Course guide
820017 - STI - Electronic Systems

Last modified: 29/06/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: GEORGINA COMPANY SE

Others: Primer quatrimestre:

TEORIA
GEORGINA COMPANY SE - Grup M1
SPARTACUS GOMARIZ CASTRO - Grup: M2
ROBERT CALATAYUD CAMPS - Grup: T1
ÓSCAR REYES FERNÁNDEZ - Grup: T2

LABORATORI
SERGIO DANIEL AVILA PEREZ - Grup: M11, M12
JORDI BATLLE - Grup: M13, M14, M23, M24
SPARTACUS GOMARIZ CASTRO - Grup: M21, M22
GUILLEM CASTILLO BARRIERAS - Grup: T11, T12
JOSE ANTONIO FERNANDEZ VARO - Grup: T13, T14
ANNA FARRÉS I CASTANY - Grup T21, T22
ROGER VERGES PEREZ - Grup T23, T24

PRIOR SKILLS

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

REQUIREMENTS

SISTEMES ELÈCTRICS - Corequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Understand the fundamentals of electronics.

Transversal:
2. EFFECTIVE USE OF INFORMATI0N 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.

TEACHING METHODOLOGY

In the sessions the teacher uses different teaching methods so that, firstly, the student achieves the objectives of the cognitive subject and, on the other hand, that students achieve certain generic objectives. These methodologies are used to involve, to varying degrees, to the student as active agent of his own learning process. Highlights include the following:

- Lecture, in its classical version (plaster board) or multimedia support, where the teacher is the active element and collects student information. Used usually by throwing items or new concepts. The risk of this methodology is the passivity of the student that the conditions for storing little information. So often, the teacher poses questions and discussions are made to force the participation of students and the "capture" of useful information from the same.
- Labor peer. In groups of two students to work problems and aspects of the subject. Used in practical sessions and exercise sessions in the classroom. Imposes a direct participation of students, so the assimilation of information is high.
- Problem-based teaching. Either individually or in small groups the teacher proposes solving problems. With these problems solved outside the classroom, to work the power of group work, exposing the weaknesses of the student in understanding the subject.

LEARNING OBJECTIVES OF THE SUBJECT

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, DC-AC, AC-DC, AC-AC conversion and their functional principle. (Knowledge/Understanding)
14. - Describe the scope of the Signal Electronics (digital and analog) and Power Electronics. (Knowledge/Understanding)

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	45,0	30.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

1. Introduction to electronic systems.

Description:
1.1. Signals and systems.
1.1.1. Magnitudes and signals . Characteristics of physical signals. Types of electronic signals.
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.
1.4.1. Instrumentation. Need for instrumentation in industrial processes. The chain of instrumentation in an industrial process. Stimulus and response instruments.
1.4.2. Electronics Laboratory. Power supply. Function generator. Multimeter. Oscilloscope.
1.4.3. Equipment under test-instrument interaction. Measurement errors. Representation of measured values. Grounding. Protection instruments and/or its users.

1.5. Introduction to Power Electronics.
1.5.1. Power. Concept of path power. Concept of efficiency. Examples.
1.5.2. Efficient power processing. Concept of the power converter. Components in the static converters. Classification of static converters. . Switches.
1.5.3. Basic structures of static converters.

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)

Related activities:
Practice 1: Instrumentation.
1.1. Description of laboratory equipment.

1.2. Exercises.

Full-or-part-time: 38h 20m
Theory classes: 12h
Laboratory classes: 2h
Self study : 24h 20m

2. Discrets components.

Description:
2.1. Circuit elements.
2.1.1. Electronic circuits. Elements and components. Models.
2.1.2. Active and passive elements. Voltage and current sources. Amplifiers. Resistors. Static characteristic. Types of resistors. Switch concept. Thevenin equivalent. Reactive components: capacitors and inductors.
2.1.3. Solution of a circuit. Kirchhoff's laws. Tellegen's theorem. Line of load and operating point. Large signal and small signal operation. Switching.
2.2. The semiconductor diode.
2.2.1. Brief history of the diode. Voltage-current characteristic of diode rectifier. Segmental modeling. Ideal diode. Transition diagram of the diode.
2.2.2. The diode in a circuit. Operation in large signal and switching. Application of diode circuits rectifier: Single-phase rectifiers, filter capacitors, limiter.
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.
2.3.2. The transistor in a circuit. Biasing. Linear operation and switching operation. BJT modeling. State transition diagram. Heat dissipation. Some application circuits. Amplifiers.
2.3.3. Other types of transistors: JFET and MOSFET.

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 6:
Solve circuits. Models. Simulation. (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)

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.

Full-or-part-time: 40h 20m
Theory classes: 14h
Laboratory classes: 4h
Self study : 22h 20m

3. Analog Systems.

Description:
3.1. Introduction to Analog Electronics.
3.1.1. Continuous signals in continuous time. Amplifier concept. Gain, input impedance and output impedance.
3.1.2. Types of amplifiers. Source-coupled amplifier. Coupling amplifier stages.
3.1.3. Voltage-mode processing. Voltage-amplifier model. Need for the power supply.
3.2. Voltage-feedback operational amplifier (VFOA).
3.2.1. VFOA ideal. Gain characteristics, input and output. Equivalent circuit of VFOA. VFOA power supply. Concept of saturation.
3.2.2. Ideal VFOA in open loop. Analog comparators.
3.2.3. Ideal VFOA I closed loop. Positive and negative feedback. Feedback factors. Stable and unstable operation. Basic examples.
3.3. Resistive-circuits VFOA applications.
3.3.1. VFOA in stable operation. Virtual ground model. VFOA circuit analysis under stable operation.
3.3.2. Linear operators. Voltage follower. Noninverting Amplifier. Inverter Amplifier. Adder. Analog Integrator. Analog differentiator.
3.3.3. Schmitt triggers: inverting and noninverting. Level and sensitivity. Applications.
3.4. Other aspects of the operational amplifier.
3.4.1. Nonlinear operators. Precision rectifiers.
3.4.2. Logarithmic and antilogarithmic amplifiers. Analog multiplier and divider.

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)

Related activities:
Practice 4: Analog Systems.
4.1. The operational amplifier operating in linear mode: voltage follower (buffer), inverting amplifier, inverting adder.
4.2. The operational amplifier in non-linear operation: Noninverting Schmitt trigger.

Full-or-part-time: 40h 20m
Theory classes: 14h
Laboratory classes: 2h
Self study : 24h 20m

4. Digital Systems.

Description:
4.1. Introduction to Digital Electronics.
4.1.1. Digital encoding of information.
4.1.2. Boolean algebra. Boolean functions and forms. Laws and theorems of Boolean algebra.
4.1.3. Complete and incomplete forms. Truth table. Canonical forms. Minimization.
4.2. Combinational systems.
4.2.1. Definition of combinational system. Logic gates. Level table. Value-level relationship. Elementary logic gates. Implementation of functions using logic gates.
4.2.2. Combinational systems with two gate levels. Analysis. Synthesis.
4.2.3. Commonly used combinational systems: adder, comparator, multiplexer/demultiplexer, encoder/decoder.
4.3. Sequential systems.
4.3.1. Definition of sequential system. General architecture of a clocked sequential system (Huffmann model). Concept of internal state.
4.3.2. Flip-flops. Definition. Asynchronous flip-flops. Clocked flip-flops. Flip-flop activation modes. Flip-flop D, T and JK: Operating tables, state and transition.
4.3.3. Some sequential blocks commonly used: shift registers, counters. 3.3.4. Programmable systems.

Specific objectives:
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)

Related activities:
Practice 5: Digital Systems.
5.1. Combinational system: 2-input multiplexer.
5.2. Sequential system: counter module 4.

Full-or-part-time: 31h
Theory classes: 10h
Laboratory classes: 2h
Self study : 19h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

Assessment of specific competence:

During the course, 2 continuous assessment tests (PAC) PAC1 and PAC2 will be carried out, each of which will have a qualification (NPAC1, NPAC2) and a theoretical assessment test of the laboratory contents (PAL) with a qualification of NPAL

In PAC1, the topics 1. Introduction to electronic systems and 2. Discrete components will be assessed, in PAC2 the topics 3. Analogue systems and 4. Digital systems will be assessed and in the PAL an assessment of all the practices will be carried out.

Over the course of 6 laboratory sessions, the work carried out in the laboratory (60%) and the answer sheet delivered at the end of the practical session (40%) will be assessed, so that at the end of the semester the student will obtain a qualification for the practical work in the laboratory, NLAB, obtained by averaging the qualifications of each and every one of the laboratory sessions.

At the end of the semester, the student will obtain the specific competency grade (NOTACOM_ESP) as follows:

NOTACOM_ESP = 0.32· NPAC1 + 0.32· NPAC2 + 0.18· NPAL + 0.18· NLAB.

Generic competency assessment:

The generic competency assessment will be based on the direct assessment, by the teacher and according to a rubric, of the generic competency Effective Use of Information Resources (USRI), level 2, and based on a written assignment, resulting in the NOTACOM_GEN grade.

Course evaluation:

The final grade for the course will be obtained from the grades obtained in the specific competency (NOTACOM_ESP) and the generic competency (NOTACOM_GEN), according to the following algorithm:

NOTACURS=0.95· NOTACOM_ESP +0.05· NOTACOM_GEN

To qualify for the pass, it is essential to complete the laboratory practices of the course.
There is no re-evaluation exam

BIBLIOGRAPHY

Basic:
- Storey, Neil. Electrónica : de los sistemas a los componentes. Wilmington, Delaware: Addison-Wesley Iberoamericana, cop. 1995. ISBN 0201625725.
- Floyd, Thomas L. Dispositivos electrónicos. 8ª ed. México: Limusa: Noriega, 2008. ISBN 9789702611936.