

## SUBJECT TEACHING GUIDE

G827 - Analogue and Mixed Electronics

Degree in Telecommunication Technologies Engineering

Academic year 2021-2022

### 1. IDENTIFYING DATA

|                                  |   |                  |                    |                  |                  |
|----------------------------------|---|------------------|--------------------|------------------|------------------|
| Degree                           | Degree in Telecommunication Technologies Engineering              |                  |                    | Type and Year    | Optional. Year 3 |
| Faculty                          | School of Industrial Engineering and Telecommunications           |                  |                    |                  |                  |
| Discipline                       | Subject Area: Electronic Systems Design                           |                  |                    |                  |                  |
| Course unit title and code       | G827 - Analogue and Mixed Electronics                             |                  |                    |                  |                  |
| Number of ECTS credits allocated | 6   | Term             | Semester based (1) |                  |                  |
| Web                              | <a href="https://moodle.unican.es/">https://moodle.unican.es/</a> |                  |                    |                  |                  |
| Language of instruction          | Spanish   | English Friendly | Yes                | Mode of delivery | Face-to-face     |

|                  |   |
|------------------|---|
| Department       | DPTO. TECNOLOGIA ELECTRONICA E INGENIERIA DE SISTEMAS Y AUTOMATICA  |
| Name of lecturer | JOSE ANGEL MIGUEL DIAZ  |
| E-mail           | joseangel.miguel@unican.es  |
| Office           | E.T.S. de Ingenieros Industriales y de Telecomunicación . Planta: - 3. DESPACHO JOSE A. MIGUEL DIAZ (S3080) |
| Other lecturers  | YOLANDA LECHUGA SOLAEGUI  |

### 3.1 LEARNING OUTCOMES

- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Introduction to Computer Aided Design (CAD) tools for analog circuit design (SPICE).
- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Analysis and design of CMOS amplifiers, including single-stage amplifier with passive and active loads; differential amplifiers; Operational Transconductance Amplifiers (OTA); Operational Amplifiers (OA).
- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Frequency response analysis of CMOS amplifiers.
- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Analysis of feedback circuits, focusing on feedback amplifiers.
- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Analysis of noise in Integrated Circuits (IC).
- Analysis and Design of Analog and Mixed-Signal Electronic Circuits. Analysis and design of analog comparator circuits, analog multiplier circuits and signal generator circuits.
- Fundamentals on switched capacitor circuits. Analysis and design of switched capacitor (SC) circuits, including SC amplifier circuits and SC integrator circuits.
- Fundamentals on switched capacitor circuits. Analysis and design of continuous and switched capacitor (SC) filters.
- Fundamentals on the most common Analog-to-Digital Converter (ADC or A/D) circuits and Digital-to-Analog Converter (DAC or D/A) circuits.

### 4. OBJECTIVES

- Becoming proficient in the use of Computer-Aided Design (CAD) tools for analog and mixed-signal circuit design and simulation (SPICE).
- Designing and analyzing basic electronic circuits (CMOS analog switches, passive and active loads, current sources and sinks), current mirrors and CMOS amplifiers (single-stage, differential, OTA and OA).
- Analyzing the frequency response of MOS amplifiers.
- Recognizing the most common sources of noise in electronic circuits. Performing the noise analysis for MOS amplifiers.
- Designing and analyzing OTA and OA-based circuits; focusing on their most common linear and nonlinear applications.
- Designing and analyzing signal generation circuits and oscillators.
- Designing and analyzing continuous filters, RC filters and gmC filters.
- Designing and analyzing switched capacitor (SC) circuits, such as amplifiers and filters.
- Knowing the fundamentals of A/D and D/A converters, focusing on their most common architectures.
- Acquiring experience and proficiency in the use of the electronics laboratory equipment and devices; to experimentally characterize the response of self-made designs.
- Understanding and interpreting datasheets for electronic components.

## 6. COURSE ORGANIZATION

### CONTENTS

|   |   |
|---|---|
| 1 | Introduction to Computer Aided Design (CAD) tools for analog circuit design (SPICE).  |
| 2 | Design and analysis of basic electronic circuits (CMOS analog switches, passive and active loads, current sources and sinks), current mirrors and CMOS amplifiers (single-stage, differential, OTA and OA). |
| 3 | Analyze the frequency response of MOS amplifiers.   |
| 4 | Fundamentals on the most common sources of noise in electronic circuits. Performing the noise analysis for MOS amplifiers.  |
| 5 | Design and analysis of OTA and OA-based circuits; focusing on their most common linear and nonlinear applications.  |
| 6 | Design and analysis of signal generation circuits and oscillators.  |
| 7 | Design and analysis of continuous filters, RC filters and gmC filters.  |
| 8 | Design and analysis of switched capacitor (SC) circuits, such as amplifiers and filters.  |
| 9 | Fundamentals on Analog-to-Digital Converter (ADC or A/D) and Digital-to-Analog Converter (DAC or D/A) circuits; focusing on their most common architectures.  |

## 7. ASSESSMENT METHODS AND CRITERIA

| Description                   | Type                  | Final Eval. | Reassesssn | %      |
|-------------------------------|-----------------------|-------------|------------|--------|
| Hands-on laboratory sessions. | Laboratory evaluation | No          | Yes        | 30,00  |
| Continuous assessment.        | Others                | No          | Yes        | 30,00  |
| Final exam.                   | Written exam          | Yes         | Yes        | 40,00  |
| TOTAL                         |                       |             |            | 100,00 |

### Observations

If the minimum acceptable grade is not obtained in any of the evaluation activities, then the highest possible grade would be a 4,9.

Any passing grades given during the evaluations will be valid until the 'Convocatoria Extraordinaria' of the course.

In order to pass the course, a passing grade in the lab class is required as well.

In order to provide a safe and accessible learning environment, the course may not be in-person. If that is the case, then the course will be either an online course or a hybrid course (a mix of in-person meetings and online activities).

If the course is delivered online or hybrid, then class activities will be done via Aula Virtual (Moodle), email, Skype for Business, and/or any other software that the University of Cantabria permits or provides.

Any tutoring session/discussion with students will be delivered online or hybrid via email or the Aula Virtual's forum . If need be, the use of Skype for Business and/or any other software that the university provides or permits maybe used.

Any online or hybrid evaluations will be based on the "Evaluación con Soporte Virtual" for each graded assignment . The weight percentage for each graded assignment will remain the same.

All students must have a computer, webcam and microphone or a mobile phone with camera, access to the internet, and Skype for Business and/or any other software that the University of Cantabria provides or permits.

### Observations for part-time students

For part-time students, the percentages assigned to the evaluations are added to the written exams.

For any part-time student whose schedule is incompatible, individual online meetings will be carried out.

If any part-time student who for justified reasons cannot attend the scheduled laboratory sessions, the possibility of passing the laboratory component through practical exams that will be held during the "Convocatoria Ordinaria" and 'Convocatoria Extraordinaria'.

## 8. BIBLIOGRAPHY AND TEACHING MATERIALS

### BASIC

A.S. Sedra, K.C. Smith. Microelectronic Circuits. Oxford University Press, 2011.

P.E. Allen, D.R. Holberg. CMOS Analog Circuit Design. Oxford University Press, 2012.