

**State University of New York at Stony Brook
Department of Electrical and Computer Engineering**

ESE 575 Advanced VLSI Signal Processing Architecture (Spring 2008)

COURSE INFORMATION

Instructor: Professor Sangjin Hong
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Office: 217 Light Engineering Building
Office Hour: Monday and Thursday 2:00 pm – 4:00 pm, or by appointment

Course Homepage:
<http://www.ece.sunysb.edu/~snjhong/ese575/ese575.html>

Time and Place:
Lecture – Wednesday 2:15 pm – 5:15 pm, P123 Physics Building

Description

This course is concerned with advanced aspects of VLSI architecture in digital signal processing and wireless communications. The first phase of the course covers the derivation of both data transformation and control sequencing from a behavioral description of an algorithm. The next phase reviews the general purpose and dedicated processor for signal processing algorithms. This course focuses on low-complexity high-performance algorithm development and evaluation, system architecture modeling, power-performance tradeoff analysis. The emphasis is on the development of application-specific VLSI architectures. An advanced experimental/research project is required.

Objective

The goal of this course is to span entire design hierarchy from algorithm design to integrated circuit layout using a mix of tools such as MATLAB (algorithm design), Verilog or VHDL (architecture), SYNOPSISYS (logic), and CADENCE (circuit). Automated synthesis and place & route tools will be employed extensively so that the design emphasis in this course will be at the algorithmic and architectural levels.

Prerequisites

1. VLSI System Design (ESE 355) or equivalent. All students are expected to be familiar with CMOS integrated circuit design, and to have carried out the design of a medium scale integrated circuit. Experience with Verilog, Synopsys, and Cadence or Mentor Graphics design automation tools is helpful.
2. Digital Signal Processing (ESE 305 or ESE 337) or equivalent.
3. Communications Theory (ESE 306 or ESE 340) or equivalent.
4. Embedded Digital System Design (ESE 380) or equivalent.

Textbook

1. Lecture notes and research papers.
2. K. K. Parhi, *VLSI Digital Signal Processing Systems: Design and Implementation*, John Wiley and Sons, 1999.

Pertinent Literature

1. *IEEE Transactions on VLSI Systems*
2. *IEEE Micro*
3. *ISD (Integrated System Design)*
4. *IEEE Journal of Solid-State Circuits*
5. *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*
6. *IEEE Design and Test*
7. *IEEE Transactions on Circuits and Systems*
8. *IEEE Transactions on Electron Devices*
9. *Conference on Advanced Research in VLSI*
10. *IEEE Solid-State Circuits Conference*
11. *Design Automation Conference*
12. *IEEE Custom Integrated Circuits Conference*
13. *International Symposium on Circuits and Systems*
14. *International Conference on Computer-Aided Design*

List of Topics

1. DSP Algorithm Design - DSP representations (data-flow, control-flow, and signal-flow graphs, block diagrams), fixed-point DSP design (A/D precision, coefficient quantization, round-off and scaling), filter structures (recursive, non-recursive and lattice), algorithmic simulations of DSP systems in C and MATLAB, behavioral modeling in VHDL. System modeling and performance measures.
2. Circuits and DSP Architecture Design - Fast filtering algorithms (Winograd's, FFT, short-length FIR), retiming and pipelining, block processing, folding, distributed arithmetic architectures, VLSI performance measures (area, power, and speed), structural modeling in VHDL. Analog signal processing for fast operation. Impact of non-ideal characteristics of analog functional blocks on the system performance.
3. DSP Module Synthesis – High performance arithmetic unit architectures (adders, multipliers, dividers), bit-parallel, bit-serial, digit-serial, carry-save architectures, redundant number system, modeling for synthesis in VHDL, synthesis via SYNOPSIS, place-and-route via CADENCE.

Homework, Exams and Grading

VLSI Signal Processing System design cannot be mastered without experience, so the lectures in this course are all related to the term project. All projects (basic and advanced) will include design reviews, a comprehensive written report and a final oral presentation. Written and oral reports will be graded on writing and presentation quality as well as technical content. It is imperative that students begin work on the advanced project at the beginning of the term in order to complete it.

One midterm exam will be given late in the term; the final oral and written reports will take the place of a final exam. Grading will be as follows:

Midterms, Final Exam: 60%

Advanced Project: 40% - Flexible topics