CMPUT 229 - Computer Organization And Architecture I
Quiz #3 — Winter 2014

Name: ___Solution_____

CMPUT 229 Honor Code

By turning in the quiz solution for grading, I certify that I have produced the solution in accordance to the academic integrity policies in Section 26.1 of the University of Alberta 2013/2014 Calendar.

Question 1 (10 points):

A MIPS program is executing with PC = 0x8000 0000. In the table below, indicate what is the lowest and the highest memory address at which the next instruction executed could be if each of the instructions indicated is at address 0x8000 0000.

Instruction at 0x8000 0000	Next Instruction	
	Lowest Possible Address	Highest Possible Address
bne	0x7FFE 0000	0x8002 0000
j	0x8000 0000	0x8FFF FFFC
jr	0x0000 0000	0xFFFF FFFC

Explanation:

(bne:) Branch instructions (I-type), 16-bit offset

Lowest address comes from most negative offset:
→ 0x8000 is most negative offset (in 16 bits)
→ multiply by 4 + sign extend to 0xFFFE 0000
(0x8000 → 1000 0000 0000 0000

→ 1111 1111 1111 1110 0000 0000 0000 0000

Then New PC = Old PC + 4 + offset
= 0x7FFE 0004 (ignore overflow)

Highest address comes from most positive offset.

→ 0x7FFF is most positive 16 bit value.

→ multiply by 4 ⇒ 0x1FFFC

→ sign extend to 32 bits ⇒ 0x0001 FFFC

New PC = Old PC + 4 + offset

$$= \begin{array}{r} 0x8000\ 0000 \\ 0x0001\ FFFC \\ +\ 0x0000\ 0004 \\ \hline \boxed{0x8002\ 0000} \end{array}$$

(j:) Jump instructions have 26 bits for address.
  Ranging from   0x000 0000 (26 bits)
        to   0x3FF FFFF (26 1 bits)

  Then multiply by 4 to get address in 28 bits
      (0x000 0000 and 0xFFF FFFC)

  Take the leftmost 4 bits from the PC.

  So the lowest address is $\boxed{0x8000\ 0000}$ and
  the highest is $\boxed{0x8FFF\ FFFC}$

(jr:) A jr instruction sets the PC to the value of
  the specified register.

  The lowest address that can be in a register
  is $\boxed{0x0000\ 0000.}$

  The highest is $\boxed{0xFFFF\ FFFC}$, since instruction
  are word addressed.