COSC 420: Computer Architecture

Assignment 1 (100 points)

Due date: February 1, 2024

1. (10 pts)

(a) On the IAS, what would the machine code instruction look like to load the contents of memory address 2 to the accumulator?

(b) How many trips to memory does the CPU need to make to complete this instruction during the instruction cycle?

2. (15 pts) Given the memory contents of the IAS computer shown below,

Address	Contents
08A	010FA210FB
08B	010FA0F08D
08C	020FA210FB

show the assembly language code for the program, starting at address 08A. Explain what this program does. *Hint: You may review The IAS Memory Formats (Figure 1.7) and The IAS Instruction Set (Table 1.1) to answer this question.*

3. (10 pts) Moore's Law, observed by Gordon Moore, the co-founder of Intel, in 1965, posits that the number of transistors on a microchip doubles approximately every two years, while the cost of computers is halved. Has Moore's prediction about the number of transistors over time been accurate? Please explain your answer.

4. **(15 pts)** On the IAS, describe in English the process that the CPU must undertake to read a value from memory and to write a value to memory in terms of what is put into the MAR, MBR, address bus, data bus, and control bus.

5 (20 pts) The following table, based on data reported in the literature [HEAT84], shows the execution times, in seconds, for five different benchmark programs on three machines.

Benchmark	Processor		
	R	M	Z
E	417	244	134
F	83	70	70
H	66	153	135
I	39,449	35,527	66,000
K	772	368	369

a. Compute the speed metric for each processor for each benchmark, normalized to machine R. That is, the ratio values for R are all 1.0. Other ratios are calculated using Equation (2.5) with R treated as the reference system. Then compute the arithmetic mean value for each system using Equation (2.3) . This is the approach taken in [HEAT84].

b. Repeat part (a) using M as the reference machine. This calculation was not tried in [HEAT84].

c. Which machine is the slowest based on each of the preceding two calculations?

d. Repeat the calculations of parts (a) and (b) using the geometric mean, defined in Equation (2.6) . Which machine is the slowest based on the two calculations?

6 (15 pts) Assume that a benchmark program executes in 480 seconds on a reference machine A. The same program executes on systems B, C, and D in 360, 540, and 210 seconds, respectively.

a. Show the speedup of each of the three systems under test relative to A.

b. Now show the relative speedup of the three systems. Comment on the three ways of comparing machines (execution time, speedup, relative speedup).

7 (15 pts) Repeat the preceding problem using machine D as the reference machine. How does this affect the relative rankings of the four systems?