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 2008
Instructor José G. Delgado-Frias

10th Day Enrollment 15 Number Completing Successfully (C grade or better) 15

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

Knowledge of discrete math was often required to solve problems in exams and homework. All the exams had problems that required math and engineering methods to get solutions. 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, 2 and final had data about the program mix (i.e. type of instructions) that needed to be interpreted. Students were asked to evaluate how these instructions affect the performance of a computer system. All students showed a good understanding of how to interpret the data and evaluate the machine’s performance.

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

Homework assignment 5, 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 jump and link (jal) instruction. This problem required students to have a good understanding of the machine and be able to modify it to implement the desired instructions.

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

In homework 3 and 5, problem 2 and 3 of second exam and final exam problems 1 and 2, students were asked to work with data, formulate their solutions, and solve these engineering problems. 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. Students were asked to model this BTB using real benchmarks and compute the hit rate and prediction performance.

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.

In this particular course, a good number of the students had a good background to take computer architecture. These students that had previously taken courses in digital design, microprocessors, and operating systems did particularly well in the course. In addition, having a relatively small number of students (15) made it easy to closely work with them on the issues that they had problems with.

Students demonstrated a good understanding of computer architecture at the end of the semester. 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- (5), B+ (1), B (2), B- (1), C+ (1) and C(1).

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 large majority of the students were adequately prepared for the material presented in class. In this class there are students with majors in EE and CptE. Both majors did well in class which is required for CptE but not for EE. The analytical techniques for evaluating CPU performance were of particular difficulty. These techniques require a system level evaluation as well as a very good understanding of how instructions are executed and their effect on performance. The large majority of the students attended class regularly; this in turn helped them to grasp the topics at a faster pace.

Signature __________________________________________ Date: ___ February 25, 2010 _______