SUBJECT TEACHING GUIDE

G992 - Electronic Devices and Circuits

Degree in Industrial Electronic Engineering and Automatic Control Systems
First Degree in Industrial Electronic Engineering and Automatic Control Systems

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Degree in Industrial Electronic Engineering and Automatic Control Systems First Degree in Industrial Electronic Engineering and Automatic Control Systems		Type and Year	Compulsory. Year 2 Compulsory. Year 2	
Faculty	School of Industrial Engineering and Telecommunications				
Discipline	Subject Area: Electronics and Automation Module in Common with the Industrial Branch				
Course unit title and code	G992 - Electronic Devices and Circuits				
Number of ECTS credits allocated	6	Term	Semester based (2)		
Web					
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	FRANCISCO JAVIER AZCONDO SANCHEZ
E-mail	javier.azcondo@unican.es
Office	E.T.S. de Ingenieros Industriales y de Telecomunicación. Planta: - 3. DESPACHO PROFESORES (S3019)
Other lecturers	FRANCISCO JAVIER DIAZ RODRIGUEZ ALEJANDRO NAVARRO CRESPIN

3.1 LEARNING OUTCOMES
- Students are equipped with the following skills: - Simulation and use of electronic devices - Design of basic analog and digital electronic circuits - Characterization of power switch devices. - Circuit building and test - Use of electronic instruments
- Students understand the following topics - Diodes, MOSFETs and BJTs operation principles - Design and analysis of single-stage amplifiers using MOSFETs and BJTs - Design and analysis of basic digital circuits using MOSFETs - Operation principles of power switches in power conversion stages

4. OBJECTIVES
Understand the operation principles of Diodes, MOSFETs and BJTs
Understand the design principles and analysis of single-stage amplifiers using MOSFETs and BJTs
Understand the operation principles of a power switch device in power conversion stages
Understand the design and analysis principles of digital circuits built with MOSFET transistors

6. SUBJECT PROGRAM	
CONTENTS	
1	Block 1. Circuits with diodes 1.1. Diodes and optoelectronic devices fundamentals. Semiconductors (Energy bands, electrons and holes; Intrinsic and doped semiconductors. Generation and recombination of charge carriers; Conduction mechanisms: Diffusion and Drift. P-N junction: Structure, inverse and direct bias, I - V characteristic. Temperature effects. Drift zone in power device. Conductivity modulation. Other diode types: Varactor, Schottky, Photodiode, LED, Solar Cell. 1.2.- Diode models. V-I characteristic of the p-n junction. Ideal diode. Constant voltage drop model. Voltage source + resistor model. Small-signal model. Zener model. Diode SPICE model. 1.3.- Applications of diodes. Battery charger. Half and Full Wave rectifiers. Bridge rectifier. Peak voltage detector. Voltage stabilizer. Effect of the load on the output voltage. Demodulator. Clamp voltage circuits. Piece-wise linear transfer functions. Diode circuit analysis with SPICE.
2	Block 2. Circuits with MOS transistors 2.1. MOS devices. MOS transistor structure. V-I characteristics. Operation in the linear or triode area. Operation in the saturation area. MOS capacitances. Large-signal model. Small-signal model. PMOS transistors. SPICE model 2.2. MOS transistor in steady-state operation. MOS transistor bias. Resistor divider. Self-bias. Design with integrated circuit technology. NMOS inverters. Enhancement-type MOS. Depletion-type MOS. Current source mode. Current mirrors. Current mirror with cascode stage. 2.3. MOS transistor in digital circuits. Static characteristics of a digital inverter. NMOS and CMOS digital inverters. Voltage transfer function. Supply current. MOS switches. Dynamic characteristic of a digital inverter. Propagation time. Power dissipation. NMOS and CMOS logic gates. 2.4. Single and multi-stage MOS amplifiers. Amplification concept. Voltage gain. Input and output resistance. Small-signal model. Single-stage discrete MOS amplifier. Active loads technique. Common source, common drain, and common gate configurations. Cascode amplifier. Multi-transistors coupling. Multi-stage amplifier. SPICE simulation examples. 2.5. The MOS differential amplifier. MOS differential pair. Large-signal operation. Small-signal operation. Common-mode gain. Differential-mode gain. Common-mode rejection ratio (CMRR). Non-ideal characteristics of the differential amplifiers. Differential amplifier with active loads. Differential input to output conversion. 2.6. MOS integrated circuits manufacturing. Introduction. Integrated circuit manufacturing steps. VSLI process to obtain integrated devices: MOSFET, Resistors, Capacitors, Inductors, Diodes and Bipolar transistors. CMOS Integrated circuit mask and layout design. Integrated devices scaling rules.
3	Block 3. Integrated circuits with bipolar transistors 3.1.- Circuits with BJT transistors. Device structure and operation principles. V-I characteristics. Operation modes. Small-signal model. Performance comparison between bipolar and MOS transistors. Bias circuits for BJTs. Resistor network. Current mirrors. Amplifiers with bipolar transistors. Single-stage amplifiers. Transistors interconnections. Differential amplifier.
4	Block 4.- Power conversion devices and circuits 4.1.- Power devices. Ideal power switch. Power diodes. Power MOSFET. Insulated Gate Bipolar Transistor (IGBT).

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Assessment of the lab practices and reports	Laboratory evaluation	Yes	Yes	30,00
Final exam	Written exam	Yes	No	0,00
Work assignment and continuous assessment	Others	Yes	Yes	70,00
TOTAL				100,00

Observations

Punctuality in the attendance to classes is requested for the students to be able to take the test linked to the continuous assessment integrated in the learning activities.
In the event that the health criteria make it necessary, the evaluation tests will be carried out following the mixed teaching format, face-to-face in the classroom and outside of it. In the most extreme case that the attendance of all students and teachers at the center is impossible or inconvenient, the evaluation tests will be developed using telematic means. In these cases, the content of the tests, being similar to the face-to-face case, can be totally or partially individualized for each student and use permitted techniques necessary to guarantee the validity of the tests that can modify the conditions and time of their completion.
In the case of a new health alert due to COVID-19 makes it impossible to carry out the evaluation in person, the remote evaluation of these same works, practical laboratory exercises and written tests is foreseen.

Observations for part-time students

Since 60% of the to total grading depends on the activities in the classroom and lab (continuous assessment and laboratory, not retrievable), the assessment criteria are the same for all students.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Sedra/Smith Microelectronic Circuits (6th edition). Oxford University Press. 2010

Behzad Razavi. Fundamentals of Microelectronics. 2nd Edition Wiley. 2013