ESE # 366
Design using Programmable Mixed-Signal Systems-on-Chip
Semester Spring 2011

2010-2011 Catalog Description: This course focuses on development of mixed-signal embedded applications that utilize systems on chip (SoC) technology. The course discusses design issues, such as (i) implementing functionality, (ii) realizing new interfacing capabilities, and (iii) improving performance through programming the embedded microcontroller and customizing the reconfigurable analog and digital hardware of SoC.

Course Designation: Elective

Text Books: A. Doboli, E. Currie, "*Introduction to Mixed-Signal Embedded Design*", ISBN: 978-0-9814679-0-0, 2008

Prerequisites: ESE 380, ESE 372, and ESE 224 or CSE230

Coordinator: Dr. Alex Doboli

Goals:
This course focuses on development of mixed-signal embedded applications that utilize Systems On Chip (SoC) technology. The course discusses design issues, such as (i) implementing new functionality, (ii) realizing new interfacing capabilities, and (iii) improving performance through programming the embedded microcontroller and customizing the reconfigurable analog and digital hardware of the SoC.

Objectives:
At the end of the course, students will possess theoretical and applied knowledge and design skills related to three main aspects:
- Utilization of a combination of analog and digital modules, as well as, writing software drivers for interfacing new devices.
- System-level design including specification, profiling, debugging, and trade-off exploration/optimization for mapping the system behavior to specific building blocks.
- Architecture customization (through analog and digital dynamic reconfiguration) for implementing new functionality and obtaining better performance is also treated.

Topics Covered:

Week 1-2.	Introduction: Types of embedded applications, simple mixed-signal embedded design example, importance of performance requirements for design, summary of mixed-signal embedded architectures, top-down design flow (Design refinement. Performance modeling. Testing).

Week 2-4.	Mixed-signal embedded SoC architecture: mixed-signal SoC architecture structure, microcontroller core, instruction set, memory system, interrupts, I/Os, ISR and drivers.
Week 5-7.	Digital subsystem: principles of RTL (Register Transfer Level) design, basic digital building blocks (timers, counters, CRC generator), dynamic reconfiguration, developing simple application specific co-processors using dynamic reconfiguration.
Week 8-9.	System level trade-off analysis: system performance modeling, trade-off curves, trade-off analysis (cost – speed – power/energy consumption – number of pins), system optimization.
Week 10-11	Analog building blocks: basics of switched capacitor analog circuits, presentation of basic building blocks (ideal op amps, comparators, gain stages, integrators.
Week 12-13	Analog filters and analog to digital converters: filter characteristics, filter types, circuit non-idealities and their impact on performance, ADC characteristics. ΔΣ ADC. ADC implementation.

* More detail can be added as needed.

Class/laboratory Schedule: Lecture: 1hr 20min/2 days per week
Lab: 3 hr/1 day per week

Document Prepared by: Dr. Alex Doboli
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