**CPSC5041 Computing Systems Principles I**

**Homework Week 6**

**Due: 02/15/2021 on canvas.**

***(45 Points)***

1. Given a two dimensional array, with 20 rows and 30 columns, allocated in ANNA-- List[20][30]. Assume row-major ordering is used to store the array in memory and the address of the first array element (List[0][0]) is 0x1234. Assuming each array element occupies one word, what would be the memory address of the element List[10][21]. (Express the address in Hexadecimal.) (“Multidimensional Array Addresses”). **(5 points)**

There was confusion with the rest of the class on if element size is always 1 or if the element should be one word as described in the problem statement. I have given both answers here.

**1 word: 0x2644 size 1: 0x1375**

1. Both multiprocessor and multi-computer systems can employ multiple microprocessors to work on a problem simultaneously. Given this, what is the fundamental difference between a multi-computer and multi-processor system? **(2 points)**

**A multi-processor system will be able to complete the task much faster as communication between the processors is extremely fast.**

1. State TRUE or FALSE for the following statements. No reasoning needed. **(8 points)**
   1. Control unit is responsible for decoding the instructions inside the CPU.

**TRUE**

* 1. Programs written in assembly language can directly execute on the computer hardware (CPU).

**FALSE**

* 1. An assembly program written by an expert assembly programmer could run faster than an equivalent program written in a high level language.

**TRUE**

* 1. Assembler is responsible for translating the programs from Level-5 (Problem-oriented language level) to Level-4 (Assembly language level).

**FALSE**

* 1. Hardware is always faster, but more expensive than the software.

**TRUE**

* 1. All programs, by default, benefit from parallelism available in multi-core architecture.

**FALSE**

* 1. Given N-bit memory space, the total number of values that can be represented is log2N.

**FALSE**

* 1. According to Nyquist–Shannon sampling theorem if the highest frequency of a sound is 10000 Hertz, a sampling rate of at least 15000 Hertz can perfectly reconstruct the original sound.

**FALSE**

1. How long would it take to run a 100 instruction program on a single cycle datapath architecture, assuming a cycle time of 35 ns? (2 points)

**3,500 ns**

1. Suppose the processing load of a computing system consists of 70% CPU activity and 30% disk activity. Your customers are complaining that the system is slow. After research, you discover that you can upgrade your disks and make them 3.5 times faster than they currently are. You also discovered you can upgrade your CPU to make it 1.4 times faster than it currently is. You only have time to implement one upgrade. Which one do you choose and why? Show your work. **(10 points)**

70% CPU 30% disk = p

1.4 times 3.5 times = s

1.4 / .7 + 1.4(.3) 3.5 / .3 + 3.5(.7)

**1.25 (25% faster) 1.27 (27% faster)**

The disk upgrade is the better choice as it will provide a faster total upgrade.

1. Amdahl’s law limits the potential speed-up achievable on a parallel computer to the following: Speedup = n/(p + n(1-p)).
2. What is the maximum possible speed-up as the number of CPUs approach infinity? **(3 points)**

**1 / 1 - p**

1. Using the expression derived in part A, compute the speedup for p = 0.99? **(5 points)**

**1 / 1 - .99 = 100 = 100 times as fast**

1. a. Why would you prefer Direct Memory Access over Interrupts during Input/Output Operations? **(5 points)**

**With direct memory access the CPU has minimal involvement which allows for faster I/O access and fewer wasted CPU cycles.**

b. Give two distinct advantages of using system calls as a means of accessing hardware devices. **(5 points)**

**System calls allow the operating system to keep the kernel mode separate from the user mode which protects from unintended negligence or outside attacks.**

**Using system calls also abstracts the internal details of interacting with a device so that only the vendor needs to know the implantation details.**