Computer Organization and Structure

Homework #1
Due: 2015/10/6

1. Using the categories in the list below, classify the following examples. Use the letters to the left of the words in the answer. Answers in this group may be used more than once.

1. application software	2. high-level programming language
3. input device	4. integrated circuit
5. embedded computer	6. output device
7. desktop computer	8. semiconductor
9. server computer	10. systems software

   a. Assembler
   b. C++
   c. Liquid Crystal Display
   d. Compiler
   e. DRAM
   f. Keyboard
   g. Apple Mac
   h. Apple iPhone
   i. Apple iPad
   j. Microprocessor
   k. Mouse
   l. Operating System
   m. Java
   n. Blade Server
   o. Printer
   p. Silicon
   q. Spreadsheet
   r. Text Editor
   s. NVIDIA Tesra
   t. Webcam

2. Which of the following contain circuits that are likely to be combinational and which contain sequential circuits? Explain your rationale.

   a. A washing machine that sequences through the soak, wash, and spin cycles for preset periods of time.
   b. A three-input majority circuit that outputs a logic 1 if any two of its inputs are 1.
   c. A circuit that divides two 2-bit numbers to yield a quotient and a remainder.
   d. A machine that takes a dollar bill and gives three quarters, two dimes, and a nickel in change, one at a time through a single coin change slot.
   e. A digital alarm clock that generates an alarm when a preset time has been reached.

3. We wish to compare the performance of two different computers: M1 and M2. The following measurements have been made on these computers:

Program	Time on M1	Time on M2
1	2.0 sec.	1.5 sec.
2	5.0 sec.	10.0 sec.

a. Which computer is faster for each program, and how many times as fast is it?

Consider the two computers and programs as the above. The following additional measurements were made:

Program	Instructions executed on M1	Instructions executed on M2
1	5×10^9	6×10^9

b. Find the instruction execution rate (instructions per second) for each computer when running program 1.
c. Suppose that M1 costs $500 and M2 costs $800. If you needed to run program 1 a large number of times, which computer would you buy in large quantities? Why?
d. If the clock rates of computers M1 and M2 are 4GHz and 6GHz, respectively, find the clock cycles per instruction (CPI) for program 1 on both computers.
e. Assuming the CPI for program 2 on each computer as the above is the same as the CPI for program 1 found in the above sub-question, find the instruction count for program 2 running on each computer using the execution times from the first sub-question.

4. Two different sequences (S1 and S2) are being tested on a 2GHz machine with four different classes of instructions. The CPI of each different Instruction Class (I1, I2, and I3) is as the following table.

Instruction Class	Cycle for each Instruction (CPI)
I1	2
I2	4
I3	6

And also, the table below shows the number of different instructions (I1, I2, and I3) used in two different sequences (S1 and S2).

Instruction Class	S1	S2
I1	6 (billion)	13 (billion)
I2	2 (billion)	3 (billion)
I3	2 (billion)	2 (billion)

a. Which sequence will be faster according to execution time?
b. Which sequence will be faster according to MIPS?
c. From these solutions above, you should understand about the execution times used by each Instruction Class (I1, I2, and I3) in sequence S2. According to Amdahl's Law, how much do we have to improve the speed of Instruction Class: **I3** in order to make the sequence **S2** to run **1.25 times faster** on performance?

5. Suppose we enhance a computer to make all floating-point instructions run five times faster. Let's look at how speedup behaves when we incorporate the faster floating-point hardware. If the execution time of some benchmark before the floating-point enhancement is 10 seconds, what will the speedup be if half of the 10 seconds is spent executing floating-point instructions?