Course guide
230915 - CA - Analog Circuits

Last modified: 11/04/2025

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

Degree: BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ANTONIO TURO PEROY

Others: Segon quadrimestre:
JUAN ANTONIO CHAVEZ DOMINGUEZ - 12, 13
ANTONIO TURO PEROY - 11, 12, 13

PRIOR SKILLS

- Circuit analysis.
- Passive components: resistor, capacitor and inductor.
- Active components: diodes and transistors.
- Basic laboratory instruments: oscilloscope, multimeter, function generator and power supply.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE4. (ENG) GREELEC: comprensió i domini dels conceptes bàsics de sistemes lineals i les funcions transformades i relacionades, teoria de circuits elèctrics, circuits elèctrics, principi físic de semiconductors i hfamilíes lògiques, dispositius electrònics i fotònics, tecnologia dels materials i la seva aplicació per a resolució de problmes per a l'enginyeria. (Mòdul de formació bàsica).
CE23. (ENG) GREELEC: Cpacitat de realitzar l'especificació, implementació, documentació i posada a pount d'equips i sistemes, electrònics, d'unstrumentació i de control, considerant tant els aspectes tècnics com les normatives reguladores corresponents. (Mòdul de tecnologia específica- Sistemes electrònics).
CE24. (ENG) GREELEC: Capacitat per aplicar l'electrònica com tecnologia de suport a altres camps i activitats, i no només en l'àmbit de les tecnologies de la informació i comunicació. (Mòdul de tecnologia específica- Sistemes electrònics).
CE25. (ENG) GREELEC: Capacitat de dissenyar circuits d'electrònica analògica i digital, de conversió analògica-digital i digital-analògica, de radiofreqüència, d'alimentació i conversió d'energia elèctrica per aplicacions de telecomunicació i computació. (Mòdul de tecnologia específica- Sistemes electrònics).

Generical:
CG1. (ENG) Capacitat per redactar, desenvolupar i signar projectes en l'àmbit de l'enginyeria de telecomunicació que tinguin per objecte la concepció i el desenvolupament o l'explotació de xarxes, serveis i aplicacions de telecomunicació i electrònica.
CG5. (ENG) GREELEC: Coneixements per a la realització de medicions, càlculs, taxacions, peritacions, estudis, informes, planificació de tasques i treballs anàlegs en l'ambit específic de la telecomunicació.

Transversal:
CT4. (ENG) GREELEC: TREBALL EN EQUIP: ser capaç de treballar com a membre d'un equip interdiscplinar, ja sigui com un membre més o realitzant tasques de direcció, amb la finalitat de contrinuir a desenvolupar projectes amb pragmatisme i sentit de la responsabillitat, assumint compromisos tenint en compte els recursos disponibles.

TEACHING METHODOLOGY

Lectures
Application classes
Laboratory activities
Individual work
Cooperative learning
Problem/project based learning
Extended answer tests (control and final exam)
Laboratory tests and reports

LEARNING OBJECTIVES OF THE SUBJECT

The main learning objective of the course is the study of the electronic circuits to implement the basic functions in analog signal processing, signal generation, and A/D and D/A conversion. The implementation of these functions will be based on the knowledge of the operation and limitations of the operational amplifiers and other analog integrated circuits.

Once this subject has been passed, the student must be able:
- To analyse and design the electronic circuits implemented with linear integrated circuits that perform the basic analog functions.
- To understand how the feedback technique is applied in electronic circuits and the influence to their stability.
- To be skilful with the design tools, simulation programs and instruments used in the development of analog electronics.
- To implement, verify and debug the electronic circuits implementing the analog functions in the most popular applications.

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	39,0	26.00
Hours small group	26,0	17.33

Total learning time: 150 h

CONTENTS

Part 1: Amplification of electrical signals and analog integrated circuits

Description:
1. Amplification
Definition of amplifier. Amplifier types. Equivalent circuit of a voltage amplifier. Input and output resistances and load effects.
2. The operational amplifier
Definition. Symbol. Equivalent circuit. Ideal operational amplifier. Basic configurations with operational amplifiers.
3. Other amplifier integrated circuits
Transconductance operational amplifier. Current feedback amplifier.

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

Part 2: Op amp limitations

Description:
1. Op amp DC limitations
Input-output transfer characteristic, dynamic ranges and operating zones. Bias currents. Offset voltage. Common mode rejection ratio (CMRR). Power supply rejection ratio (PSRR). Error balance.
2. Frequency response and op amp AC limitations
Transfer function, frequency response and Bode diagrams. Op amp frequency response. Gain bandwidth product. Rise time. Slew-rate.

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Part 3: Feedback techniques in electronic circuits

Description:
1. Feedback
Concept of feedback. Canonical representation of a feedback system. Signal flow graph of feedback systems using op amps.
2. Stability in electronic circuits using feedback techniques
Concept of stability. Routh stability criterion. Root locus. Stability margins. Frequency compensation techniques.

Full-or-part-time: 17h 30m
Theory classes: 7h
Self study : 10h 30m

Part 4: Analog electronic functions

Description:
1. Linear applications
Current to voltage converter. Voltage to current converter. Current amplifiers. Differential amplifiers. Instrumentation amplifier.
2. Nonlinear applications
Voltage comparators. Schmitt triggers. Precision rectifiers. Signal limiter and clamper circuits.

Full-or-part-time: 23h
Theory classes: 9h
Self study : 14h

Part 5: Signal generators

Description:
1. Sine wave generators
Necessary conditions for circuit oscillation. Start-up condition and amplitude stabilization. Wien-bridge oscillator. Quadrature oscillator.
2. Relaxation generators
Astables. Monostables. 555 timer IC. Square-triangular wave generators.

Full-or-part-time: 17h 30m
Theory classes: 7h
Self study : 10h 30m

Part 6: A/D and D/A conversion

Description:
1. Interfacing analog and digital worlds
2. D/A conversion
Performance specifications. D/A conversion techniques.
3. A/D conversion
Performance specifications. Sample and hold. A/D conversion techniques.

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

Part 7: Other analog integrated circuits

Description:
1. Analog switches and multiplexers
2. Logarithmic amplifiers
3. Analog multipliers
4. PLL

Full-or-part-time: 7h 30m
Theory classes: 3h
Self study : 4h 30m

Laboratory activities

Description:
Lab 1: Analog signal measurements (2 hours)
Lab 2: Introductory session to PSPICE simulator (2 hours)
Lab 3: Real operational amplifier. PSPICE simulation (4 hours)
Lab 4: Design, implementation and characterization of a two-stage amplifier based on op amps (6 hours)
Lab 5: Simulation and experimental verification of a filter and an oscillator (4 hours)
Lab 6: Distance measurement by means of ultrasound (8 hours)

Full-or-part-time: 52h
Laboratory classes: 26h
Self study : 26h

GRADING SYSTEM

Theory midterm exam (EXPAR): 20%
Theory final exam (EXFIN): 40%

Laboratory activities (LAB): 20%
Laboratory final exam (EXLAB): 20%

Final grade (NF) is the major of the two following expressions:
NF = 0,2*LAB + 0,2*EXLAB + 0,2*EXPAR + 0,4*EXFIN , or
NF = 0,2*LAB + 0,2*EXLAB + 0,6*EXFIN , in case the result of this expression is greater than the previous one.

The reassessment only includes the theory exam of the course. Grades of the laboratoy part are maintained from the previous assessment.

BIBLIOGRAPHY

Basic:
- Franco, S. Diseño con amplificadores operacionales y circuitos integrados analógicos. México: McGraw-Hill, 2005. ISBN 9701045955.

Complementary:
- Floyd, T.L.; Buchla, D. Fundamentals of analog circuits. 2nd ed. Upper Saddle River, N.J.: Prentice Hall, 2002. ISBN 0130606197.
- Fiore, J.M. Amplificadores operacionales y circuitos integrados lineales: teoría y aplicación. Madrid: Thomson, 2002. ISBN 8497320999.