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

Course Number: EE 466  
Course Title: DIGITAL VLSI DESIGN  
Semester Offered: Fall 2008  
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 can be made available if needed for inspection.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Ability to apply knowledge of mathematics, science and engineering.</td>
<td>2-8</td>
<td>Exam 1: (all problems), Exam 2: (problems 1 and 2) and Final Exam: (problems 1 and 4), Homework assignments: HW1 (1, 2, and 4), HW2 (Problems 1, 2 and 3), HW3 (problems 1, 2, 3, 4 and 5), HW4 (all problems), HW5</td>
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<tr>
<td>(B) Ability to design and conduct experiments as well as analyze and interpret data.</td>
<td>7-8</td>
<td>Exam 2: (problems 5), Term project and Lab 3, HW5 and all of HW6</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, Final Exam (problems 3 and 4), Lab 3</td>
</tr>
<tr>
<td>(E) Ability to identify, formulate, and solve engineering problems</td>
<td>9</td>
<td>Term Project and Laboratory Assignment 3</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 (prob. 4), Labs 1 and 2 along with Exam 2 (problems 3 and 4) Final Exam (prob. 3)</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 99%. 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 examination problems measuring this criterion were adequately answered by the students. The second and Final 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 94% 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 to or to read from. The decoder will eventually be part of the 16 x 16 memory array of the final project. The laboratory experiment and the term project were completed successfully and an average score of 90% recorded._

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

_The third laboratory assignment was successfully completed by the students with an 85% average score. The term project was also successfully completed with students designing components of a system to meet power budget and speed requirements specifications. The average score for the final project was 90%. The final examination also tested students’ understanding of system design: requiring them to perform computations that would enable a design to meet specific performance requirements. The average score for this question of the final exam was 87%._
(E) Ability to identify, formulate, and solve engineering problems.

The term project’s specification was under specified allowing students to formulate and solve design problems. There was success with the term project with an average score of 90%.

(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 using 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 96%. The second exam also allowed students to analyze circuits/subsystems using modern day techniques. The problem with this component received an average score of 86%.

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 two exams, the final exam, 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 concepts tested. The comprehensive nature of the final exam allows for a better evaluation and leads to the conclusion that the scores earned along the way were not an accident for many. 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. The students through their comments included with course evaluation indicate that they have enjoyed and learned something in the course.

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.

During the 2008 Fall semester there were nine students enrolled in this course compared to just four students the previous year. The students in both the Electrical and Computer Engineering programs had the proper pre-requisites for the course and did very well. There were two international students on an exchange program and they had difficulties particularly with the computer aided design tools used for the bulk of the work in the course. There are no major 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. In the past some students have commented that the pace of the lectures was some what slow and this has been addressed appropriately by the instructor.

Signature ___________ Jabualni Nyathi _______________ Date: _____ May 13, 2009 ______

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