EE334 Computer Architecture **Spring 2004**
Homework 2. **Due: February 16, 2004**

Problem 1.

Consider two machines (Alpha and Beta) that have the following classes of instructions: Arithmetic and Logic integer instructions (AL), Load (Ld), Store (St), Branch (Br), Floating Point Add (FPadd), Floating Point Multiply (FPmult), and Floating Point Divide (FPdiv). Both machines have the **same** instruction set architecture. These machines execute a program that have the following instruction mix

AL:	33%	Ld:	27%	St:	9%	Br:	14.2%
FPadd:	10.5%	FPmult:	6%	FPdiv:	0.3%		

Machine Alpha has a clock rate of 3.0 GHz. For this machine instructions take the following number of cycles to be executed.

AL:	1	Ld:	2	St:	2	Br:	2
FPadd:	3	FPmult:	6	FPdiv:	30		

On the other hand, machine Beta has a clock rate of 3.8 GHz. For this machine instructions take the following number of cycles to be executed.

AL:	1	Ld:	3	St:	3	Br:	2
FPadd:	4	FPmult:	7	FPdiv:	33		

Please determine what machine is faster and by how much.

Problem 2.

A machine (with a clock rate is 4.1 GHz) executes 400 million instructions of a program. 56% of the instructions are arithmetic instructions that require 2 clock cycles to be executed, 32% are branches and 12% are memory references (either loads or stores). Branch and memory reference instructions take 3 cycles to be executed.

a) Consider an improvement for this machine, the number of cycles that are needed to execute a branch can be reduced depending on the branch decision. If a branch is taken, the machine needs 3 cycles as before. However, if the branch is not taken the machine needs only two cycles to execute the branch. In this program, 54% of the branches are taken. Please determine the impact (i.e. speedup) of the improvement.

b) Let us have an additional improvement. We incorporate a buffer that helps to reduce the number of cycles needed to execute store instructions (which comprise 33% of the memory references). Now, store instructions take 2 cycles. With these two improvements (in a and b) what is the speedup in comparison with the original machine.