Course Guide

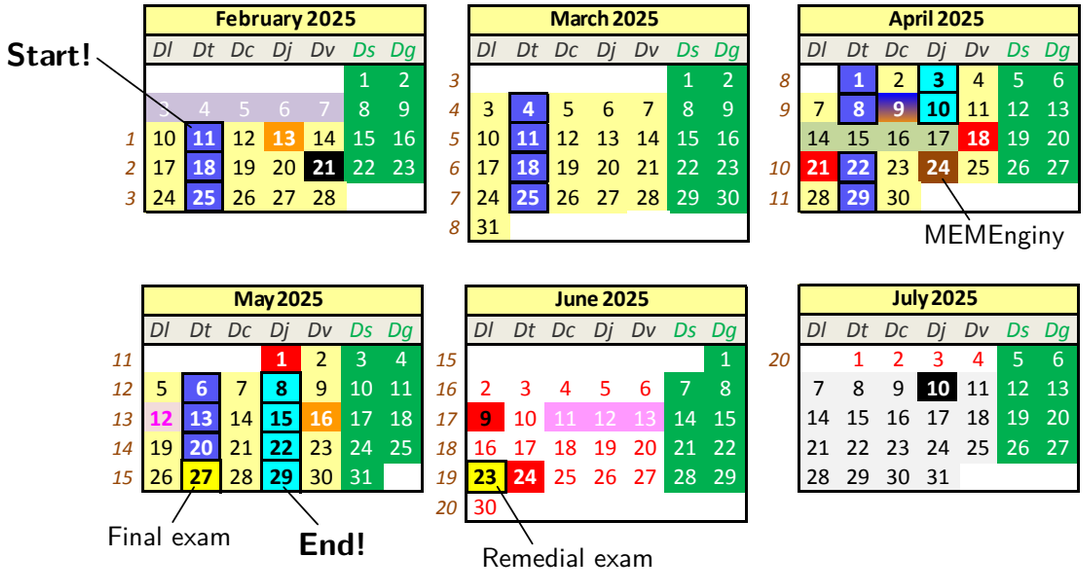
Francesc Serra Graells

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)

Basic Info

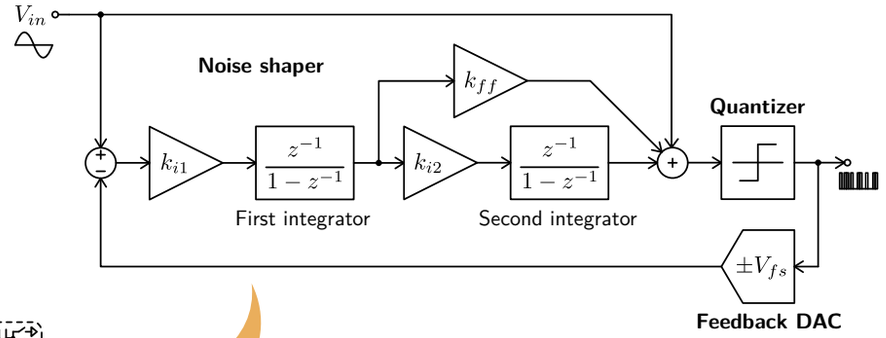
- **Who**:
  - Francesc Serra Graells
    IMB-CNM(CSIC)
    paco.serra@imb-cnm.csic.es
    tel. 935 947 700
  - Stepan Sutula
- **Where**:
  - Classroom: Seminari B
  - Laboratory: Q5/2005
  - `https://cv.uab.cat`
  - `http://www.cnm.es/users/pserra/uab/ihsd`
- **When**:

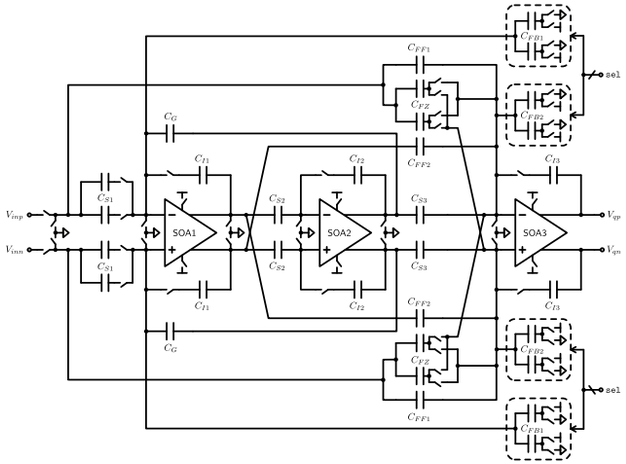


  - Classroom Tuesdays 15:00h-17:00h
  - Laboratory Thursdays 17:00h-19:00h
  - Final exam May 27th 15:00h
  - Remedial exam June 23rd 15:00h

Objectives

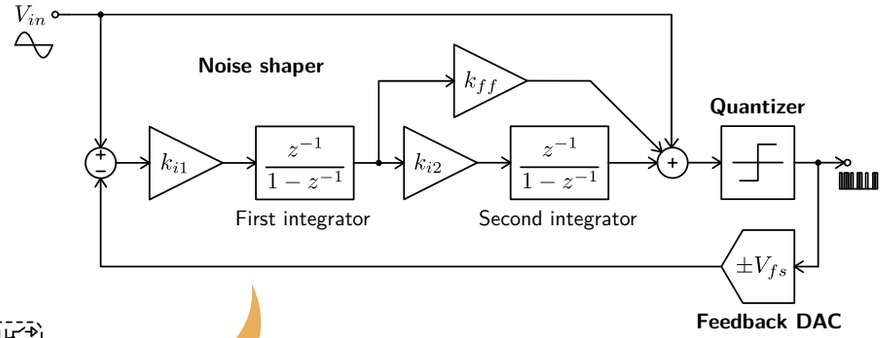
- Design techniques for **A/D** and **D/A converters** in **CMOS** technologies

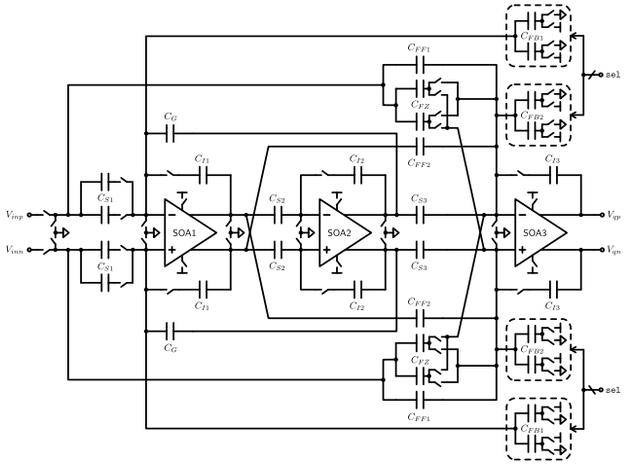


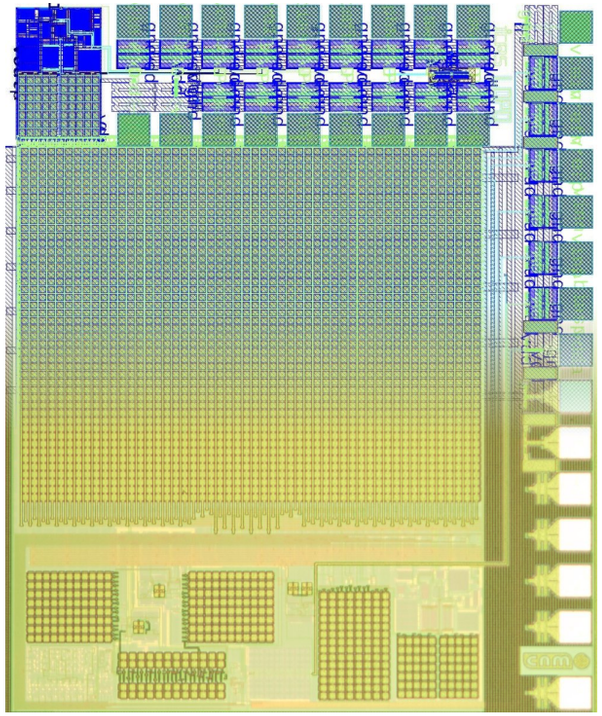


Objectives

- Design techniques for **A/D** and **D/A converters** in **CMOS** technologies
- Design methodology and EDA tools for **mixed-signal** and **full-custom** ASICs





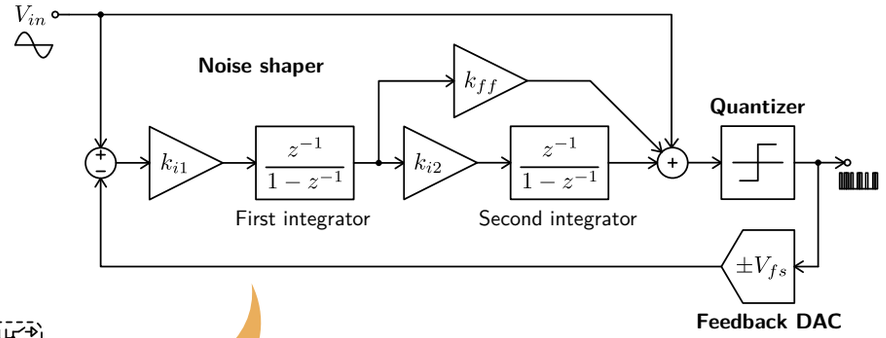


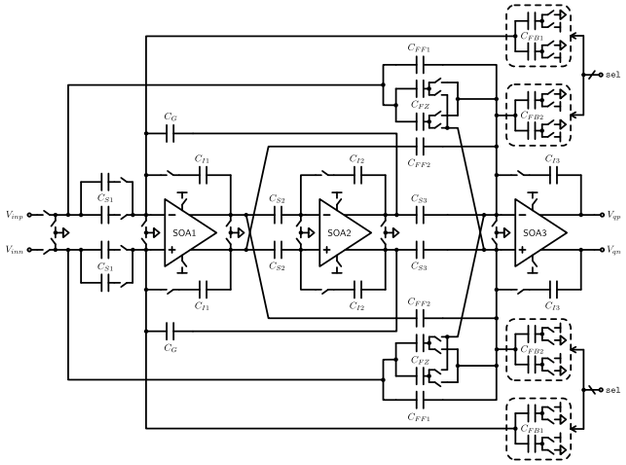
Objectives

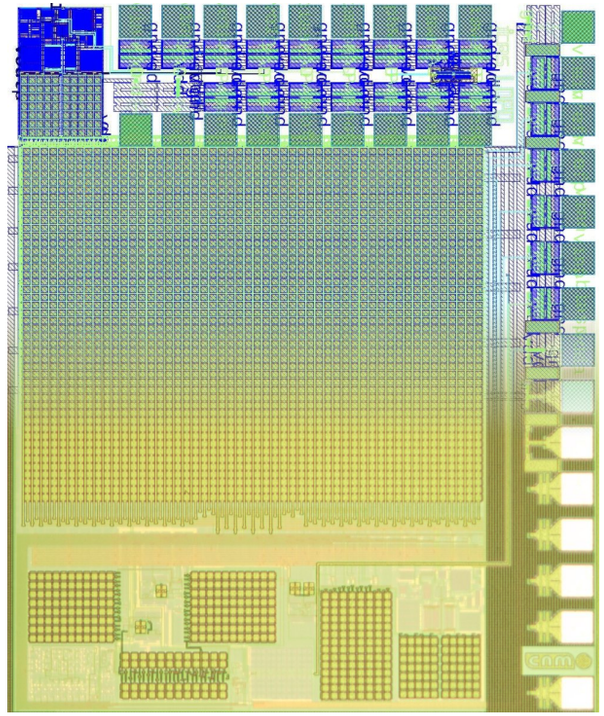
- Design techniques for **A/D** and **D/A converters** in **CMOS** technologies
- Design methodology and EDA tools for **mixed-signal** and **full-custom** ASICs

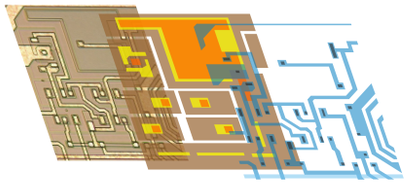
Prerequisites

- Signal processing
- Circuit theory
- Electronic devices
- Analog CMOS design
- Microelectronics technology









Theory Contents

1 Introduction to Integrated Heterogeneous Systems

- 1.1 Evolution of CMOS Technologies
- 1.2 Trends in Analog and Mixed IC Design
- 1.3 A/D and D/A Conversion Principles
- 1.4 ADC and DAC Figures of Merit
- 1.5 Lab Proposal: My Delta-Sigma ADC in 2.5µm CMOS Technology (CNM25)

2 ADC Architectures and CMOS Circuits

- 2.1 ADC Classification
- 2.2 Flash Converters
- 2.3 Sub-Ranging, Time-Interleaving and Pipelining
- 2.4 Successive-Approximation Converters
- 2.5 Integrating Techniques
- 2.6 Delta-Sigma Modulation
- 2.7 Time-Domain Converters

3 DAC Architectures and CMOS Circuits

- 3.1 DAC Classification
- 3.2 Flash Converters
- 3.3 Pulse-Width Modulation
- 3.4 Delta-Sigma Modulation

4 Full-Custom IC Design Methodology

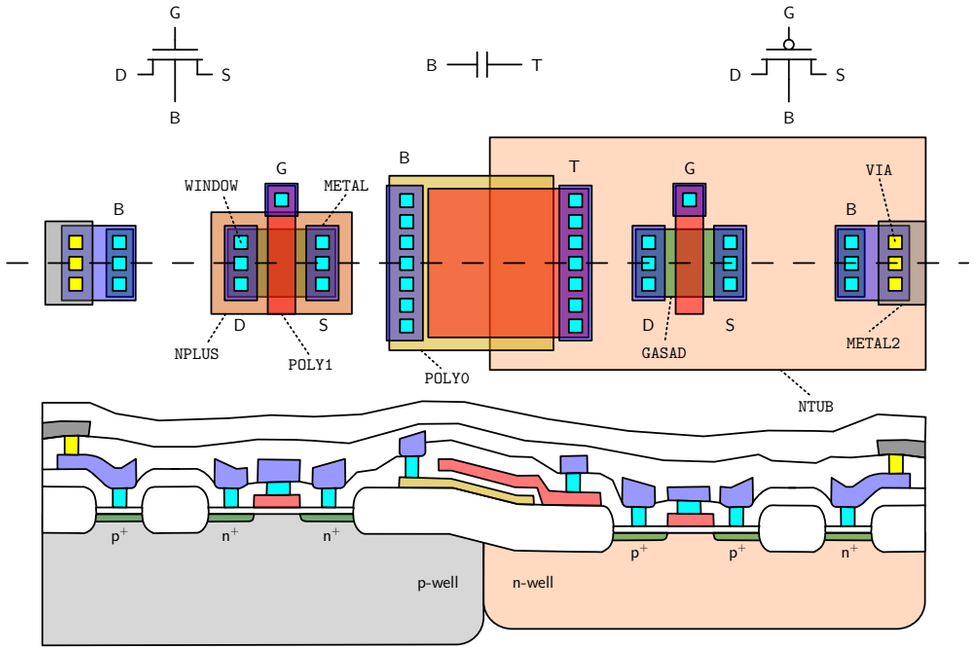
- 4.1 Mixed-Signal Design Flow
- 4.2 AMS Hardware Description Languages
- 4.3 Device Sizing
- 4.4 Process and Mismatching Simulation
- 4.5 The Art of Analog Layout
- 4.6 Physical Verification
- 4.7 Parasitics Extraction
- 4.8 DFM Techniques

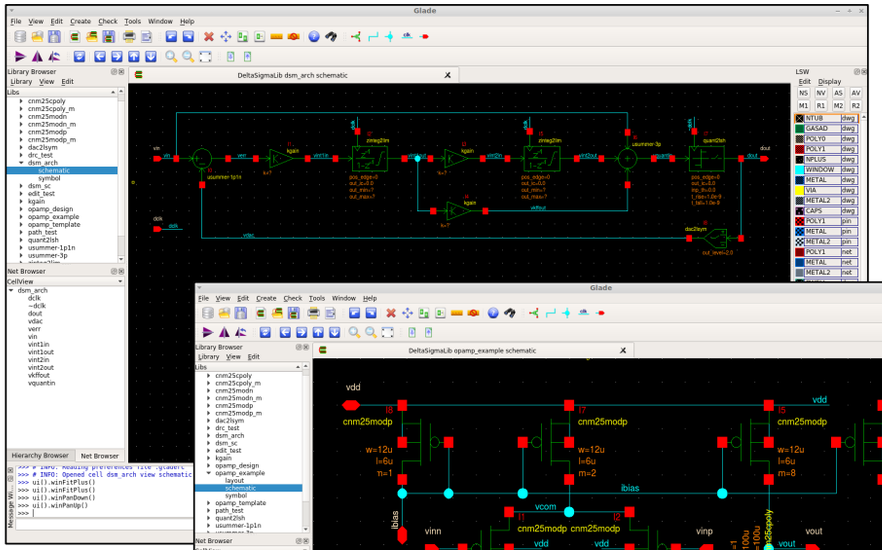
(Seminar: **Lab Exercises in CNM25**)

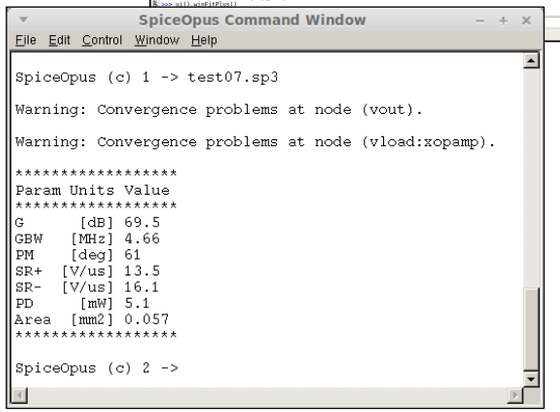
Theory Contents

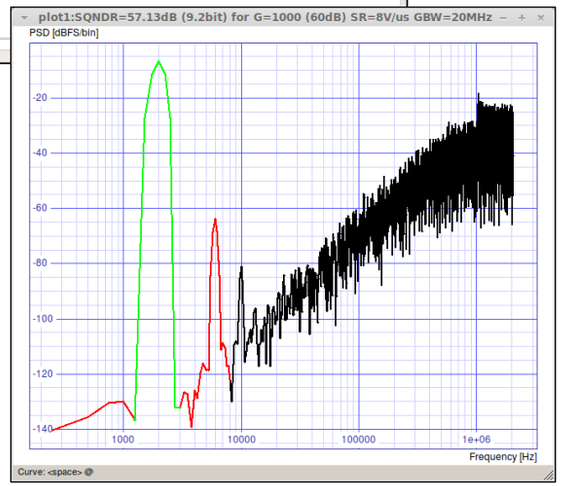
Lab Exercises

- Second-order single-bit A/D **ΔΣ modulator** design case
- **Simple** 2.5µm 2P2M CMOS technology (CNM25)



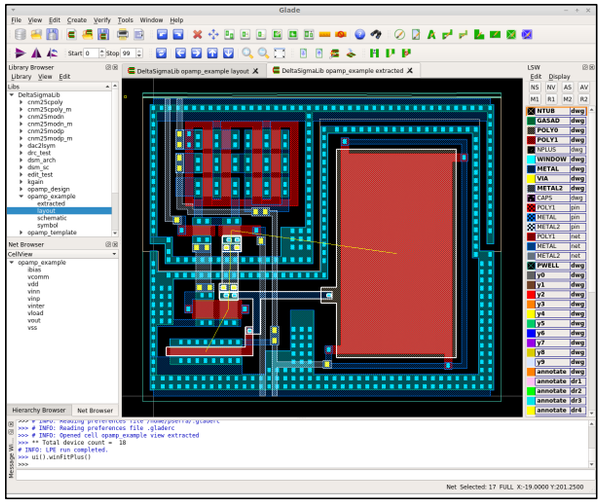




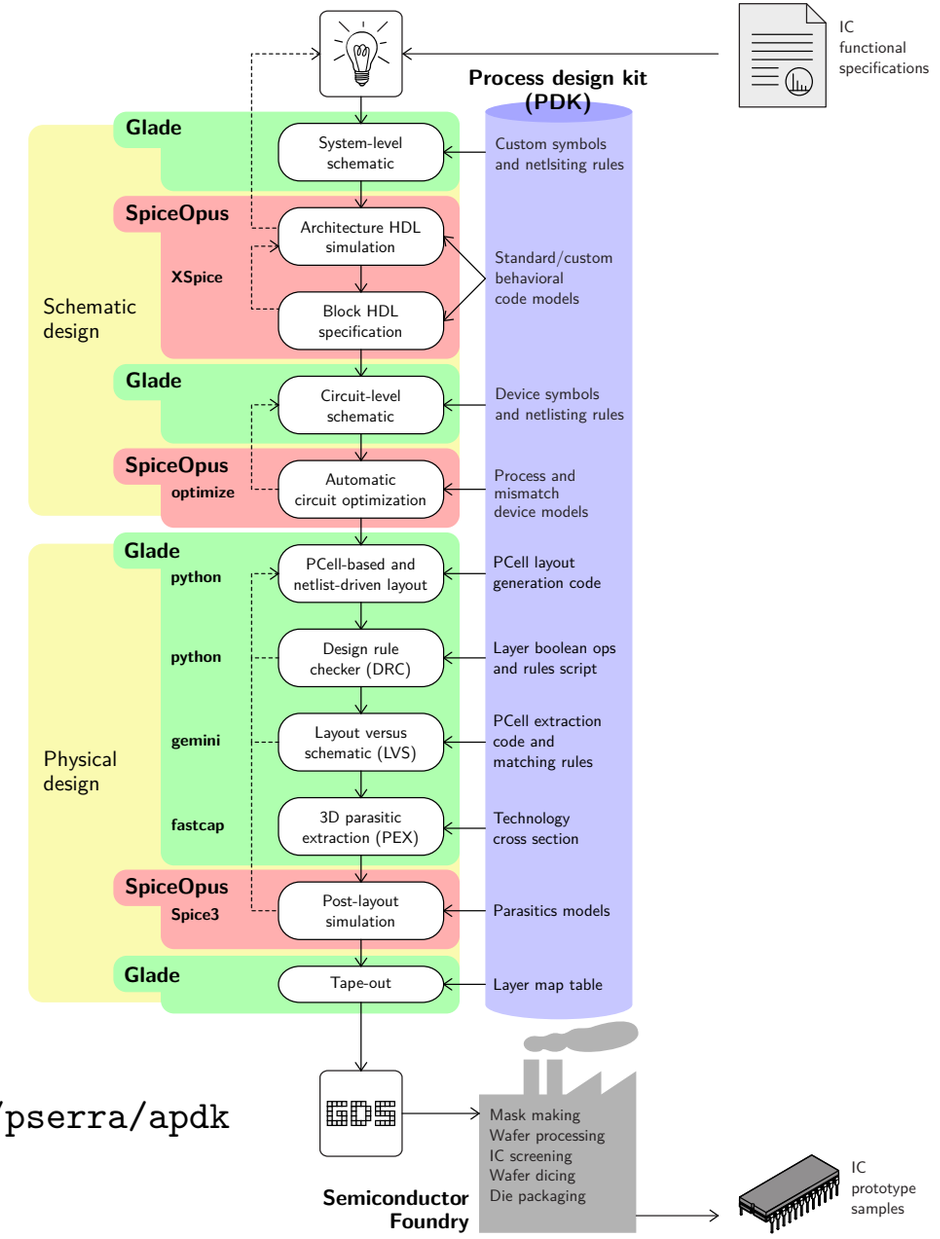


Lab Exercises

- Second-order single-bit A/D **ΔΣ modulator** design case
- **Simple** 2.5µm 2P2M CMOS technology (CNM25)
- **Freeware** and **multi-OS** (MS Windows, Linux) EDA tools
- Work at **home** and tutorial at **lab**...



- `http://www.cnm.es/users/pserra/apdk`



Evaluation Methodology

- If $Q_{\text{exams,lab}} \geq \frac{4}{10}$:

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

homework exercises

mandatory activities

$$Q_{\text{exams}} = \max\left(Q_{\text{exam1}}, 0.8Q_{\text{exam2}}\right)$$

remedial exam

- ▲ **Distributed** weights
- ▲ **Continuous** evaluation
- ▲ **Second** opportunity to pass exam
- ▼ **Hard work** to obtain top marks

Recommended Bibliography

- Self-contained theory in slides
- Practical problems solved at classroom
- Hands-on lab exercises
- **Reference** material:
  - R. van de Plassche, *CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*, Kluwer Academic Publishers
  - R. Schreier and G. C. Temes, *Understanding Delta-Sigma Data Converters*, John Wiley & Sons
  - V. Peluso, M. Steyaert and W. Sansen, *Design of Low-Voltage and Low-Power CMOS Delta-Sigma A/D Converters*, Kluwer Academic Publishers
  - F. Medeiro, A. Pérez-Verdú and A. Rodríguez-Vázquez, *Top-Down Design of High-Performance Sigma-Delta Modulators*, 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

Recommended Bibliography

- **Additional** references for those students lacking of some background:

Signal Processing

- A.V. Oppenheim, *Signals and Systems*, Prentice Hall
- A.B. Carlson, *Communication Systems*, McGraw Hill
- H. Baher, *Analog & digital signal processing*, John Wiley

Circuit Theory & Electronic Devices

- A.B. Carlson, *Teoría de circuitos*, Thomson-Paraninfo
- D.E. Scott, *Introducción al análisis de circuitos*, McGraw Hill
- J.D. Irwin, *Análisis básico de circuitos en Ingeniería*, Prentice Hall Hispanoamericana
- L.O. Chua, *Linear and non linear circuits*, McGraw Hill
- R.C. Dorf, J.A. Svoboda, *Introduction to electric circuits*, John Wiley & Sons
- A.R. Hambley, *Electrónica*, Prentice Hall
- C.J. Savant Jr., M.S. Roden, G.L. Carpenter, *Diseño Electrónico, Circuitos y sistemas*, Prentice Hall
- R. Boylestad, L. Nashelsky, *Electronic Devices and Circuit Theory*, Prentice Hall

Microelectronics Technology & VLSI Design

- P.E. Allen, D.R. Holberg, *CMOS analog circuit design*, HRW Series in Electrical and Computer Engineering
- B. Razavi, *Design of analog CMOS integrated circuits*, McGraw-Hill
- M. N. Horenstein, *Microelectrónica: circuitos y dispositivos*, Prentice-Hall
- J. Millman, A. Grabel, *Microelectrónica*, Ed. Hispano Europea
- R.J.Baker, H.W. Li, D.E. Boyce, *CMOS circuit design, layout, and simulation*, IEEE Press Series on Microelectronic Systems
- R.L. Geiger, P.E. Allen, N.R. Strader, *VLSI design techniques for analog and digital circuits*, McGrawHill
- N.H.E. Weste, K. Eshraghian, *Principles of CMOS VLSI design a systems perspective*, Addison-Wesley
- J.P.Uyemura, *Introduction to VLSI circuits and systems*, John Wiley and Sons