Course guide
320038 - ELA - Analogue Electronics

Unit in charge:	Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	710 - EEL - Department of Electronic Engineering.

Degree:	BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023   **ECTS Credits:** 6.0   **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Jordi Zaragoza Bertomeu

Others: Néstor Berbel Artal

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. ELO: Knowledge of the foundations and applications of analogue electronics.

2. ELO: Capability for designing analog , digital and power electronic systems.

TEACHING METHODOLOGY

- Face-to-face lecture sessions.
- Face-to-face practical work sessions.
- Independent learning and exercises.
- Preparation and completion of group activities subject to assessment.
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In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.
Practical laboratory work will be covered in two types of sessions:
a) Sessions in which the lecturer provides students with guidelines to design, analyse and implement analogue electronic circuits (90%).
b) Examination sessions (10%).
Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.

LEARNING OBJECTIVES OF THE SUBJECT

In this subject, students will learn about the various active components (bipolar junction transistors, field-effect transistors and operational voltage amplifiers) and analyse circuits that contain these components. Students will learn how to apply these techniques to solve common practical problems encountered by engineers. They will learn how to use appropriate software to find solutions to problems examined on the course. They will build on the specific and transversal competencies associated with coursework, as described below.

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

TOPIC 1: BIPOLAR JUNCTION TRANSISTORS

Description:
1.1. Basic concepts
1.2. Bipolar junction transistors in continuous and low-frequency uses.
1.3. Bipolar junction transistors as amplifiers.

Specific objectives:
- An understanding of the bipolar junction transistor as a device around which much more complex electronic systems can be designed.

Related activities:
Laboratory. Practical 1: Bipolar junction transistors. In this practical, students will study the polarisation of a bipolar junction transistor and the design of a common-emitter amplifier. The students will analyse its circuit, design and implementation in the laboratory.

Full-or-part-time: 16h
Theory classes: 4h
Laboratory classes: 4h
Self study : 8h

TOPIC 2: FIELD-EFFECT TRANSISTORS

Description:
2.1. MOS field-effect transistors. Basic concepts.
2.2. Continuous-current-source MOS transistors.
2.3. MOS transistors as amplifiers.
2.4. MOS transistors as switches.
2.5. Logic gates.

Specific objectives:
- An understanding of the field-effect transistor as a device around which much more complex electronic systems--such as the logic gates studied in Electronic Systems--can be designed.

Related activities:
Laboratory. Practical 2. MOSFET TRANSISTORS. In this practical, students will study and determine the static characteristics of MOS field-effect transistors (MOSFETs). They will also implement amplifiers using MOSFETs and design and characterise NOT logic gates.

Full-or-part-time: 16h
Theory classes: 4h
Laboratory classes: 4h
Self study : 8h

TOPIC 3: REAL OPERATIONAL AMPLIFIERS

Description:
3.1. Introduction to ideal operational amplifiers.
3.2. Real operational amplifiers.
3.2.1. Polarisation currents.
3.2.2. Offset voltages.
3.2.3. CMRR.
3.2.4. PSRR.
3.2.5. Frequency limitations.
3.2.6. Slew rate.

Specific objectives:
- A better understanding of the basic concepts of operational amplifiers.
- An understanding of the main non-idealities of operational amplifiers, such as polarisation currents, offset voltages, CMRR, PSRR, frequency limitations and slew rate.
- An understanding of the non-idealities of operational amplifiers in analogue setups.

Related activities:
Laboratory. Practical 3: Non-idealities of operational amplifiers. In this practical, students will observe the non-ideal effects of operational amplifiers in various different setups.

Full-or-part-time: 20h
Theory classes: 4h
Laboratory classes: 4h
Self study : 12h

TOPIC 4: ACTIVE FILTERS

Description:
4.1. Introduction to electronic filtering.
4.2. Passive filters.
4.3. Sallen¿Key topology.
4.4. Rauch topology.
4.5. Filters higher than second-order. The Butterworth and Chebyshev approaches.

Specific objectives:
- An understanding of electronic filter specifications.
- Design and implementation of passive filters.
- Design and implementation of active filters using the Rauch and Sallen¿Key topologies.
- Design and implementation of filters higher than second-order using the Butterworth and Chebyshev approaches.

Related activities:
Laboratory. Practicals 4 and 5. Active filters. In practicals 4 and 5, students will design the second-order Rauch and Sallen¿Key filters and design and implement filters higher than second-order in order to obtain a sinusoidal signal from a square wave. Students will design, simulate and select the components of the various filters and carry out the final implementation.

Full-or-part-time: 32h
Theory classes: 8h
Laboratory classes: 8h
Self study : 16h

TOPIC 5: NON-LINEAR APPLICATIONS

Description:
5.1. Introduction to non-linear applications.
5.2. Non-linear circuits.
5.2.1. Comparators.
5.2.2. Schmitt triggers.
5.2.3. Active rectifiers and clippers.
5.2.4. Logarithmic amplifiers.
5.2.5. Oscillators.

Specific objectives:
- An understanding of the difference between linear and non-linear applications.
- Design and implementation of various non-linear circuits.

Related activities:
Laboratory. Practical 6. Mixed circuits. In this practical, students will implement a mixed circuit that combines linear and non-linear circuits. Optoelectronic components will be used as a complement to this practical.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 4h
Self study : 10h

TOPIC 6: LINEAR POWER SOURCES

Description:
6.1. Introduction to power sources. Differences between switched-mode and linear power sources.
6.2. Integrated voltage regulators.
6.3. Performance specifications.
6.4. Reference voltage sources.
6.5. Design of linear voltage sources.

Specific objectives:
- The ability to differentiate between linear and switched-mode power sources.
- An understanding of the main characteristics of linear power sources.
- The ability to design a linear power source.

Full-or-part-time: 5h
Theory classes: 3h
Self study : 2h

TOPIC 7: SIGNAL CONVERTERS

Description:
7.1. Introduction to signal converters.
7.2. Signal sampling and reconstruction.
7.3 Analogue multiplexors.
7.4. Analogue-to-digital converters (ADCs).
7.5. Digital-to-analogue converters (DACs).

Specific objectives:
- An understanding of interaction between the analogue and digital worlds.
- Familiarity with the main characteristics of analogue-to-digital converters (ADCs).
- Familiarity with the main characteristics of digital-to-analogue converters (DACs).

Related activities:
Laboratory. Practical 7. Power sources and signal converters. In this practical, students will implement the various setups covered in topics 6 and 7.

Full-or-part-time: 9h
Theory classes: 1h
Laboratory classes: 6h
Self study : 2h

GRADING SYSTEM

- First examination: 25%
- Second examination: 40%
- Laboratory: 35%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

In order to take Analogue Electronics, students are expected to have passed the first-year mathematics subject and have assimilated the content covered in Electronic Systems and Electrical Systems.

BIBLIOGRAPHY

Basic:
- Malvino, Albert Paul. Principios de electrónica [on line]. 7a ed. Madrid: McGraw-Hill, 2007 [Consultation: 11/05/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4146.   ISBN 9788448156190.
- Prat Viñas, Lluís [et al.]. Circuitos y dispositivos electrónicos: fundamentos de electrónica. 6a ed. Barcelona: Ediciones UPC, 1999. ISBN 848301291X.

Complementary:
- El-Ali, Taan Said. Discrete systems and digital signal processing with MATLAB. Boca Raton: CRC Press, 2004. ISBN 0849310938.
- Millman, Jacob. Microelectrónica. Barcelona: Hispano Europea, 1991. ISBN 8425508851.