

Syllabus Guide

Francesc Serra Graells

francesc.serra.graells@uab.cat

Departament de Microelectrònica i Sistemes Electrònics
Universitat Autònoma de Barcelona

paco.serra@imb-cnm.csic.es

Integrated Circuits and Systems
IMB-CNM(CSIC)

- 1 Basic Information
- 2 Objectives and Prerequisites
- 3 Theoretical Contents
- 4 Lab Exercises
- 5 Evaluation Methodology
- 6 Recommended Bibliography

1 Basic Information

2 Objectives and Prerequisites

3 Theoretical Contents

4 Lab Exercises

5 Evaluation Methodology

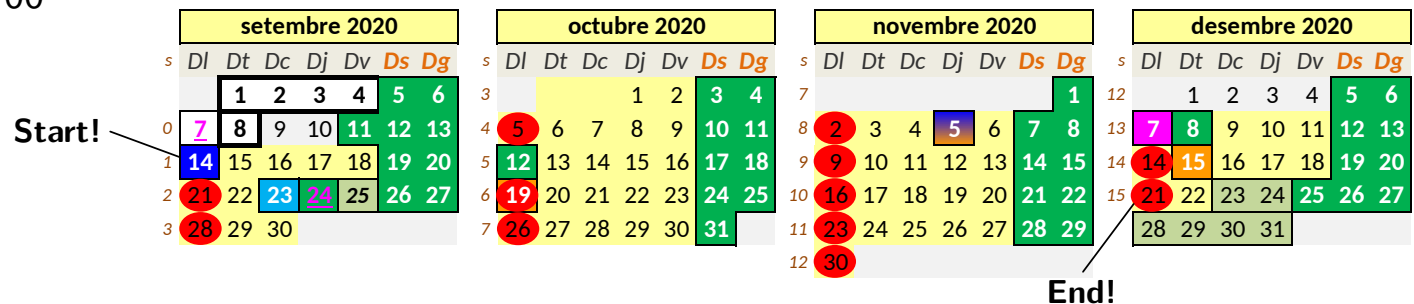
6 Recommended Bibliography

Basic Info

Who:

- Francesc Serra Graells (**theory** + **exercises** + **lab sessions**)
IMB-CNM(CSIC)
paco.serra@imb-cnm.csic.es
tel. 93 5947700

When:



Where:

- Classroom: Q2/1005
- Laboratory: **TBD**
- <http://cv.uab.cat>
- <http://www.cnm.es/~pserra/uab/damics>

- Classroom (Mondays 15:00h-18:00h)
- Laboratory (**TBD**)
- Work presentation (or remedial exam)

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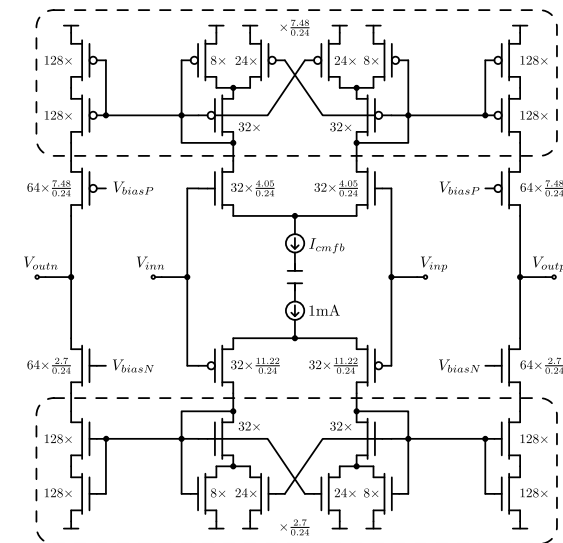
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Objectives

- Design techniques for **analog** and mixed integrated circuits in **CMOS** technologies



Specs

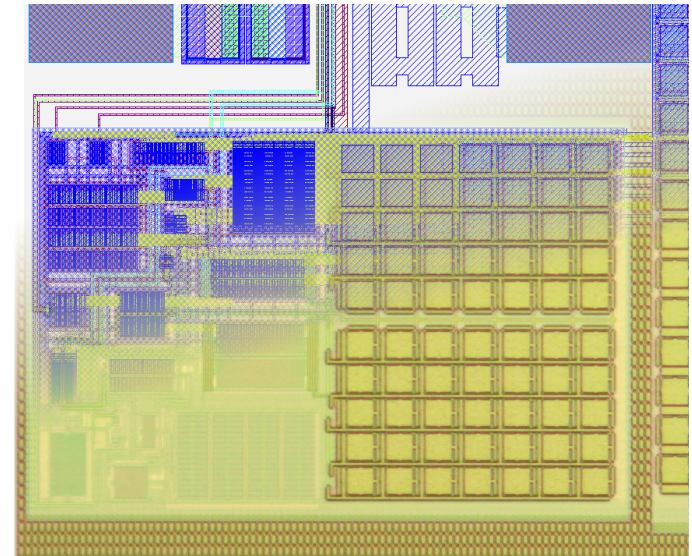
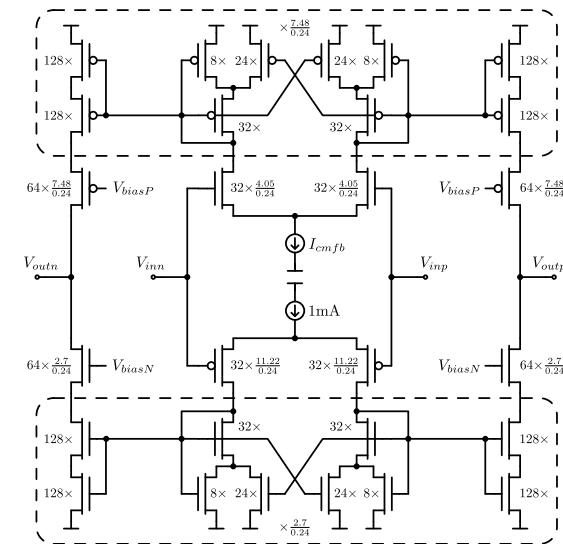


Objectives

- ▶ Design techniques for **analog** and mixed integrated circuits in **CMOS** technologies
- ▶ Design methodology and EDA tools for **full-custom** ASICs



Specs

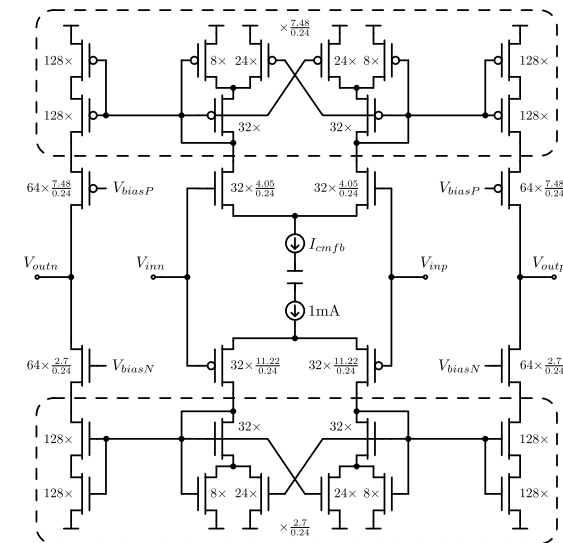


Objectives

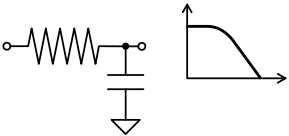
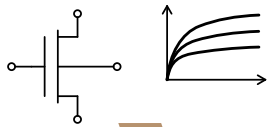
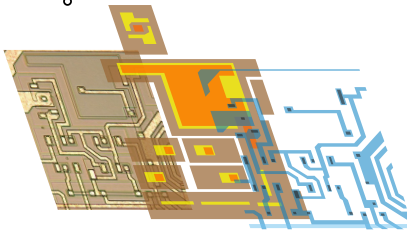
- ▶ Design techniques for **analog** and mixed integrated circuits in **CMOS** technologies
- ▶ Design methodology and EDA tools for **full-custom** ASICs

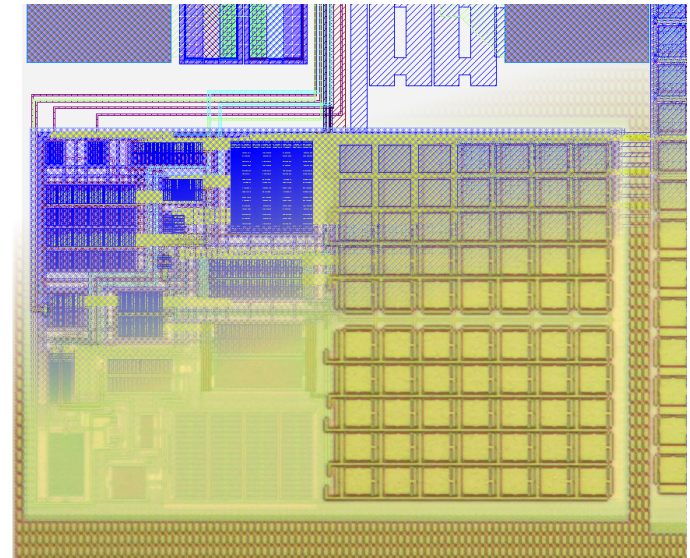


Specs



Prerequisites

- ▲ Circuit theory 
- ▲ Electronic devices 
- ▲ Microelectronics technology 



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Theory Contents

1 Introduction to the Design of Analog Integrated Circuits

- 1.1 From the Idea to the Chip
- 1.2 Microelectronic vs Electronic Design
- 1.3 CMOS Technologies
- 1.4 Device Modeling
- 1.5 The Operational Amplifier and its FoMs
- 1.6 Lab Proposal: My OpAmp in CNM
2.5 μ m CMOS Technology (CNM25)

2 Single Stage OpAmps

- 2.1 The Mono-Transistor Amplifier
- 2.2 Differential Topologies
- 2.3 Common Mode Feedback
- 2.4 Folded Amplifiers
- 2.5 Cascode Topologies
- 2.6 Gain Enhancement Techniques

3 Multi-Stage OpAmps

- 3.1 Two-Stage Topologies
- 3.2 Miller Effect
- 3.3 Frequency Compensation
- 3.4 Design Space

4 Full-Custom Analog Design Methodology

- 4.1 Device Sizing
- 4.2 Process and Mismatching Simulation
- 4.3 The Art of Analog Layout
- 4.4 Physical Verification
- 4.5 Parasitics Extraction
- 4.6 DFM Techniques

Theory Contents

(Seminar: **Lab Exercices in CNM25**)

5 Low-Power OpAmps

- 5.1 Low-Voltage vs Low-Current
- 5.2 Subthreshold Operation
- 5.3 Class-AB Output Stages
- 5.4 Rail-to-Rail Topologies
- 5.5 Inverted-Based Pseudo-Differential
Multi-Stage Architectures

6 OpAmp Application Examples

- 6.1 Pre-Amplification
- 6.2 MRC-Amplifiers for AGC
- 6.3 Continuous-Time Gm-C Filters
- 6.4 Switched-Capacitor Filters

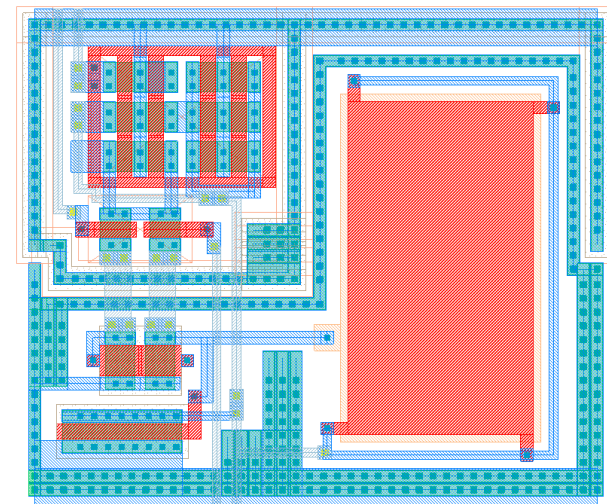
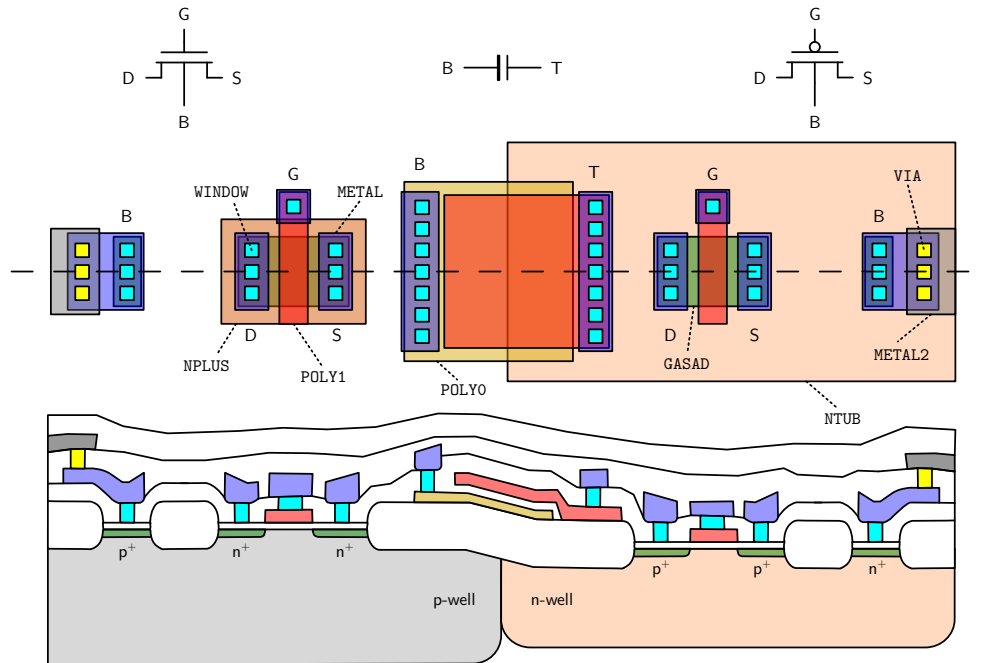
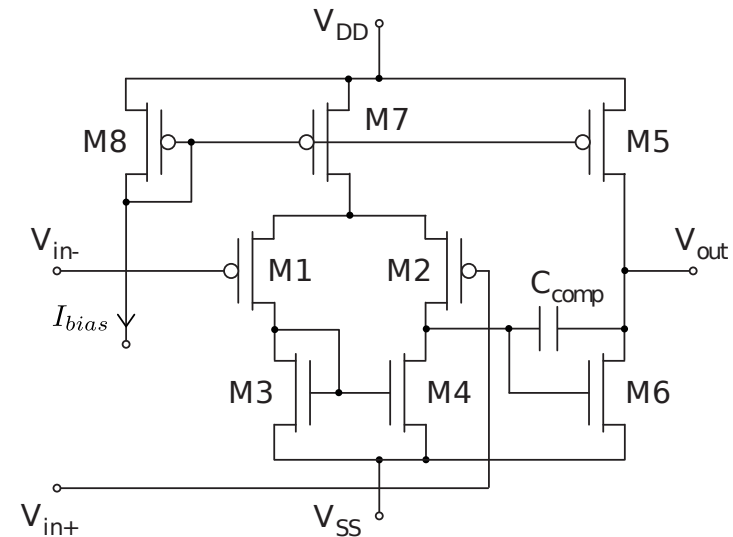
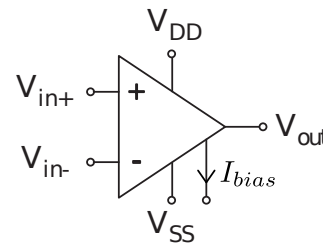
7 Integrated Data Converters

- 7.1 ADC vs DAC
- 7.2 Flash Architectures
- 7.3 SAR Topologies
- 7.4 Integrating Solutions
- 7.5 Delta-Sigma Modulators

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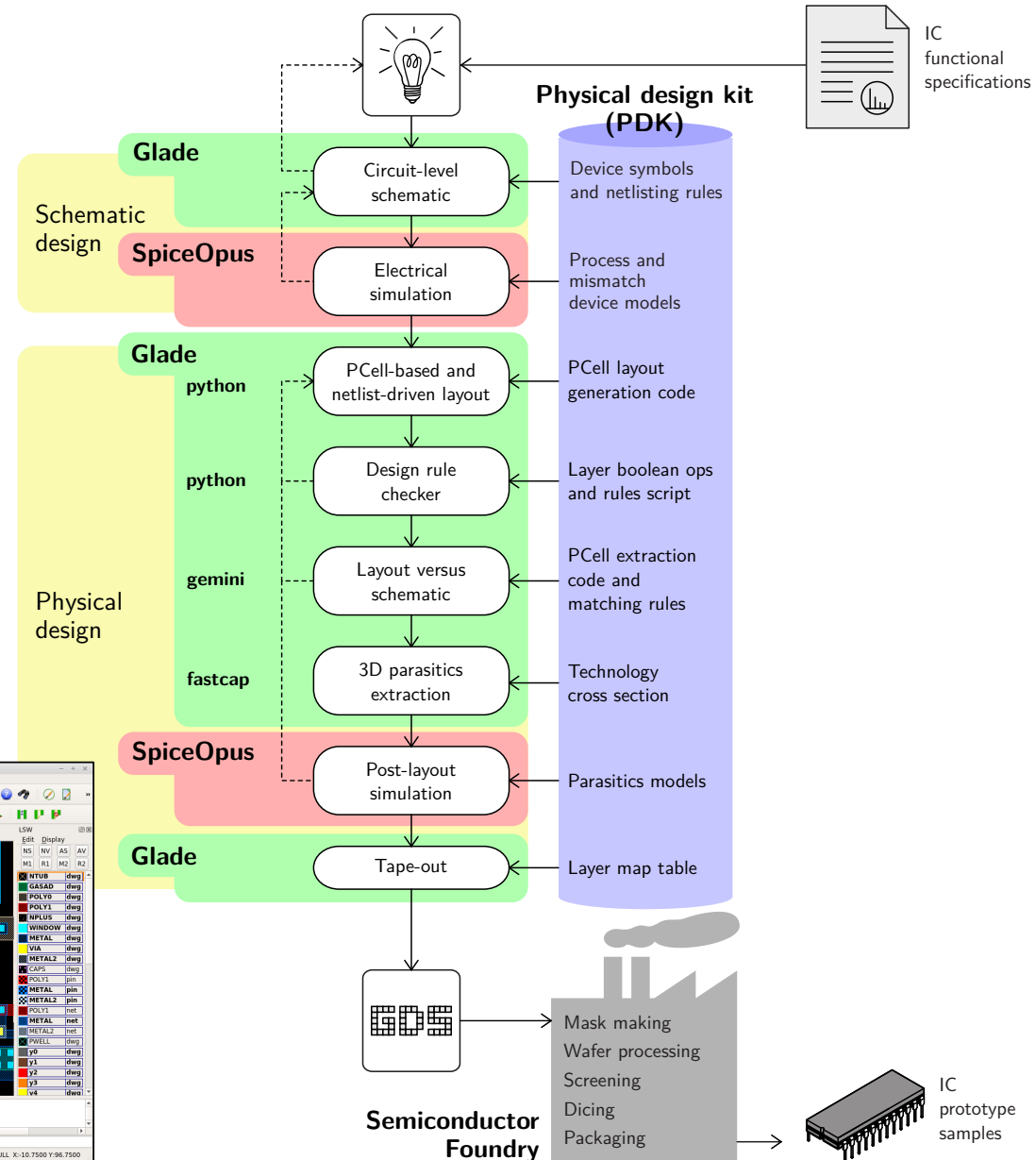
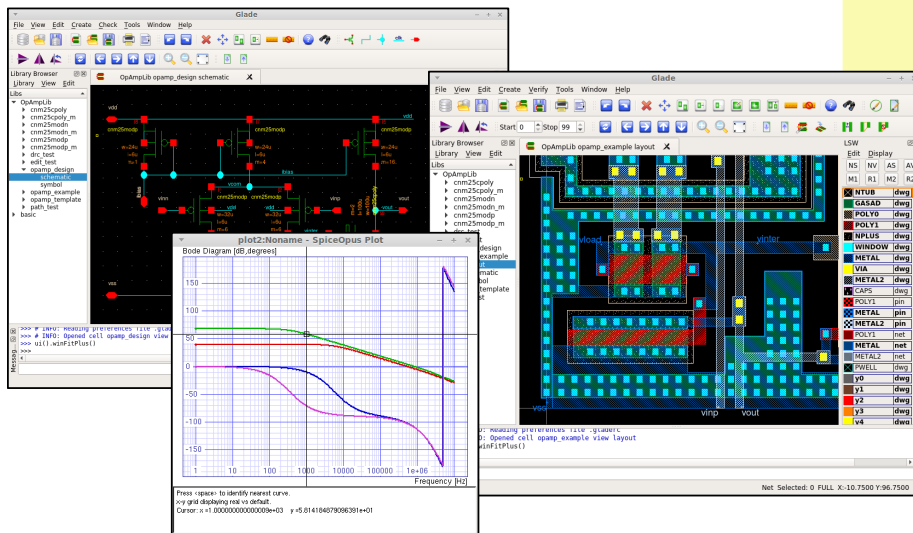
Lab Exercises

- ▶ Two-stage Miller **OpAmp** design case
- ▲ **Simple** 2.5 μm 2P2M CMOS technology (CNM25)



Lab Exercises

- ▶ Two-stage Miller **OpAmp** design case
- ▲ **Simple** 2.5 μm 2P2M CMOS technology (CNM25)
- ▲ **Freeware** and **multi-OS** (MS Windows, Linux) full-custom EDA tools
- ▲ Work at **home** and tutorial at **lab...**



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Evaluation Methodology

► If $Q_{\text{work,lab}} \geq \frac{3}{10}$:

homework exercises

$$Q_{\text{overall}} = 0.1Q_{\text{exercises}} + 0.4Q_{\text{lab}} + 0.5Q_{\text{work}}$$

else or if $Q_{\text{overall}} < \frac{5}{10}$:

$$Q_{\text{overall}} = 0.1Q_{\text{exercises}} + 0.4Q_{\text{lab}} + 0.5Q_{\text{exam}}$$

▲ **Distributed** weights

▲ **Continuous** evaluation

▲ **No exam** need to be passed

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Recommended Bibliography

- ▲ Self-contained theory in slides
- ▲ Practical problems solved at classroom
- ▲ Hands-on lab exercises

 <http://www.aicdesign.org>

► **Additional** reference material:

- P. E. Allen and D. R. Holberg, *CMOS Analog Circuit Design*, Oxford University Press
- B. Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill Education
- F. Maloberti, *Analog Design for CMOS VLSI Systems*, Kluwer Academic Publishers
- T. Tuma and A. Burmen, *Circuit Simulation with SPICE OPUS: Theory and Practice*, Modeling and Simulation Science, Engineering and Technology, Birkhäuser Boston
- A. Hastings, *The Art of Analog Layout*, Pearson Prentice Hall

