

# COMMUNICATION ENGINEERING AND ELECTRONIC TECHNOLOGIES

(Lecce - Università degli Studi)

## Teaching MICROELECTRONIC DESIGN C.I.

GenCod A005769

Owner professor STEFANO D'AMICO

**Teaching in italian** MICROELECTRONIC DESIGN C.I.

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**SSD code** ING-INF/01

**Reference course** COMMUNICATION ENGINEERING AND ELECTRONIC

**Course type** Laurea Magistrale

**Credits** 6.0

**Teaching hours** Front activity hours: 54.0

**For enrolled in** 2019/2020

**Taught in** 2020/2021

**Course year** 2

**Language** ENGLISH

**Curriculum** PERCORSO COMUNE

**Location** Lecce

**Semester**

**Exam type** Oral

**Assessment**

**Course timetable**

<https://easyroom.unisalento.it/Orario>

### BRIEF COURSE DESCRIPTION

The course is aimed at providing principles and tools to analyze and design analog circuits in CMOS integrated technology.

### REQUIREMENTS

Fundamental bases of Analog Electronics are required.

### COURSE AIMS

After the course the student should be able to:

- 1) Describe the basic analog circuits (bandgap reference, current mirrors, differential couple, Miller opamp, class A and class AB output stages, etc...).
- 2) Evaluate the performance parameters and discuss complexity issues associated with different basic analog circuits.
- 3) Demonstrate circuit analysis capability of not standard circuits.
- 4) Understand the technology limits in circuit design.
- 5) Use the simulator to analyse performance of analog circuits.
- 6) Express properly the results of the analysis and the design of analog circuits.

### TEACHING METHODOLOGY

The Course forecasts 33 hours of theoretical lectures about technology description and fundamental circuit analysis. The theoretical concepts are verified in laboratory by using state of the art circuit simulator. 21 hours of laboratory are forecast.

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## ASSESSMENT TYPE

The final (oral) exam consists of two cascaded parts:

1. the first part is based on the discussion about a report on the assigned circuit. The circuit must be simulated at the calculator. The student is asked to learn using the simulator, to illustrate the circuit design, to evaluate the performance parameters, and to define the operation of each part of the circuit. it is aimed to verify to what extent the student has gained knowledge and understanding of the use of the circuit simulator and the circuit analysis.
2. the second part is on circuit analysis of one of the basic circuits studied during the course; it is aimed to determine to what extent the student the circuit analysis capability, ability to identify and use data to formulate responses to well-defined problems, problem solving abilities and the capacity integrate different concepts and tools.

## FULL SYLLABUS

- The MOS transistor<sup>1,2,3,4,5,6</sup> (6 ore)
  - Description of the NMOS transistor
  - Second order effects: velocity saturation of carriers and variation of the threshold voltage
  - Noise in MOS device
  - MOS transistor layout
  
- Passive components<sup>1,7</sup> (6 ore)
  - Integrated capacitors: implementation, accuracy and layout issue
  - Integrated resistors: implementation, accuracy and layout issue
  
- Analog switches<sup>1,8</sup> (6 ore)
  - Analog switches implementation
  - Charge injection and clock feedthrough
  
- Bias circuits<sup>1,9,10</sup> (6 ore)
  - CMOS current mirrors
  - Current reference
  - Voltage reference
  
- Basic gain stages<sup>1,11</sup> (9 ore)
  - Gain stages
  - Output stages
  - Level shifter
  
- Laboratory
  - Design experiences by using the circuit simulator 12 (21 ore):
    - Transistor Behaviour:
      - Coarse MOS parameter extraction
      - MOS behaviour worst case variation
      - Channel length modulation effects
      - Low-voltage current mirror design
      - V<sub>TH</sub> dependence on MOS gate length (L)
      - V<sub>TH</sub> dependence on MOS gate width (W)
      - Velocity saturation effects
    - Circuit design
      - A Low-voltage bandgap

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## REFERENCE TEXT BOOKS

1. Baschirotto, "Slides del corso"
2. S. D'Amico "Chapter 4: The MOS transistor"
3. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 7-45.
4. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 102-107.
5. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 116-130.
6. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 187-226.
7. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 108-115.
8. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 401-451.
9. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 131-175.
10. Gray, Hurst, Lewis, Mayer "Analysis and design of integrated circuits" Fourth edition, John Wiley and Sons, Inc. pages 299-332
11. Johns & Martin "Analog Integrated circuits design", John Wiley and Sons, Inc., pages 227-310.
12. A. Baschirotto, S. D'Amico "IDESA Advanced tutorial series"