Brown University
School of Engineering
EN1640 Design of Computing Systems
Professor Sherief Reda
HW 03. 30 points. Due Date: Wednesday April 13th in class.

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1. [8 points] Given the two decimal numbers 9.25 and 4.625:
   a. [3 points] Transform these two numbers to binary assuming a floating point format with 4 bits for the exponent part, 5 bits for the fraction and a bias of 7.
   b. [3 points] Add the two numbers in binary.
   c. [2 point] Convert the addition results from binary to decimal and verify that your solution is correct.

2. [5 points]
   a. [2 points] Give the single-precision floating point representation of the real decimal number 0.1.
   b. [1 points] Calculate the error between the floating point representation and the real value 0.1.
   c. [2 points] An embedded system uses an internal counter, *n*, that is incremented every 0.1s to keep track of time. The counter is initialized to zero, and a program can calculate the elapsed time by calculating 0.1×n. What would be error in calculating the elapsed time after 100 hours of operation?

3. [12 points] Assume that we are considering enhancing a machine by adding vector hardware to it. When a computation is run in vector mode on the vector hardware, it is 10 times faster than the normal mode of execution. We call the percentage of time that could be spent using vector mode the percentage of vectorization.
   a. [4 points] Draw a graph that plots the speedup as percentage of the computation performed in vector mode. Label the y-axis "net speedup" and label the x-axis "percent vectorization".
   b. [2 points] What percentage of vectorization is needed to achieve a speedup of 2?
   c. [3 points] What percentage of the computation runtime is spent in vector mode if a speedup of 2 is achieved?
   d. [3 points] What percentage of vectorization is needed to achieve one-half the maximum speedup attainable from using vector mode?

4. (5 points) Assume a program has 1000 instructions with a dynamic instruction count of 20% branches, 20% loads, 10% stores, and 50% ALU instructions. Calculate the runtime of the program on the following machines assuming no hazards.
   a. (1 points) A 4 GHz pipelined, 1-way superscalar machine, where we can retire only one instruction in a given cycle.
   b. (4 points) A 4 GHz pipelined, 3-way superscalar machine, where we can retire any of the following groups in a given cycle: 3 ALU instructions, or 1 load instruction, or 1 store instruction, or 3 branch instructions.