EEE 232 – Key Mixed-Signal Integrated Circuit Building Blocks

Elective Course **Date:** 2/27/07

Microelectronic Design area

Course Coordinators: Perry L Heedley and Thomas W Matthews

Catalog Description: This course covers the key mixed-signal integrated circuit building blocks most often used in modern ICs. Topics covered include data converter fundamentals, comparators, and important circuit architectures for Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs) and Phase-Locked Loops (PLLs). 3 units.

Prerequisites: EEE 230 or consent of the instructor.

Text: "Analog Integrated Circuit Design" by David Johns and Ken Martin, John Wiley & Sons, Inc. 1997

Additional Resources (optional):
"Analysis and Design of Analog Integrated Circuits" by Paul Gray and Robert Meyer, John Wiley & Sons, Inc.
"Design of Analog CMOS Integrated Circuits" by Behzad Razavi, McGraw Hill 2001

Course Objectives: This class covers the key circuits most important to modern mixed-signal integrated circuits, such as Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs) and Phase-Locked Loops (PLLs). Multiple architectures are explored for each type of circuit, focusing on the advantages of each for different applications and the tradeoffs that designers typically have to make among competing effects. Both the underlying concepts for each type of circuit and specific design examples are covered, providing students with the tools they need to tackle real designs for these complex mixed-signal building blocks.

Prerequisites by Topic:

1. BJT and MOS device models
2. Single-stage and differential amplifiers
3. Current sources and active loads
4. Operational amplifiers at the transistor level, including frequency response and compensation
5. Fully-differential circuits
6. Sampling and discrete time circuits

Topics Covered:

1) Data converter fundamentals such as quantization noise and linearity
2) Analysis and design of comparators
3) Analysis and design of Analog-to-Digital Converters (ADCs)
4) Analysis and design of Digital-to-Analog Converters (DACs)
5) Analysis and design of Phase-Locked Loops (PLLs)

Evaluation: Student performance will be evaluated using the following: Exams (60%), Projects (30%), and Homework (10%). Projects will be assigned to reinforce and expand upon classroom discussions. Typical projects include the design of key circuits used in ADCs, DACs and PLLs, such as high speed comparators, sample-and-hold amplifiers, voltage-controlled oscillators and charge pumps.

EEE 232 Course Outline/Schedule

Week	Topics
1-2	Course introduction, data converter fundamentals, quantization noise, differential and integral non-linearity
3	Comparators, open-loop vs latching architectures, hystersis
4-7	Analog-to-Digital Converters (ADCs): successive-approximation, dual-slope, Flash architectures, folding and interpolation, Pipelined and algorithmic architectures
8	Review, Mid-Term Exam
9-11	Digital-to-Analog Converters (DACs): current steered, charge-redistribution, dynamic element matching and calibration
12-14	Phase-Locked Loops (PLLs): basic concepts, linearized loop analysis, phase detectors and charge pumps, ring oscillator and LC tank VCOs
15	High-speed data communications, Review for Final Exam