ECE 464, ECE 520 : Digital ASIC Design
Spring 2012
Course Overview & Policies

Class Schedule: Monday, Wednesday, Friday 3.50 – 5.05;
EB 2, 1025, as per the class schedule.

Instructor: Professor Paul D. Franzon, Ph.D.
Office: EGRC 443, (919) 515-7351
E-mail: paulf@ncsu.edu
Home page: www.ece.ncsu.edu/erl/faculty/paulf.html
Office Hours: Mon 2.30 – 3.30 (EB2 2116) on days with a scheduled class.

Lab TAs/Graders: To be announced on web site.

Class Format and Schedule: Approximately 26 classes will be held over the slots available during the semester. Which slots to be used will be announced on the website.

Communications: Students are strongly encouraged to use the Bulletin Board for questions that are not considered “private”. If the question is a good discussion topic, or one that a peer can answer, myself and the TAs might not specifically respond unless it is clear the discussion is not solving it. However, if it is clear that the questions can only be answered by one of us, we will do so as soon as practical. TA-manned Labs should be used for problems related to CAD tool and code debug issues. For addressing issues that the above methods are not suited for, email is preferred over the telephone.

Labs. Regular TA-manned labs will be established. You will find these very useful for resolving design and tool questions and should be your primary method to do so.

Class Attendance. On campus students are expected to come to attend the “live” classes. If you can not attend a live class, I suggest getting with a peer and reviewing his or her notes.

Textbooks & Notes:
Purchase is Optional.
  - D.R. Smith and P.D. Franzon, "Verilog Styles for Synthesis," (Pearson Education [Prentice Hall]), 2000. ISBN. 0-201-61860-5. 'The chapters on design, timing, test benches are lifted straight from this course.
  - Course notes, etc. on class web page. Please make sure you print the first set of notes before the first class.
  - References:

You will find the course website and bulletin board on wolfware, as linked from the page www.courses.ncsu.edu/ece520 . I emailed the class earlier this week. If you did NOT receive these emails, check your “official” email address at www.ncsu.edu under “directories” in the top right corner, and update it if need be.

Prerequisite: Grade of C or better in ECE 212 or equivalent. ECE 406 is useful but not assumed. Functionally, I assume that students are familiar with logic design, including combinational logic gates, sequential logic gates, timing design, Finite State Machines, etc. If you have never designed and verified even a small digital circuit, and
remember the principles by which they work, you will be seriously disadvantaged in this class. I do not assume knowledge of Verilog.

Course Objectives

1. To prepare the student to be an entry-level industrial standard cell ASIC or FPGA designer.
2. To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation, including timing, performance and power optimization, verification and manufacturing test.

Course Outcomes

1. Students will be able to design and synthesize a complex digital functional block, containing over 1,000 gates, using Verilog HDL and Synopsys Design Compiler.
2. Students will demonstrate an understanding of how to optimize the performance, area, and power of a complex digital functional block, and the tradeoffs between these.
3. Students will demonstrate an understanding of issues involved in ASIC design, including technology choice, design management, tool-flow, verification, debug and test, as well as the impact of technology scaling on ASIC design.

ECE 464 or ECE 520? ECE 520 has wide recognition for preparing ASIC designers for industry. ECE 464 does not. If you are interested in gaining a “job qualification”, and found ECE 406 straightforward, I’ll advise you to take ECE 520, rather than 464. However, the ECE 520 is an order of magnitude more difficult than the 464 project and includes a strong design optimization component. The 464 project does not require much optimization.

Course Approach:

Lectures: Designed to prepare you for the project and cover issues important to ASIC designers.
Laboratories: A lab schedule will be established. Though lab attendance is not required, you are strongly encouraged to use the help available in the labs to sort through homework and project issues. In fact, only minimal help will be available outside the laboratory times.
Homeworks: The homeworks are designed to either help you gain the skills required for the project or to help prepare you for the exams. Collaboration is encouraged though each student is expected to turn in individual solutions.
Project: A fixed project will be published for each class. The project will be done by the students in pairs. You will be evaluated as a pair.
Written Exams: There will be two written exams, a one hour midterm and a three hour final. Both are comprehensive, open-book, open-notes exams.

Course Syllabus

1. Introduction to ASIC design
2. Timing design
3. Design of digital hardware using Verilog HDL I
4. Design of digital hardware using Verilog HDL II
6. Verification.
7. Design for Test.
8. Low Power Design.
9. Introduction to FPGAs

Homework TurnIn

o On-campus students. Unless specifically requested, please bring a paper copy to class.

Student Evaluation

<table>
<thead>
<tr>
<th>Item</th>
<th>Date</th>
<th>ECE 520</th>
<th>ECE 464</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeworks</td>
<td></td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>February, 20</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Project – Prelim Report</td>
<td>March 2</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Project – Final Report</td>
<td>April 18</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Wednesday, May 2, 1-4 pm</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Each non-exam item can be up to one week late with a 10% penalty. After more than a week, the item can not be accepted. Exams are open book, open notes. You may NOT use computers, mobile phones and PDAs during exams. Though you can collaborate during homeworks, **direct copying of solutions, in part or in whole, is not permitted. All code required for the homeworks should be individually designed and developed.** We will be running code comparison tools on homework solutions, and projects. An Audit requires completing all the homeworks with a grade of at least 80%.

**EOL Students**

The differences for you are as follows:

- One TA will be designated as your major point of contact. He/she will most likely organize electronic office hours using elluminate
- Please turn in all homeworks and reports on-line via wolfware assignment submit function
- All tools are available remotely. Please see the class web site (“resources”) about how to do this. You will need to access to Verilog simulator and Synthesis tool. A stripped down simulator is available with the Ciletti book. You can use the Xilinx ISI student package but note that it is only good for 30 days (after which you would have to use the on-campus installation.) You are free to use tools and cell libraries available at your workplace but I don’t want NCSU exposed to confidentiality issues. (Note, on campus students are expected to use the on campus tool and libraries.)
- Your due dates are the same as for the on-campus students, except midterm and final are held the day AFTER the on-campus test/exam
- You will need a proctor for your exams – please try to find one now who is willing and available

**Important Dates**

See Class Schedule

**Instructor Research Interests**

- Application specific processors. Current projects are in applications of 3DICs and secure IP design.
- Interconnect, including transceivers, electronic packaging, on-chip interconnect, and between-chip interconnect.
- Nanocomputing – how to build the computers that will eventually displace or complement CMOS.

**Students with disabilities**

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653. [http://www.ncsu.edu/provost/offices/affirm_action/dss](http://www.ncsu.edu/provost/offices/affirm_action/dss) For more information on NC State's policy on working with students with disabilities, please see [http://www.ncsu.edu/provost/hat/current/appendix/append_k.html](http://www.ncsu.edu/provost/hat/current/appendix/append_k.html)

**Academic integrity**

All the provisions of the [code of academic integrity](http://www.ncsu.edu/provost/hat/current/appendix/append_k.html) apply to this course. In addition, it is my understanding and expectation that your submission of any test or assignment means that you neither gave nor received unauthorized aid. **My policy for homeworks and projects is that while you are free to collaborate, sharing of design data, specifically Verilog code, is expressly forbidden.** If you collaborate on a design problem, I still expect you to turn in individually developed code.