACOM_GEN.

Evaluation of the subject:

The final rating will be obtained from the results at the specific competence (NOTACOM_ESP) and generic competition (NOTACOM_GEN), according to the following algorithm:

\[
\text{NOTACURS} = 0.9 \cdot \text{NOTACOM}_{\text{ESP}} + 0.1 \cdot \text{NOTACOM}_{\text{GEN}}
\]

If NOTACURS is below 5.0 the student will obtain a valuation of ECTS F (fail).

The pass mark in the subject may be obtained only if performed laboratory practices.

Bibliography

Basic: