Washington State University
School of Electrical Engineering and Computer Science
Electrical and Computer Engineering Course Assessment Report

Course Number  EE334
Course Title  Computer Architecture
Semester Offered: Spring 2007
Instructor  José G. Delgado-Frias
10th Day Enrollment 11 Number Completing Successfully (C grade or better) 10

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. Computer Abstractions and Technology.
   - Programs, Integrated circuits and Microprocessors
2. Instruction Set Architecture: Instruction and operand types
   - Instruction types: Arithmetic, Logic, Branch, Memory
   - Operand storage, type and size
   - Examples of instruction sets (MIPS and DLX)
3. Computer Arithmetic
   - Number representation
   - Addition/Subtraction and Multiplication/Division
   - ALU and Floating Point
4. Performance Issues
   - Metrics
   - Benchmark Programs
5. Processor’s Datapath
   - Building a Datapath
   - Implementation issues
6. Pipelining
   - Pipelined datapath
   - Data Hazards and forwarding
   - Branch Hazards
   - Static and Dynamic Branch Prediction (Branch Target Buffer)
   - PowerPC 604

7. Memory Hierarchy
   - Principle of locality
   - Memory hierarchy
   - Cache and virtual memory

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</th>
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</table>
| (A) Ability to apply knowledge of mathematics, science and engineering. | 3-7 | Exam 1: Problem 1.a and Problem 2  
Exam 2: Problem 1, Problem 2  
Homework 8: problems 1 and 2 |
| (B) Ability to design and conduct experiments as well as analyze and interpret data. | 4-6 | Exam 1: Problem 3.  
Homework 4: problem 3 |
| (C) Ability to design a system, component, or process to meet desired needs. | 4-7 | Exam 2: Problem 3  
Homework 3  
Homework 7  
Homework 9 |
| (E) Ability to identify, formulate, and solve engineering problems. | 5-6 | Final Exam: Problem 1 and Problem 2.  
Homework 5 |
| (K) Ability to use techniques, skills and modern engineering tools necessary for engineering practices. | 2, 4-7 | Final Exam, Problem 3  
Homework 6  
Homework 9 |

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.

Students worked on problems that required knowledge of discrete math. Exam 1 had problems that required math as well as engineering methods to find satisfactory solutions. Problem 2 in Exam 1 corroborated what students have learned in other digital courses about binary arithmetic. Students show competence on applying math and engineering methods.

(B) Ability to design and conduct experiments as well as analyze and interpret data.
Questions in the homework assignments and exams 1 and 2 had data about the program mix (i.e. type of instructions) that needed to be interpreted. Students were able to figure out how these data affected the performance of a computer system.

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

Homework assignment 6, problem 1 required to modify the data path and the controller of the processor in order to implement a new instruction that was needed to incorporate function calls. This problem required students to have a good understanding of the machine and be able to modify it to implement the desired instructions. In problem 3 of the second exam the students were asked to optimized the code to reduce the number of cycles. Students were able to reduce the clock cycles while keeping the program’s computations/results.

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

In homework 8 problem 1, exam2 problem 2 and final exam problem 1 students worked on problems with data from real computer systems. They were asked to calculate the performance of the system and/or optimize the system to get a better performance. All the students had a very good grasp of the basic concepts and were able to identify the potential bottlenecks. They worked out satisfactory solutions to the engineering problems presented to them.

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

In this course analytical techniques were used to obtain the performance of a computer system. Thus, questions in homework assignments and exams were targeted to apply these analytical techniques. Students had a bit of a problem at the beginning since these techniques require having a systems level perspective of the CPU. However, as the semester progressed students were able to grasp the concepts. A branch target buffer (BTB) was introduced to handle dynamic branch prediction. BTB are used by modern processors. For homework 9, students were asked to model this BTB using real benchmarks and compute the hit rate and prediction performance. Problem 3 of the final exam was a question on BTB performance. Students showed a good grasp of this concept.

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.

With a relatively small number of students (10), it was easy for me to observe their performance and work with them on the issues that they had problems with. Students in this course had had courses on digital design, microprocessors, and operating systems. Thus, they had a good background to take this course in computer architecture.

The large majority of the students demonstrated a very good understanding of computer architecture. Students were able to tackle the problems that required an in-depth understanding and the use of math and engineering methods. The grade distribution was as follows: A (4), A- (3), B+(2), and C(1). Students utilized my office hours (or made appointments) to seek help on problematic issues/concepts.
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.

Students in this course were adequately prepared for the material presented in class. They asked questions during class (which I actively encouraged) and the large majority of the questions were very relevant to the topic at hand. As mentioned earlier, students had a bit of a problem at the beginning since analytical techniques used in the course required having a systems level perspective of the CPU. However, as the semester progressed students were able to grasp the concepts. The large majority of the students attended class regularly; this in turn helped them to grasp the topics at a faster pace.

Signature __________________________________________ Date: ___May 11, 2007_______