Washington State University
School of EECS
Electrical Engineering Course Assessment Report

Course Number: EE214
Course Title: Digital Logic Design
Semester Offered: Spring 2007
Instructor: Clint Cole
10th Day Enrollment: 57  Number Completing Successfully (C grade or better): 46

I. Assessment Outcomes from the Course Syllabus

- (A) Ability to apply knowledge of mathematics, science and engineering.
- (B) Ability to design and conduct experiments as well as analyze and interpret data.
- (C) Ability to design a system, component, or process to meet desired needs.
- (D) Ability to function on multidisciplinary teams.
- (E) Ability to identify, formulate, and solve engineering problems.
- (F) An understanding of professional and ethical responsibility.
- (G) Ability to communicate effectively in written and oral formats.
- (H) A broad education necessary to understand the impact of engineering solutions in global, economic, and societal context.
- (I) Recognize the need for, and have the ability to engage in life long learning.
- (J) Have a broad education and knowledge of contemporary issues.
- (K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.

II. List of Course Topics from the Course Syllabus

1. Basic digital electronics, including introduction to transistors and integrated circuits;
2. Binary state terminology, CMOS terminology and symbology, basic logic functions, reading and construction of logic circuits;
3. Logic circuit definition, minimization, and construction;
4. Number systems, binary arithmetic, and codes;
5. Design and application of multiplexers, decoders, encoders, code converters, comparators, parity circuits, and shifters;
6. Introduction to VHDL with applications to the behavioral and structural representation of basic combinational logic devices;
7. Application of programmable logic devices (ROMs, PLDs, FPGAs) to combinational logic design;
8. Design and application of arithmetic circuits including various adders, multipliers, and arithmetic logic units (ALUs);
9. Introduction to timing defects in combinational logic circuits;
10. Introduction to the design of sequential circuits, including latches, flip-flops, registers, and counters.

III. Course Assessment Summary Table: one row of the table should be devoted to each of the checked outcomes in part I.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Topics</th>
<th>Specific Measures (Samples available for inspection.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Ability to apply knowledge of mathematics, science and engineering.</td>
<td>1, 3, 4, 5, 6, 7, 8, 9, 10</td>
<td>Exam 1: all problems; Exam 2: all problems; Final Exam: all problems; Homework/Lab: 2, 4, 5, 6, 7, 8.</td>
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<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>8, 9</td>
<td>Exam 1: Exam 2: 4, 11; Final Exam: 5; Homework/Lab: 8, 9.</td>
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<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>5, 6, 7, 8, 9, 10</td>
<td>Exam 1: 4, 5, 10; Exam 2: 1, 2, 11; Final Exam: 1, 2, 8, 14; Homework/Lab: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>3, 5, 6, 7, 8, 9, 10</td>
<td>Exam 1: 1, 3, 4, 5, 6, 7, 8, 9, 10, 11; Exam 2: 1, 2, 10; Final Exam: 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14; Homework/Lab: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>4, 5, 6, 7, 8, 9, 10</td>
<td>Exam 1: all problems; Exam 2: all problems; Final Exam: all problems; Homework/Lab: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.</td>
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IV. Using the table as a guide, for each outcome summarize your evaluation of the students’ achievement of that outcome; cite student performance on the identified measures as evidence to support your conclusions.

(A) Ability to apply knowledge of mathematics, science and engineering.

Since EE214 is typically the first engineering class taken by Electrical Engineering, Computer Engineering, or Computer Science students, the class highlights engineering formalisms and methods, and encourages the identification and use of good engineering design practices. Weekly design projects form the core of the class, with designs increasing in complexity each week. Every lab requires engineering skills, and later labs build on the engineering knowledge gained in earlier labs. The use of good design practices are emphasized throughout the class and the lab.

Some labs require formal mathematical methods to arrive at acceptable solutions, and some require experimentation, data gathering, and reaching conclusions based on the
data. Students who successfully pass the class could not complete the required work without gaining engineering, scientific, and to a lesser degree, mathematical skills. Lab assistants are encouraged to work with every student to ensure they comprehend the class materials, and to ensure they are performing all the activities required in the lab.

(B) Ability to design and conduct experiments as well as analyze and interpret data.

Since this is the initial engineering course students take, the experimental content is limited to two experiments. In one (lab #8), students must modify timing parameters in various circuits, and then measure the behavior and analyze the effects. In another experiment (#9), students are given guidance towards solving one problem, and then they must apply their new knowledge to design a second experiment, collect data, and analyze the results. These labs highlight data gathering, challenging assumptions, and self reliance as necessary skills. Although the experimental content is light, the spirit of experimentation and self-learning is present.

(C) Ability to design a system, component, or process to meet desired needs.

Every lab design in the class requires that students design circuits and components to meet a specified requirement. Students do not receive passing marks unless their completed designs meet the stated requirements – this is clearly one of the stronger points of the class.

(E) Ability to identify, formulate and solve engineering problems.

Since this is the initial design course for most students, designs are somewhat constrained to emphasize basic design methods and skills. Later in the class, some assignments provide an opportunity for students to “discover” areas where they need to gain knowledge on their own, through experimentation and/or the application of engineering methods to gain further insight into a problem. For example, in the timing experiment (#8), they must construct circuits with timing defects, discover the effect the timing defect has on circuit performance, and then design a circuit that does not suffer from timing issues. Also, in the final lab, they must experiment with their hardware in order to develop a sufficient knowledge base from which to complete the required work. Once they have learned about the circuit and requirements, they can design a suitable solution.

(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.

Every week student’s work on a new lab assignment, and after the fourth week, every assignment requires use of state-of-the-art CAD tools and modern design technologies. Each design requires that a circuit be defined, captured, simulated, and implemented using state-of-the-art CAD tools and circuit implementation technology. Students who complete the class have strong experience in schematic-based circuit design, behavioral circuit design using VHDL, circuit simulation, and circuit synthesis. Since every lab requires students to implement circuits using an FPGA-based circuit board, students also gain strong exposure to programmable devices and technologies.
All design experiences in the class emphasize knowledge and skills that are directly applicable to designs that are found in industry today. After successfully completing this course, students are capable of attacking relatively complex designs using the latest tools and methods.

V. Qualitative Assessment of Student Performance: using the arguments above and other data support the claim that students who completed this course with a grade of C or better have achieved each of the intended outcomes of this course.

The class is anchored in the hands-on design experiences that students gain in the weekly lab assignments. The lab assistants are instructed to work with each student individually and to ensure each student completes and comprehends their own work. The exams focus on applied engineering knowledge and skills, and serve to reinforce the goal of imparting real, demonstrable skills to all students.

All students have unrestricted access to the CAD software used in class (the state-of-the-art Xilinx ISE/WebPack 9.1), and every student purchases their own design hardware (an FPGA-based circuit board). Every assignment contains a significant amount of design work, and students can work on their designs anywhere they have access to a PC (like their living quarters). Lab assignments encourage self-learning and exploring. We have had good access to very qualified lab assistants, and they are instructed to interact with every student every week. The combination of weekly assignments requiring the use of modern design technologies, some open-ended design assignments, good lab assistants, and a constant progression through course materials creates a very good learning environment.

The students seem to enjoy the applied, hands-on emphasis of the class, and many go beyond the class assignments and embellish their designs.

Average class performance measured through student performance on exams and on lab assignments (exams 1, 2, 3: 72%, 73%, 74%; lab assignments completion rate: 89%; lab assignment average grade: 87%), indicates students are learning the materials well, and that they are emerging from the class prepared to take the next steps in their careers.

VI. Concerns: state any concerns you may hold about this class – were the students adequately prepared coming into it? Are there topics or outcomes where (some) students were weak after completing the course? Other concerns? Were there any comments on students' course evaluations that should be addressed in future instances of the course? This section is very important for improving our program: it provides critical input to the curriculum committee for identifying areas requiring attention.

I think this class is well designed and well positioned in the program. Students are well prepared on entry (only general classes are prerequisites), they engage well with the
materials, and attrition is relatively low for an entry-level class. Students routinely show a high completion rate on class assignments, and average scores on exams are healthy.

Average attendance was a bit lower this semester than in previous semesters, quite probably because of the 8:00AM time slot. It may be better to offer this class in the afternoon, since this class serves mostly sophomore students who may not have developed good time management skills.

Student evaluations are mostly very positive. The few negative comments seem directed more at the work-load than the class structure. This is a four-credit class that presents essential and foundational engineering concepts, and most students are unfamiliar with the nature and amount of work required. In my assessment, actionable themes are present in the student reviews.

The curricula and materials used in this class are posted on a publicly viewable website, and many other educational institutions have adopted all or part of the materials. Some of these institutions provide feedback, helping ensure the class topics are current and pertinent.

Much of the success of the class is attributable to consistent access to a good computing infrastructure, and the availability of very qualified lab assistants. As long as we keep a good infrastructure and good assistants, this class will remain solid.

Signature: Clint Cole Date: 5/9/07