

ECE 351

DIGITAL LOGIC

LABORATORY

INTRODUCTION

Summer 2007

ECE 351, Digital Logic Laboratory, covers and extends design material that you have studied in the classroom in ECE/Comp Sci. 352 (or an equivalent logic design course). The primary new elements in ECE 351 that go beyond your past study are the actual implementation and testing of logic circuits. In addition, new computer-aided design tools will be employed including automatic synthesis of logic circuits from state diagrams and from hardware description language code.

The primary implementation vehicle in ECE 351 will be the field-programmable gate array (FPGA). An FPGA is an integrated circuit within which logic circuits can be constructed by a programming process, which loads a stream of bits into the FPGA. In the type of FPGA used in the lab, the stream of bits is stored in an SRAM so it is erased if the power is turned off or if a new bit stream is loaded. This makes it very easy to modify a design and makes the FPGA essentially infinitely reusable for checking out different designs.

In this introduction, we will cover the following topics: 1) Course goals 2) course prerequisites, 3) course outline, 4) lab operation, 5) lab reports, and 6) course grading.

1 OVERVIEW

This introduction contains important information with respect to conduct of the course and the course grading. **Failure to read and be very familiar with its contents may jeopardize your performance, your grade, and your lab partner's grade in the course!**

2 COURSE GOALS

This course has the following goals:

- 1) To acquire basic laboratory skills in operating digital test equipment,
- 2) To relate behavior of implemented digital logic to classroom models used for such logic,
- 3) To gain experience in designing, using a variety of methods, in a programmable logic environment, and
- 3) To develop skills in testing digital logic including generating test inputs and analyzing outputs.

3 COURSE PREREQUISITES

ECE 170 and ECE352 or their equivalents are **required prerequisites** for ECE 351, and ECE 230 is a co-requisite, i.e., must be taken at the same time as or before ECE 351. If you do not have the required prerequisites, you are to drop the course immediately. You must have an active Windows account at CAE to access the lab tools and to store designs and results.

4 COURSE OUTLINE

1. Course Introduction and Experiment 1: Logic Gate Parameters
2. Experiment 2: Design and Test Using Field-Programmable Gate Arrays
3. Experiment 3: Combinational Logic Circuits
4. Experiment 4: Sequential Logic Circuits
5. Experiment 5: Control Unit
6. Experiment 6: Team Project
7. Bench Exam

5 COURSE EFFORT

ECE 351 involves considerable design work. As with any design work, the amount of time required is typically more than that required for courses not involving design and depends on such things as the designer's familiarity with procedures (such as from ECE/CS 352), skill in using the design tools, care in following detailed instructions exactly, the complexity of the design, design errors made and tool pitfalls encountered. These factors cause considerable variability in the amount of time required for the prelabs for this course. Further, the effort in ECE 351 is not equally distributed throughout the semester since some experiments have simple prelabs requiring only an hour or so while others have prelabs that require considerably more than three hours. Overall, the course is targeted to take about 40 hours over the semester. Due, however, to the factors mentioned above, more or less time might be required for different experiments and different teams.

To make efficient use of your team resources, you and your partner should work in parallel on the various parts of a prelab whenever possible, rather than one team member doing the work with the other watching. It is advantageous to work at the same time, however, so that if questions arise about the interface between the parts of the design, they can be addressed immediately and so you can otherwise share knowledge.

6 LABORATORY OPERATION

Most experiments have two major sections: Prelab and Lab Work. You are to study the Prelab material, answer prelab questions, do the prelab design work and look over the Lab Work before lab. A prelab sometimes involves significant work and should not be put off until close to the due date. Do appropriate preparation for the lab to facilitate rapid recording and interpretation of results. For most of the experiments, a single design is to be produced by each lab team, but the other parts of the Prelab and the Lab Experiment Write-ups are to be individually performed. All work that appears in reports except for team results is to be yours including answers to all questions. Cooperation is limited to the design and the experimental work in lab unless indicated otherwise. Submit your lab report containing the prelab for the upcoming experiment and the postlab report for the preceding experiment in the submission box outside of the lab door at the time specified by your instructor. In lab, your graded prelab is returned and you perform the Lab Work portion of the experiment. If there is a problem with designs required for the lab, you and your lab partner must have correct designs for the lab verified by the instructor before beginning the experiment. The lab sessions last up to three hours; if your group does not complete the lab or if you miss a lab, you will need to make arrangements with your instructor to complete the work at another time. You may enter the lab by using the door combination during hours when Engineering Hall is open to use the workstations for design and other purposes. Otherwise, the software is available on CAE workstations. Lab hardware will be available to you only during scheduled lab periods.

7 LABORATORY REPORT

Laboratory reports are to be 8.5 by 11 inches on paper or in a lab notebook. The lab notebook must fit into the slot in the submission box outside of the lab door. Printouts from the lab may be report pages or taped or pasted into a lab notebook. They can also be electronically included in a word-processed document. All reports shall follow the format of the lab report template on the course web page.

WARNING ON PRINTER USE: The printer in the lab is for convenience in printing ECE 351 results such as schematics, simulation output and oscilloscope waveforms and is supported only by ECE's meager supplies budget. **It is not to be used for printing experiments, handouts or manuals for ECE 351. Further, it is not to be used for printing anything unrelated to ECE 351.** Such printing must be done elsewhere. If printing is detected outside of these restrictions, the printer will be removed and printing from lab workstations will be provided only on CAE printers.

8 COURSE GRADING

Bench exams will be given during the last lab period. These will consist of a short individual written exam, and a practical exam completed with your lab partner. To be well prepared for the bench exam, you should understand all design and lab procedures well, including those performed by your lab partner. More on the specifics of the bench exam will be provided later in the semester.

Your grade in the course will be calculated as follows;

Lab Experiments (including prelab/postlab reports)	80%
Bench Exam	15%
Quality and Effort	5%
Total	<u>100%</u>

Your instructor will assign you a grade for Quality and Effort (Q&E) to reflect her/his assessment of your contribution to your team's efforts, the overall quality of your work, and the level of professionalism displayed in the lab. As part of that score, each student will complete a confidential assessment of their individual contributions as well as their lab partner's. Note that the Q&E score will be weighted such that an average student, fully contributing to the team effort, will receive a score of 3 out of 5. Scores above and below that mark are reserved for clearly exceptional cases. Please note that lab performance averages and bench exam averages are usually fairly high, so that lab scores and exam scores in the 90's do not guarantee an A in the course.

In each section, the lab instructor may optionally award a single project the distinction as 'best in class'. The determination will be based the project's complexity, functionality, and creativity. A team that earns this distinction will be exempt from the bench exam.

Special Point Deductions

One point will be deducted for each of the following each time they are missing from submitted work: your name, other team member names, your instructor's name, and the experiment number and name.

Late Work Policies

PRELABS:

10% deducted if turned in within 24 hours of due date and time; 20% deducted if turned in more than 24 hours after due date and time; 100% deducted if not turned in before the beginning of the corresponding lab.

POSTLABS:

10% deducted if turned in within 24 hours of due date and time, and a 10% additional deduction for each added 24-hour period thereafter.