ELEN 610: Data Converters

Instructor: Sebastian Hoyos
Office: 318 G. WERC
Phone/email: (979) 862-4253/hoyos@ece.tamu.edu
Office Hours: Tu/Th 11:00-12:00 AM
TA: Pradeep Kotte

Spring 2007
Time: M/W/F 12:40 – 1:30 p.m.
Location: ZACH 223A

Course Description

Filters, analog-to-digital converters (ADCs) and digital-to-analog converters (DACs) represent fundamental mixed-signal building blocks of integrated circuits widely used in signal processing, communications and networks applications. The ever increasing bandwidths and data rates of these applications have made the design of theses blocks extremely challenging. Besides explaining the details of the classical systems and circuit structures used for the design of these blocks, this course also introduces some advance signal processing techniques that are currently pushing the performance envelope of the mixed-signal interfaces. Both bipolar and CMOS technology will be used in the circuit diagrams but the course will make emphasis on CMOS for homeworks and projects.

Course Outline

1. Sampled-data signal processing (~2 hrs)
2. Review of switched-capacitor filters (~2 hours)
   - Analog integrator, biquad, ladder, antialiasing filters.
3. Non-filtering applications of SC circuits (~1 hrs)
4. Nyquist-rate data converters (~13 hrs)
   - D/A, Flash, algorithmic, SAR, folding & interpolating, and pipeline A/Ds.
5. Oversampled data converters (~10 hrs)
   - 1st-order, higher-order, multi-bit, continuous-time, and bandpass ΣΔ modulators, decimation filters, and D/A
6. Parallel Paths ADCs (~3 hrs): Time Interleaving, Signal Expansion ADCs, Frequency Domain ADCs
7. Precision techniques (~7 hrs)
   - Offset cancellation, digital redundancy, ratio-independent techniques, and analog/digital calibration and error correction.

References

No textbook required. But the following reference books can be useful.

[1] *Low-Voltage Low Power Integrated Circuits*, E. Sánchez-Sinencio , A. Andreou, IEEE Press,1999.
[2] A.B. Grebene. *Bipolar and MOS Analog Integrated Circuit Design*, John Wiley &Sons, Inc., New York 1984.
[3] B. Razavi, *Principles of Data Conversion*
Gregorian et al*., Analog MOS Integrated Circuits for Signal Processing*, Wiley, 1986.

[4] Razavi, *Principles of Data Conversion System Design*, IEEE Press, 1995.
[5]P.E. Allen and E. Sánchez-Sinencio, *Switched Capacitor Circuits*, Van Nostrand Reinhold, New York 1984.
[6]van de Plassche, *CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters*, Kluwer, 2003.
[7]Norsworthy et al., *Delta-Sigma Data Converters: Theory, Design, and Simulation*, Wiley, 1996.
[8]Gray, et al., *Analysis and Design of Analog Integrated Circuits (4th Ed.)*, Wiley, 2001.
[9]Rodríguez-Vázquez, Medeiro, Janssens, CMOS Telecom Data Converters, Kluwer
[10]Schreier, Temes, Understanding Delta-Sigma Data Converters, Wiley-IEEE Press

CAD Tools

MATLAB, Simulink: Mixed-signal modeling in simulink and plain m-file, analog/digital filter synthesis, etc.

- Spectre RF

  SPICE-type analyses: .dc, .ac, .xf, .noise, .tran, and etc.

  Additional capabilities: pss, pac, pxf, pnoise, pdisto to analyze large-signal nonlinear circuits (e.g., switched-apacitor circuits, RF circuits).

- awd, ocean, icfb, msfb, icde, icms, and etc.

  Cadence GUI suite for design entry, layout, waveform display, and etc.

- Eldo for noise transient analysis.

Helpful Links

- Affirma Spectre RF Simulator User Guide (v446)
- Affirma Spectre RF Simulator Theory (v446)
- HSPICE Manual
- Berkeley SPICE User's Guide

Grading Policy

- Homeworks: 15% Biweekly
- Lab: 10%
- Midterm: 20% In class.
- Term Project: 25% Assigned after midterm.
- Proj. Presentation: In class.
- Final Exam: 30% University schedule