CS1S Computer Systems: Questions
May 2016

Duration: 1 hour
Rubric: Answer both questions
This examination is worth a total of 50 marks

1. **(a)** Convert 1110 1011 to a decimal number, assuming binary representation.

[2]

(b) Convert 1110 1011 to a decimal number, assuming two's complement representation.

[3]

(c) All of the four-digit constants in this question are hexadecimal numbers. Suppose R1 = 002b; R2 = 0004; R3 = ffff. Also suppose mem[002b] = 00a3; mem[002c] = 0c21; mem[002d] = ca00. Consider the following Sigma16 instructions. Give the values of registers R4, R5 and R6 after the instructions are executed.

```
load   R4,$0002[R1]
lea    R5,$0003[R1]
add    R6,R2,R3
```

[3]

(d) Explain what the Sigma16 instruction `trap R1,R2,R3` does. Give two differences between a `jump` instruction and a `trap` instruction, and explain why `trap` (rather than `jump`) is used to make a request to the operating system.

[5]

(e) There is an array named `x` that contains `n` integers, where `n` is an integer variable in memory. Write a Sigma16 assembly language program that overwrites each element of the array with its absolute value. The program should define `n = 6` and define the initial elements of the array as 3, 0, -41, 7, -9, 2. After the program runs the elements should be 3, 0, 41, 7, 9, 2, but the program must work correctly for any nonnegative `n` and initial array elements.

[12]

2. **(a)** Describe the behavior of a 1-bit register (the reg1 circuit). Draw a diagram of the circuit.

[4]

(b) Explain the purpose of the clock in a synchronous circuit. Describe how a suitable clock speed for the circuit is determined.

[5]

(c) Give two reasons that user programs are not allowed to execute Input/Output instructions directly, but must request the Operating System to perform I/O.

[4]

(d) Define the term *privileged instruction*. Explain how privileged instructions prevent the user from performing I/O directly.

[4]

(e) Host A is sending packets through the Internet to Host B, and these packets normally go through a router R. Suppose the router R fails because it loses power. Explain how the Internet can eventually recover and regain the ability to send packets from A to B.

[8]