ICS 152, Problem Set 2

- Please show your work.
- Bottom line answers without proper explanation are worth **zero** points.

1. Text Problem 4.6

2. Text Problem 4.10

3. Text Problem 4.11

4. Text Problem 4.48

5. Text Problem 4.51

6. CellMorph is a photo-editor for your cellphone. Morphing an image requires floating-point operations. High-end cellphones come equipped with a floating-point coprocessor that CellMorph uses. For low-end cellphones (without the coprocessor), the program uses integer-based software routines to perform the floating-point operations. Both types of cellphones use a 20MHz processor. The high-end cellphone has a CPI of 10 and takes 1 second to morph an image, whereas the low-end cellphone has a CPI of 6 and takes 10 seconds for the same task.

a) What is the MIPS (Million Instructions Per Second) rating for both runs?

b) What is the total number of instructions executed for both runs?

c) On the average, how many integer instructions does it take to perform a floating-point operation in software?

7. Suppose we enhance a machine by making all floating point instructions run five times faster. Amdahl's Law is sometimes expressed in another form that yields the speedup:

$$Speedup = \frac{performance\ after\ improvement}{performance\ before\ improvement} = \frac{execution\ time\ before\ improvement}{execution\ time\ after\ improvement}$$

(a) If the execution time of some benchmark before the floating point enhancement is 10 seconds, what will the speedup be if half the 10 seconds is spent executing floating point instructions?

(b) We are looking for a benchmark to show off the new floating point unit described above, and we want the overall benchmark to show a speedup of 3. The benchmark we are considering runs for 100 seconds with the old floating point hardware. How much of the initial execution time would floating point instructions have to account for to show an overall speedup of 3 on this benchmark?