



## Course guide

# 820222 - EAEIA - Analogue Electronics

**Last modified:** 08/07/2024

**Unit in charge:** Barcelona East School of 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:** 2024

**ECTS Credits:** 6.0

**Languages:** Catalan, Spanish, English

### LECTURER

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**Coordinating lecturer:** HERMINIO MARTINEZ GARCIA

**Others:**

Primer quadrimestre:

PEDRO FRANCISCO GAYA SUÑER - Grup: T13, Grup: T14

HERMINIO MARTINEZ GARCIA - Grup: T11, Grup: T12, Grup: T13, Grup: T14, Grup: T15, Grup: T16

NOELIA VAQUERO GALLARDO - Grup: T11, Grup: T12

Segon quadrimestre:

PEDRO FRANCISCO GAYA SUÑER - Grup: M11, Grup: M12, Grup: M13, Grup: M21, Grup: M22, Grup: M23, Grup: M24

HERMINIO MARTINEZ GARCIA - Grup: M11, Grup: M12, Grup: M13, Grup: M14

NOELIA VAQUERO GALLARDO - Grup: M21, Grup: M22, Grup: M23, Grup: M24

### PRIOR SKILLS

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The skills acquired in the following courses of the Bachelor's Degree in Industrial Electronics and Automation Engineering (EIA):

- Electronic Systems (STI - 820017).
- Circuit Theory and Electrical Machines (TCME - 820225).
- Electronics Technology (TE-EIA - 820231).

## REQUIREMENTS

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Per G\* ENG ELEC IND AUTO  
REGULACIÓ AUTOMÀTICA - Corequisit  
SISTEMES ELECTRÒNICS - Prerequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit  
Per DG BIO-ELECT IND AUT  
REGULACIÓ AUTOMÀTICA - Corequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit  
Per DG ELECT IND AUT-BIO  
REGULACIÓ AUTOMÀTICA - Corequisit  
SISTEMES ELECTRÒNICS - Prerequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit  
Per DG ELECT IND AU-MEC  
REGULACIÓ AUTOMÀTICA - Corequisit  
SISTEMES ELECTRÒNICS - Prerequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit  
Per DG MEC-ELECT IND AU  
REGULACIÓ AUTOMÀTICA - Corequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit  
Per DG QUÍM-ELECT IND AU  
REGULACIÓ AUTOMÀTICA - Corequisit  
TECNOLOGIA ELECTRÒNICA - Corequisit  
TEORIA DE CIRCUITS I MÀQUINES ELÈCTRIQUES - Prerequisit

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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### Specific:

1. Design analogue, digital and power systems.
3. Understand the applications of electronic instrumentation.
4. Understand the fundamentals and applications of analogue electronics.

### Transversal:

10. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

## TEACHING METHODOLOGY

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Two theory classes per week with a total of 3.0 h/week, which encompass matter of theory and problems, and 1 h/set. of laboratory classes, grouped into fortnightly sessions.

Additionally, throughout the semester, different classes will be held (schedule will be announced at the beginning of term) with the whole group or part thereof in order to explain, develop and assess cross (generic) competences assigned to the subject.

The course uses:

- Lecture methodology by 40%.
- Individual work by 30% .
- Work in groups by 30 %.

The student will develop, in groups of, at most, 2 students, a project of the course design, simulation, and/or implementation related to the content of the course.

## LEARNING OBJECTIVES OF THE SUBJECT

- 1.- To know the different types, internal structures, operation and application circuits of commercial devices and integrated circuits for analog signal processing (VFOAs, OTAs, CCIs, CCIIs, CFOAs, etc.).
- 2.- To know the main electrical characteristics and practical limitations (static and dynamic) of the main commercial integrated circuits for analog signal processing.
- 3.- To understand the concept of 'saturated state' and 'non-saturated state', 'linear electronic function' and 'non-linear electronic function'.
- 4.- To know how to analyze, design, simulate, and implement basic and advanced analog systems that implement linear and nonlinear generation of waveforms and sinusoidal oscillators, regulators and voltage references, etc.
- 5.- To know the synthesis of analog and digital filtering structures, the principle of switched capacitor circuits (SC), and the classification and types of SC circuits.
- 6.- To develop skills in simulation techniques and experimental measurement in analog electronic circuits and systems.
- 7.- Autonomous learning and the development of student teamwork.
- 8.- To use English in advanced information search (manufacturers datasheets, IEEE journal articles, etc.), regarding the presentation of written and oral work in the course.

## STUDY LOAD

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

**Total learning time:** 150 h

## CONTENTS

### 1.- Analysis and Design of Operational Amplifier Internal Structures.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 10h

Theory classes: 5h

Self study : 5h



## 2.- Practical Limitations of Analog Integrated Circuits.

### Description:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Specific objectives:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Related competencies :

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

### Full-or-part-time: 8h

Theory classes: 3h

Self study : 5h

## 3.- Alternatives to VFOA: Commercial Analog Integrated Circuits (OTA, CCI, CCII, CFOA, etc.). Types, Characteristics, and Classification.

### Description:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Specific objectives:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Related competencies :

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

### Full-or-part-time: 8h

Theory classes: 3h

Self study : 5h



#### 4.- Implementation of Linear and Non-Linear Electronic Functions by Means of Analog Integrated Circuits Operating in Non-Saturation and Saturation Zones.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-23. Understand the applications of electronic instrumentation.

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 12h 30m

Theory classes: 3h 30m

Laboratory classes: 4h

Self study : 5h

#### 5.- Frequency Response of Transistor Amplifiers.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 14h

Theory classes: 4h

Self study : 10h



## 6.- Transistor and VFOA Feedback Amplifiers: Effects of the Negative and Positive Feedback.

### Description:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Specific objectives:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Related competencies :

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

### Full-or-part-time: 8h

Theory classes: 3h

Self study : 5h

## 7.- Time Circuits, Signal Generation and Sinusoidal Oscillators.

### Description:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Specific objectives:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Related competencies :

CEEIA-23. Understand the applications of electronic instrumentation.

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

### Full-or-part-time: 18h

Theory classes: 4h

Laboratory classes: 4h

Self study : 10h

## 8.- Continuous and Discrete Transfer Functions: 's' and 'z' Transforms for Electrical Filter.

### Description:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Specific objectives:

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

### Related competencies :

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

### Full-or-part-time: 8h 30m

Theory classes: 3h 30m

Self study : 5h



### 9.- Continuous-Time and Digital Active Filtering Cells. Design and Analysis of High-Order Filters by Means of Polynomials, Tables, and Software.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-23. Understand the applications of electronic instrumentation.

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 19h

Theory classes: 5h

Laboratory classes: 4h

Self study : 10h

### 10.- Switched-Capacitor Circuits (SCC) and Programmable Analog Devices (FPAAs).

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-23. Understand the applications of electronic instrumentation.

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 11h

Theory classes: 3h

Laboratory classes: 3h

Self study : 5h



### 11.- Power Amplification: Output Stages.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 13h

Theory classes: 3h

Self study : 10h

### 12.- Current and Voltage Regulators and References.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 13h

Theory classes: 3h

Self study : 10h

### 13.- Other Important Applications of the Analog Electronics.

**Description:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Specific objectives:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.

**Related competencies :**

CEEIA-20. Understand the fundamentals and applications of analogue electronics.

CEEIA-24. Design analogue, digital and power systems.

07 AAT N3. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

**Full-or-part-time:** 7h

Theory classes: 2h

Self study : 5h



## GRADING SYSTEM

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The grade or scoring of the course will be carried out according to:

- 1 or 2 midterm exams: 20 %.
- Final Exam: 40 %.
- Course project (project to design, simulate, and implement analog electronic systems): 20 %.
- Laboratory activities and tests: 20 %.

All these tasks will also serve to assess the cross (generic) competences assigned to the course.

This course does not have re-assessment test ("prova de reavaluació").

## EXAMINATION RULES.

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The implementation of the different tests consists of:

- Midterm exams: written tests, theoretical or sizing problems of solar energy testing, and analysis and/or synthesis (design) of analog electronic systems.
- Final exam: written, theoretical and/or sizing problems of solar energy test, and analysis and synthesis (design) of analog electronic systems.
- Course project: The course project will involve conducting course design work, sizing and/or simulation related to the contents of the subject.
- Activities, testing and laboratory experiments: Laboratory experiences and activities on Electronics Engineering.

Thanks to all these tasks, the cross (generic) competences assigned to the course will be also evaluated.

## BIBLIOGRAPHY

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### Basic:

- Clayton, George; Winder, Steve. Operational amplifiers [on line]. 5th ed. Oxford [etc.]: Newnes, 2003 [Consultation: 29/04/2020]. Available on: <https://www.sciencedirect.com/science/book/9780750659147>. ISBN 0750659149.
- Coughlin, Robert F.; Driscoll, Frederick F. Amplificadores operacionales y circuitos integrados lineales. 3ª ed. México [etc.]: Prentice-hall Hispano Americana, 1999. ISBN 9701702670.
- Franco, Sergio. Diseño con amplificadores operacionales y circuitos integrados analógicos. México [etc.]: McGraw-Hill, 2005. ISBN 9701045955.
- Fiore, James M. Amplificadores operacionales y circuitos integrados lineales : teoría y aplicación. Madrid: Thomson, cop. 2002. ISBN 8497320999.
- Pérez García, Miguel Ángel. Instrumentación electrónica. Madrid: Paraninfo, cop. 2014. ISBN 9788428337021.

### Complementary:

- Op amp applications handbook. Amsterdam: Newnes, 2004. ISBN 9780750678445.
- Malik, Norbert R. Circuitos electrónicos : análisis, diseño y simulación. Madrid [etc.]: Prentice Hall, cop. 1996. ISBN 8489660034.
- Rashid, M. H.. Circuitos microelectrónicos : análisis y diseño. Madrid: International Thomson, 2002. ISBN 8497320573.
- Sedra, Adel S.; Smith, Kenneth Carless. Circuitos microelectrónicos. 5ª ed.. México: Oxford University Press, 2006. ISBN 9701054725.
- Gayakwad, Ramakant A.. OP-AMPS and linear integrated circuits. 4th ed. Englewood Cliffs, NJ [etc.]: Prentice-Hall, cop. 2000. ISBN 0132808684.
- Mancini, Ron. Op amps for everyone : design reference [on line]. Boston: Newnes, 2001 [Consultation: 29/04/2020]. Available on: <https://www.cypress.com/file/65366/download>. ISBN 0750677015.



## RESOURCES

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**Hyperlink:**

- Moodle ATENEA: <http://atenea.upc.edu/moodle/>

**Other resources:**

Please, see the Spanish or Catalan version of the contents in order to see the detailed course syllabus.