Homework 4
Performance, Multiplication, Division, Floating Point Representation

Total points: 85 + 30 (Extra credit)

This assignment is due Wednesday, November 3rd 2004.

Learning Objectives

In the process of completing this homework assignment, students will develop their abilities to

- Determine the performance of a processor.
- Determine how different parameters affect the performance of a machine
- Apply Amdahl's law to determine how much speedup can be obtained by improving an architecture.
- Apply multiplication and division algorithms.
- Interpret and represent floating point numbers.

General Instructions - Submit your solutions on a separate sheet of paper.

Problems

1. [7 points] Suppose we have two implementations of the same instruction set architecture. Computer A has a clock cycle time of 4 ns and a CPI of 2.0 for some program, and computer B has a clock cycle time of 2 ns and a CPI of 1.2 for the same program. Which computer is faster for this program?

2. [8 points] Suppose we could improve the speed of the CPU in a computer by a factor of 5 (without affecting I/O performance) for 5 times the cost. Also assume that the CPU is used 50% of the time, and the rest of the time the CPU is waiting for I/O. If the CPU is one-third of the total cost of the computer, is increasing the CPU speed by a factor of 5 a good investment from a cost/performance viewpoint?

3. [Extra credit] [15 points] Problem 4.10 from Hennessy and Patterson.

4. [Extra credit] [15 points] Problem 3.23 (page IMD 3.11-5) from your text. Prove that this modified algorithm would cause at most $n/2$ adds, regardless of the multiplier, where n is the number of bits in the numbers being multiplied.

5. [15 points] Use the 2-bit Booth's algorithm to multiply 21 (multiplicand) and 27 (multiplier). Show all of your work and verify that the result is +567.

6. [15 points] Use the modified Booth's algorithm (designed in Problem 4) to multiply 21 (multiplicand) and 27 (multiplier). Show all of your work and result is +567. Compare the 3-bit Booth's algorithm to the 2-bit.

7. [15 points] Use the restoring division algorithm described in class to compute the quotient (Q) and remainder (R) if the dividend (DN) is 130 and the divisor (DR) is 11. For full credit do all of the following:
    - Express DR and DN as 8-bit unsigned numbers.
    - Initialize the 16-bit double register RDN.
    - Show the contents of RDN at each step of the algorithm.
    - On each iteration you should: indicate the bit of RDN under scrutiny; show the
    - action taken, if any, with an explanation; and, shift the contents of RDN.
    - Verify that the result (Q, R) is correct.

8. (10 points) Convert the following decimal numbers to single precision IEEE 754 floating point format:
    (a) -21.625
    (b) 9.25

9. (15 points) The following bit patterns are floating point numbers in single precision IEEE 754 format. Convert them to decimal:
    (a) 1 1001 1000 01101100000000000000000
    (b) 0 0111 1011 00110000000000000000000
    (c) 0 0000 0000 01110000000000000000000