Principles of VLSI Design

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CS 45111 / 55111

Instructor

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to be determined…

Course Prerequisites

The *2004-2005 Undergraduate Catalog* lists the prerequisites for this course as *CS 35101 Computer Architecture*; an equivalent course taken elsewhere is also acceptable.

Course Overview

The goal of this course is to provide a "computer science"-oriented introduction to VLSI design, focused on developing the practical skills necessary to implement combinational and sequential designs, including state machines, using Field Programmable Logic Devices (FPLDs).

In a computer engineering program, students might take a semester or two of logic design at the sophomore level, followed by several senior- or graduate-level courses on the internals of a VLSI chip, the use of Computer-Aided Design (CAD) tools, and the algorithms employed by those tools. Furthermore, those courses would be supplemented by additional courses in circuit design, electronics, quantum physics, and computer architecture.

Since we do not have 5-10 semesters of work time available to us in this course, or the benefit of a computer engineering background, this course will provide only a brief overview of the VLSI design process, concentrating primarily on practical training in the use of commercial CAD tools for the design of digital circuits using Field-Programmable Logic Devices (FPLDs).

Textbook

Several textbooks will be used in this course.

The first textbook is listed as "required", and as such is highly recommended, as it will be used for over half of the course:

- *Digital Systems Design and Prototyping Using Field Programmable Logic and Hardware Description Languages, Second Edition*, Zoran Salcic and Asim Smailagic, Kluwer Academic Publishers, 2000.

While portions of this textbook contain materials more or less available in vendor's data sheets, other portions of this book are not available elsewhere. This textbook also includes a copy of the Altera MAX+PLUSII software on a CDROM, which you can install on your home PC if you have one. However, a copy of this software will also be installed on several PCs in the VLSI Design Laboratory (MSB 353), so having a home PC is not a requirement for this course.

The second textbook is listed as "optional". This textbook is primarily a lab manual — it shows you how to use the Altera MAX+PLUSII CAD tool and the prototyping board that we will be using for projects. If you plan on doing some of your lab work at home, you might want to buy it, but since buying two textbooks is sometimes hard, and we won't be using it for a prolonged period, perhaps you can share a copy with someone else in the class:

- *Rapid Prototyping of Digital Systems — A Tutorial Approach, Second Edition*, James O. Hamblen and Michael D. Furman, Kluwer Academic Publishers, 2001.

The CDROM at the back of this book also has a slightly newer version of the Altera MAX+PLUSII CAD tool than the Salcic book, but either version will suffice for our purposes.

The third and final textbook is not required, but I will use it for several lectures in the course:

- *Application-Specific Integrated Circuits*, Smith, Addison-Wesley, 1997.

By now this book is somewhat dated, but since Prof. Smith has very generously put *the entire textbook* online, you might want to follow the link to the book on the class web page when I cover that material.

Class Web Page

The web page for this class is **http://www.cs.kent.edu/~walker/classes/vlsi.f04** (links to this page, and to my other classes, are all available on my home page). The web page will contain links to the current class syllabus and schedule, lecture notes, homework assignments, exams and solutions, etc. You might want to check the web page on a regular basis, in particular when a homework assignment is outstanding or an exam is eminent.

Lectures

Students are expected to attend each lecture. I will not take roll, and I understand that it may occasionally be necessary to miss a class, but in general I expect you to attend each lecture and to be in the classroom when I start my lecture. If too many students start skipping class, or coming to class late, I reserve the right to give a "pop quiz" at the beginning of class that will count as a homework assignment in determining your course grade.

At each class, I will hand out one sheet of paper containing reduced copies of *at most eight* of my slides for that lecture. If you would like to have reduced copies of *all* of my slides for that lecture, the full version of the lecture notes will be on the class web page before the lecture, and you can print them out. Note that you are not required to either look at or print out these notes; they are provided solely for your convenience should you want them. However, you should ***not*** consider skimming these notes to be an adequate substitute for attending the lecture, as they will contain only the text of my slides, not the comments that I will make in class.

My lecture notes will be drawn from a variety of sources. The textbooks listed above will serve as a primary reference, although some material will be drawn from other books on logic design, CAD, VLSI design, etc. I may also use lecture notes from other professors as a reference.

Students "Sitting In"

Students who want to unofficially "sit in" on the course for any reason should contact me as soon as possible. In general, I allow sit-ins if there is space in the room, but I will not grade any assignments or exams for anyone other than officially-enrolled students.

VLSI Design Projects

There will be approximately 5 VLSI design projects during the semester. The following information is ***tentative*** and subject to change, but should give you some idea of what to expect. The first and second projects will be manual designs of a combinational and sequential circuit, respectively, entered using the schematic capture tools in MAX+PLUSII. The third and fourth projects will be designs entered using AHDL in MAX+PLUSII. The fifth and final project will be a project of your choice that must satisfy a set of specific requirements.

In general, you will have adequate time to complete each assignment. However, you should begin work on each assignment early so that you will have plenty of time to become familiar with it and with the CAD tools that you will be using, and so that you will have time to "sleep on" the difficult parts. Waiting until two days before the due date to start the project is a bad idea.

Late projects ***will*** be accepted with a 10% penalty for ***each day or portion thereof*** that the project is late. Other extensions will not be granted, unless you make *prior* arrangements with me, or have a *documented* illness (in which case I expect you to contact me as soon as possible).

Exams

There will be one exam (a mid-term exam held during class) and a final exam (held during finals week). All exams are closed book and closed notes, and must be individual work. It is expected that you take each exam at the scheduled time, unless you make *prior* arrangements with me, or have a *documented* illness (in which case I expect you to contact me as soon as possible).

The mid-term exam will be given in class in mid-October, on a date to be announced later.

The final exam will either be given in class at one of the two officially-approved times during final exams week (once I consult with the other professor whose class conflicts with our class time), or will be a take-home exam due at that time. A decision on these issues will be made prior to the Thanksgiving break.

Academic Integrity

Student-teacher relationships are built on trust. Students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments which students turn in are their own. Acts which violate this trust undermine the educational process. In this course, the penalty for ***any*** act of academic dishonesty is a final course grade of F.

Cooperation on Projects

For the VLSI design projects, I strongly believe that discussion with your peers is an excellent way to learn. If you don't understand something, discussing it with someone who does can be far more productive than beating your head against the wall.

Having advocated discussion, then, I must be about clear what is allowed, and what is not. In general, students are allowed to cooperate as follows: you are allowed to discuss with other students *the assignment*, and *general methods for solving the assignment*. However, you are ***not allowed*** to work with someone else to actually *solve* the assignment, and you are certainly ***not allowed*** to *copy* anyone else's solution. You are also ***not allowed*** to *copy* material from the book, the Internet or anywhere else which acknowledgement. Doing any of these things will be considered cheating, and will be grounds for failing the course.

Note that there is a fine line between discussion and cheating. If you are unsure what is allowed and what isn't, feel free to discuss the distinction with me, but if something feels uncomfortable, it's probably not allowed.

Finally, you should be careful not to give others access to your project. This means that you shouldn't keep your project in a publicly-accessible directory, you shouldn't leave your terminal unattended, and you shouldn't forget to pick up your printouts.

Grades

Your final course grade will be broken down as follows:

- VLSI design projects (5) 75% (weighted 10, 10, 10, 15, and 30%)
- Midterm & final exam 25% (weighted 15 and 10%

The final course grade will be determined with A = 90–100, B = 80–99.99, etc. There will be no curve at the end of the course, so you should always be able to determine your course grade.

Instructor Absences

Over the course of the semester, it may occasionally be necessary for me to miss a class, usually with plenty of advance notice. I realize that it may be frustrating to hear that your instructor is going out of town, instead of always being in the classroom to teach the class that you are paying him to teach.

However, I have two answers to those frustrations. First, you are choosing to attend classes at Kent State University — a research-oriented university with a flourishing graduate program — instead of a liberal arts college or community college. Professors at research-oriented universities are generally expected to attend conferences and professional meetings on a regular basis as a way of staying current in their fields, and by staying current, presumably bring knowledge that is more up-to-date than most textbooks into the classroom, which benefits you as a student. Second, by attending those meetings, I make other professionals aware of Kent State, which increases your visibility and the value of your degree.

Having said all this, I will make every effort to minimize these absences, or to arrange for my class to be covered during my absence in such a way to avoid disrupting the flow of the class. When this is not possible, it may occasionally be necessary for me to cancel a class, or to schedule a makeup class at some other time.

Students With Disabilities

In accordance with University policy, if you have a documented disability and require accommodations to obtain equal access in this course, please contact the instructor at the beginning of the semester or when given an assignment for which an accommodation is required. Students with disabilities must verify their eligibility through the Office of Student Disability Services (SDS) in the Michael Schwartz Student Services Center (672-3391).