

CS2810 Homework 2 – 50 points - Due by midnight September 13. Submit this homework through Eagle.

For this homework assignment you may work individually or in a group of up to 3 students. If working in a group, be sure that when you turn in your homework through Eagle you include the names of everyone in the group.

If a question is not answered, give 0 points.

GRADER: *I believe these answers are correct. Of course, I sometimes make a mistake so if you see everyone or several with a different answer, recheck my answer.*

Questions 1-3: (Fill in the blank) 1 point each

If all is correct except for spelling, give full credit

1.) The essence of computer science is _____

Abstraction

2.) The science of computer science is _____

Algorithms

3.) The challenge of computer science is the _____

Exception

Questions 4-6: 4 points each

4.) In decimal (exactly), if a computer has a 32-bit address for every byte in memory, how many memory locations can this computer address?

$2^{32} = 4,294,967,296$

-2 if they have the wrong value

5.) In decimal, if one does an exhaustive search of all possible paths in a traveling salesperson problem with 29 cities to visit, how many individual paths will there be? Assume that each path is a circle, i.e. after visiting all cities, the salesperson makes one final trip back to her/his start city.

Since the path is really a circle, i.e. start city is also the end city, a path like 1,2,3 is the same as a paths 2,3,1 and 3,1,2. Therefore, rather than there being 29! Paths, there are actually 28! Paths = $3.04888344612 \times 10^{29}$

If they have the correct factorial but a slightly different final result because of greater accuracy (that's all my calculator would give) then give full credit.

- 6.) Assume that you are evaluating all of the transits or paths of problem (5), and you have a computer defined as follows:

Single core
Clock speed is 4 GHz
Evaluating a single transit requires 128 clock cycles

How many seconds will it take to evaluate all of the transits of problem 5?

$$4 \text{ GHz} = 4 \times 10^9$$

Thus, this machine can perform $4 \times 10^9 / 128 = 31,250,000$ transits/second

Therefore, to do $3.04888344612 \times 10^{29}$ transits will take

$$3.04888344612 \times 10^{29} / 31,250,000 = 9.76 \times 10^{21} \text{ seconds or } 3.09 \times 10^{14} \text{ years}$$

Questions 7-11: 2 points each

- 7.) (True/False) If I examine a program in terms of its machine (binary) language instructions and the logic gates needed to execute those instructions, I am examining that program from a computer organization perspective.

True

- 8.) If it costs \$1,000,000 to build a chip manufacturing plant today, how much would you expect it to cost to build a chip manufacturing plant in 2021?

Since cost increase by a factor of 2 every 4 years it will cost \$8,000,000

- 9.) (True/False) Increasing the size of an integrated circuit die will increase the chip yield rate.

False

- 10.) (True/False) The machine level of a computer is also known as the assembly language level.

False – it is also called the ISA level but not the assembly level

- 11.) (True/False) The HIV virus' diameter is greater than the current wire width for Intel's core duo chips.

True

Questions 12-16: 5 points each

- 12.) Let's say I have a program consisting of 100,000 instructions. In building a new computer I discover that 25% of those instructions actually run twice as fast in the new machine as in the old machine. The other 75% of the instructions run at the same speed on both computers. If the old computer took 10 seconds to execute this program, how long will the new computer take to execute the program.

Using Amdahl's formula

$$\text{speedup}_{\text{enhanced}}(f, S) = \frac{1}{(1-f) + \frac{f}{S}}$$

$$\text{Speedup} = 1/((1-0.25) + .25/2) = 1.14286$$

Thus it will take 10/1.14286 = 8.75 seconds

- 13.) Let's say my favorite computer program runs in 10 seconds on computer A, which has a 2 Ghz. clock. We are trying to help a computer designer build a new machine B, that will run this program in 5 seconds. The designer can use new (or perhaps more expensive) technology to substantially increase the clock rate, but has informed us that this increase will affect the rest of the CPU design, causing machine B to require 1.25 times as many clock cycles as machine A for the same program. What clock rate should we tell the designer to target for machine B?

$$\frac{\text{Time}_A}{\text{Time}_B} = \frac{\left(\frac{1}{2 \text{ GHz}}\right) (\text{CPI}_A) (\text{Instructions})}{\left(\frac{1}{X \text{ GHz}}\right) (1.25 \text{ CPI}_A) (\text{Instructions})}$$

$$\frac{10}{5} = \frac{X}{2(1.25)}$$

$$X = \frac{25}{5} = 5 \text{ GHz}$$

- 14.) What is the performance of a system that uses 1,000,000 clock cycles to execute a program? The system has a 500 MHz clock.

Remember, Performance = 1/execution time

Normally execution time is computed as:

(# instructions)(clock cycle time)(average number of cycles/instruction or CPI)

By telling us that the program used 1,000,000 clock cycles, we know
 (# instructions)(CPI) and thus all we need is clock cycle time
Clock cycle time = 1/clock frequency

Execution time = (1/500X10⁻⁶)(10⁶)= 2X10⁽⁻³⁾
Performance = 500

- 15.) Assume that my computer has only three categories of instructions as shown in the table below. If my computer has a clock speed of 2.0 GHz, how long, in seconds, will it take to execute a 100,000,000 instruction program?

<i>Category</i>	<i>CPI</i>	<i>Frequency</i>
arithmetic	6	20%
memory	3	60%
I/O	21	20%

First compute the CPI, i.e. the average CPI

$$CPI=6*0.2 + 3*0.6 +21*0.2 = 7.2$$

Thus, the execution time is

$$exTime = CPI*clock\ cycle\ time * Number\ of\ Instructions$$

$$exTime=7.2 * (1/(2X10^9)) * (100X10^6) = 0.36\ seconds$$

- 16.) Consider the computer in problem 15 as computer A, and computer B is defined as follows:

<i>Category</i>	<i>CPI</i>	<i>Frequency</i>
arithmetic	10	15%
memory	4	45%
I/O	15	40%

If both computers have the same clock rate, and for any program require the same number of instructions, which will have the better performance?

$$CPI\ computer\ B = 10*0.15 + 4 * 0.45 + 15 *0.4 = 9.3$$

Since the CPI of machine B is > that of Machine A, Machine A will have the better performance.