COMP 273
Assignment #2
Due: Thursday February 12, 2014 at 23:30 on myCourses

Elements of a CPU

Please answer these questions on your own and submit your own unique solution to myCourses.

QUESTION 1: Full 3-Bit Adder (10 Points)

In class we saw a circuit diagram for an 1-bit full adder. This question asks you to build a 3-bit full adder. You do not need to use black-boxes, but you can create some if you like. You are permitted to use only the following elements from Logisim: clock, flip-flop (any kind), wires, gates (and,or,not,xor), and input + output pins. No other custom elements can be used. The circuit you will build for this question will have the following elements:
   - A 3-bit L-register (storing the first operand)
   - A 3-bit R-register (storing the second operand)
   - The 3-bit full adder (computes only positive integer numbers from 0 to 7)
   - A 3-bit A-register (storing the answer)
   - A 1-bit status register recording the overflow from the adder.

Your circuit must be able to add all numbers from 0 to 7. It must be able to handle overflows. Using input pins store a number into the L-register and another number into the R-register. Then turn on the clock and the answer and overflow should appear in the A-register and overflow bit (status register). The A-register and the 1-bit status register must be actual registers. You can use out pins to let the user see what is stored in them.

QUESTION 2: CPU Computations (10 Points)

Answer the following questions:

(A) If a CPU runs at 2 GHz then how many clock ticks does it make in a second?
(B) If a CPU "cycle" is 2 nanoseconds (ie. 2×10^{-9} seconds) then how many clock ticks make 1 cycle?
(C) What does a cycle mean given (B)?
(D) In many of today's microprocessors a pipeline is used to speed up execution of instructions in stages. If we have an 4-stage pipeline and we assume it takes 1 cycle of 2 nanoseconds to pass through a single stage, how many instructions (fully and fractionally) can our four stage CPU execute in 1 second?
(E) Assume we have a classical CPU similar to (D). It needs 4 steps to execute any instruction, and each step takes 1 cycle of 2 nanoseconds. It can execute only one instruction at a time. How many instructions can it execute in 1 second?
(F) Compare the results from (D) and (E). Why is one faster than the other.

WHAT TO HAND IN

Everything should be handed in electronically on myCourses.

Each student is to submit his or her own unique solution to these questions. Please submit this as a Logisim or PDF file. Please submit this in the box called Assignment #2.

This assignment is due on the same day as the midterm exam. This is less than 2 weeks.

HOW IT WILL BE GRADED

This assignment is worth 20 points, the questions are graded proportionally.

- Question 1 – total 10 points (hand in as a Logisim file)
  - 5 points – Adder
  - 3 point – R, L and A registers
  - 2 point – Status register
  - The TA must be able to run the circuit and test it fully
- Question 2 – total 10 points (hand in as PDF)
  - (A) and (B) are 1 point each
  - (C), (D), (E), (F) are 2 points each