

## ECEC 490-001 Introduction to VLSI Design

Fall 2007

Dr. Baris Taskin

This is an introductory course in the field of Very Large Scale Integration (VLSI) circuit and systems design. Systematic understanding, design and analysis of VLSI integrated circuits will be covered. This course will focus exclusively on digital CMOS VLSI circuit and system design, although some issues in mixed-signal mode will also be addressed.

The course will begin with a review of CMOS transistor operation and semiconductor manufacturing process. Logic design with CMOS transistors and circuit families will be presented. Specifically, layout, design rules, and circuit simulation will be addressed.

**Knowledge of digital logic design and digital electronics is required.** Previous exposure to transistors and semiconductor devices would be useful, but not required. These introductory topics will be discussed in early stages of the course to provide necessary background to all students from EE and CE.

## ECEC 690-502 Electronic Design Automation for VLSI Circuits I

Fall 2007

Dr. Baris Taskin

This course is the first of a two-course-sequence that focuses on the electronic design automation techniques in the physical design process of digital VLSI circuits. In this course, electronic design automation (EDA) techniques are discussed in theory and implementation in order to build CAD tools for VLSI design (instead of using/analyzing commercially available tools). In this first quarter of the course, algorithms, techniques and heuristics structuring the foundations of contemporary VLSI CAD tools are presented. Within this context, common data structures used for computer manipulation of circuit design data are analyzed. Optimization, satisfiability, graph theory and boolean algebra topics are presented. There are no prerequisites for this course, however, some background on digital VLSI circuit design, data structures and algorithms are required. Previous exposure to VLSI CAD tools is not necessary.

## ECEC 490-001 VLSI Design and Automation

Winter 2008

Dr. Baris Taskin

This is a course in the field of Very Large Scale Integration (VLSI) circuit and systems design. Design and analysis of VLSI integrated circuits will be covered from a circuit design perspective. This course will focus exclusively on digital CMOS VLSI circuit design.

The course will start with the discussion of system design issues in VLSI circuit design. Integrated circuit physical design flows will be presented. System timing principles and arithmetic building blocks will be presented. Electronic design automation principles will be covered through hands-on practice using VLSI CAD tools. Hierarchical design principles at circuit and system levels will be discussed. Hardware Description Language (HDL) and formal design procedures will be introduced.

**Knowledge of digital logic design (ECE200) and computer organization & architecture is required.**

## ECEC 690-501 Dependable Computing Systems

Winter 2008

Dr. Nagarajan Kandasamy

This graduate-level course focuses on current state-of-the-art approaches to designing dependable computing systems as well as the quantitative evaluation of the notion of dependability. For the purposes of this course, dependable systems include ones that are safe, fault tolerant, secure, timely, maintainable, and designed correctly. The following areas will be covered:

- Dependability attributes: availability, reliability, and safety
- Fault models
- Techniques for dependability modeling and analysis
- Hardware fault-tolerance, physical and temporal redundancy, graceful degradation, prediction of hardware failure rates
- Software safety, software fault tolerance
- Safety-critical embedded systems
- Safety-critical networking
- Case studies of dependable-system design and best-known industry practices

The textbook Safety-Critical Computer Systems by Neil Storey, Addison Wesley, 1996 will be used for this course. Students will also be expected to read and critique a number of research papers in the above topics. You will also be expected to select a reading assignment and make class presentation on that topic. In addition, there will be a midterm and a final exam.

## ECEC 690-502 Electronic Design Automation for VLSI Circuits II

Winter 2008

Dr. Baris Taskin

This course is the second of a two-course-sequence that focuses on the electronic design automation techniques in the physical design process of digital VLSI circuits. In this course, electronic design automation (EDA) techniques are discussed in theory and implementation in order to build CAD tools for VLSI design (instead of using/analyzing commercially available tools). The emphasis in this second quarter of the course is on the fundamentals and design automation of the VLSI physical design flow. Various physical design flow steps including synthesis, technology mapping, partitioning, floorplanning, placement, routing and timing are analyzed in detail. Individual and team-based, small-to-medium scale programming projects are an integral part of the course.

**The prerequisite for this course is ECEC 690-502 (ST: EDA for VLSI Circuits I) or consent of the instructor.**

## ECES 690-501 Biologic Signal Processing I

Winter 2008

Dr. Gail Rosen

We hear about the Human Genome Project and how many genomes have now been "completed", or sequenced. As of 2006, there are 364 completed genomes with 2000+ in various stages of construction. DNA contains the instructions for life, and by analyzing its content, we can begin to gain insight into how organisms function and evolve. This course is the first in a series of two that look at challenges in biology and how signal processing methods can be used for analysis.

The course is project-based with each homework as a mini-project, and students will be encouraged to pursue an independent final project. The first part of the course will provide the fundamental knowledge of biology for engineers to get started in bioinformatics and will familiarize students with publicly available resources and databases. Next, we will examine how to measure sequence similarity using dynamic programming methods and signal processing approaches. The course will cover Fourier methods to detect protein-coding regions, Hidden Markov Model's for gene recognition, and information-theoretic measures for motif recognition. The course will also cover comparative genomics and prediction of signals and structures in noncoding DNA (such as microRNAs, approximate repeats, etc.).

### ECEC 690-502 Deep Sub-Micron Integrated Circuit Design

Spring 2008

Dr. Baris Taskin

This course focuses on the design challenges of digital VLSI integrated circuits in deep sub-micron (e.g. nanometer) manufacturing technologies. Topics of interest include electronic design automation (EDA) challenges due to increased design complexities and high-performance circuit design techniques such as low-power and variation-aware design. The impacts of nanometer scaling on CMOS technology are discussed extensively—within the contexts of interconnect planning, buffer insertion, signal integrity, power distribution, clock tree synthesis, low power circuit design and design for manufacturing (DFM). The course is structured on recent presentations, articles and tutorials from the industry and academia; advancing the discussions to state-of-the-art VLSI design techniques. The course material is delivered cohesively in a lecture format (not as a training session or a discussion from a list of papers). **There are no prerequisites for this course, however, some background on digital VLSI circuit design is required.**

### ECEC 490-001 Modern VLSI IC Design

Spring 2008

Dr. Baris Taskin

This is a project-oriented course in the field of Very Large Scale Integration (VLSI) circuit and systems design. Design and analysis of VLSI integrated circuits will be covered from circuit and system design perspectives. A quarter-long, high-complexity project will be assigned to students working in teams. Team-work, task assignment and team communication will be mediated in an industry setting, stimulating a realistic design environment. Design tasks will cover the entire IC design flow range, from system specification to RTL description to timing and power analysis. Successful designs will be sent to MOSIS for fabrication. **The prerequisite for this course is “VLSI Design and Automation.”**

### ECES 690-501 Biologic Signal Processing II

Spring 2008

Dr. Gail Rosen

After examining the DNA sequence, we can identify gene locations and which proteins they produce, but questions still remain -- HOW MUCH protein is produced and what controls gene expression? How many genes control a physical trait and which genes have the most influence? How does gene expression differ in healthy and cancerous cells? Only by going beyond DNA to gene interactions, can we understand function and diseases.

Recent research indicates that engineering approaches for prediction, signal processing, and control are well suited for studying multivariate interactions. This course will examine genetic engineering tools such as microarrays and PCR and the resulting analysis that will look at gene expression, gene regulatory networks, evolutionary tree construction of organisms, metagenomics, and microarray analysis. Also, we will discuss signal processing approaches that can be used to alter the behavior of gene networks in the hope that this alteration will move the network from a diseased state to a disease-free state. The course will be project-driven and literature-review based due to the novelty of the course content.

**ECES 690-501 Advanced Statistical Signal Processing**

Spring 2008

Dr. John Walsh

This course introduces a collection of advanced topics in statistical signal processing, with the intent of providing the graduate student with a catalogue of branching off points for confident independent further research investigation. Theoretical topics to be covered include multidimensional Fourier theory and sampling, information theory, convex and nonlinear programming, exponential families and inference in graphical models, relevant ideas in statistical mechanics, and adaptive filtering. The course also focuses on advanced applications of statistical signal processing, including tomography for medical imaging and radar and sonar signal processing. While the first half of the course will follow a traditional lecture format with homework assignments and a midterm exam, the second half will consist of student presentations of results from review papers or award winning papers in applications of statistical signal processing. Some suggested topic areas for these presentations include: genomic signal processing, recent algorithmic techniques for medical imaging, distributed detection and/or estimation in sensor networks, advanced radar signal processing, equalization techniques for multi-carrier systems, recent trends in image and video compression, recent trends in channel coding, network coding, recent trends in speech recognition or speaker identification, protein structure prediction, and hostile user detection for network security.