Washington State University
School of EECS
Computer/Electrical Engineering Course Assessment Report

Course Number   EE 466
Course Title    DIGITAL VLSI DESIGN
Semester Offered Fall 2006
Instructor      Jabulani Nyathi
10th Day Enrollment 9  Number Completing Successfully (C grade or better) 9

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. Introduction to CMOS circuits: MOS transistor, CMOS Logic, Circuit representation, nMOS and pMOS transistors, MOS transistor design, The CMOS inverter (etc).
2. MOS Transistor Theory: Enhancement pMOS and nMOS devices, MOS device design equations and DC characteristics of a CMOS inverter.
3. CMOS processing Technology: Circuit elements, Layout Design rules and Latchup
5. CMOS Circuit Logic and Design: Physical design of logic gates, CMOS logic structures, Logic Delay estimation, I/O Structures and Clocking schemes.
6. Design methods: Design strategies, Design options (gate arrays) and Advanced design tools (capture and verification)
7. Subsystem Design: Adders, comparators, multipliers, Memories, and Programmable logic arrays (PLAs)
8. VLSI Processor: Datapath and control unit, Register file, Arithmetic logic unit (ALU)
9. Advanced Topics: A peak into emerging devices and new nano-architectures
### 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 are available in the course materials file for inspection.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Ability to apply knowledge of mathematics, science and engineering.</td>
<td>2-7</td>
<td>Exam 1, Exam 2 and Exam 3. Homework assignments 1-4.</td>
</tr>
<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>7-8</td>
<td>Exam 2, Exam 3, Term project and Lab 3</td>
</tr>
<tr>
<td>(C) Ability to design a system, component, or process to meet desired needs.</td>
<td>6-8</td>
<td>Term Project, Lab 3, and Lab 4.</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems.</td>
<td>8-9</td>
<td>The Term Project and Lab 4.</td>
</tr>
<tr>
<td>(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.</td>
<td>5-8</td>
<td>Homework 2, Labs 1, 2, 3 and 4 along with Exams 1 and 2, including the term project.</td>
</tr>
</tbody>
</table>

### 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.

The laboratory experiments and homework assignments matching this evaluation criterion were performed well by students with an estimated success rate of 80%. There was always assistance from the teaching assistant and the instructor to ensure successful completion of the labs and homework assignments as a result many of those who sought help were successful. The first laboratory experiment saw students registering very low grades because of their failure to follow specified guidelines on their required laboratory reports. This brought the average low. The examination problems measuring this criterion were adequately answered by the students. All three examinations had a component of criterion A and the students performed well, solving the relevant mathematical problems and relating the theory to the practical problems well. An average score of 80% was recorded in these examinations.

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

The students were asked to design a simple decoder that could be used to select words in memory to write or to read. A simple 4-bit ALU design would allow the students to interface their decoder with the ALU subsystem. The laboratory experiment and the term project were completed successfully and an average score of 95% recorded.

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

The third and fourth laboratory assignments were successfully completed by the students with a 96% average score. The term project was also successfully completed with students designing components of a sub-system to meet power budget and speed requirements specifications. The average score for the final project was 92%. The third examination also had a design component
requiring students to perform computations that would enable a design to meet specific requirements. The average score for this question of the final exam was 90%.

(E) Ability to identify, formulate, and solve engineering problems.
The Term project was purposely under-specified to allow students the freedom to identify key metrics of a VLSI design and aim to meet power and performance budgets. Students were also given the option to propose a project of interest to them and one team successfully did so. Laboratory experiment 4 also allowed students to formulate an engineering problem, requesting them to design a three-port memory and state its importance. An 90% average was attained between the project and laboratory 4.

(K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices.
Students get to use modern techniques and tools as evidenced by the requirements of each laboratory experiment. Students get to realize their designs use state of the art computer aided tools such as cadence at both schematic and layout levels. They get to determine the worst case propagation delays of their designs and identify the sources of power dissipation and how they can minimize both. Average scores of the laboratory experiments recorded were at 94%. The second exam also allowed students to analyze circuits/subsystems using modern day techniques. The problem with this component received an average score of 80%.

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 three exams, the different homework and laboratory assignments as well as the term project form a good basis for one to believe that the students earning a C or better in the course have some level of understanding of the topics covered in lectures and tested during in class exams, laboratory and homework assignments. The course is the first VLSI design course the students get to take and they like the idea of being able to analyze and design circuits from transistor level through gate level and eventually system level. Comments by students point to the fact that the laboratory experiments are very valuable as they get a chance to have hands on experiments.

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.

The course is attended primarily by senior undergraduate students in the computer engineering program and they have the proper pre-requisites and seem to do well. There are no concerns about this course except maybe for the fact that it has to evolve with the changes in technology as CMOS approaches its physical limits. Some students feel that the pace of the lectures is some what slow and this will be addressed appropriately by the instructor.

Signature __________________________________________ Date: _______________________

Please email a copy of the completed form to Patricia Arnold, patricia@eeecs.wsu.edu and deliver a signed hardcopy to her mailbox.