The UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Comp 411 Computer Organization
Prof. Montek Singh
Fall 2012

Quiz #2, Monday 10/15/12 — Solutions
15 minutes, 10 points

Instructions: **Circle ONE correct/best answer for each question below. If you make a mistake, completely erase your selection (or fill it solid entirely), and then mark one clear circle.**

1) The von Neumann model of a computer consists of three major components: the central processing unit (CPU), main memory, and input-output. In which of these components might we find the 32 registers of a MIPS processor?
   A. CPU
   B. Main memory
   C. Input-output
   D. CPU as well as main memory
   E. Main memory as well as input-output

   Correct answer is A. The registers are in the CPU, not in the memory.

2) Suppose we want to put the 32-bit value 0x456789AB into register **`$4`**. Which of the following is a good sequence of assembly instructions to do so?
   A.
```
addi $4, $0, 0x4567
sll $4, $4, 8
addi $4, $4, 0x89AB
```
   B.
```
addiu $4, $0, 0x4567
srl $4, $4, 8
addiu $4, $4, 0x89AB
```
   C.
```
lui $4, 0x4567
addi $4, $4, 0x89AB
```
   D.
```
lui $4, 0x4567
addiu $4, $4, 0x89AB
```
   E. All of the above

   Correct answer is D. C is incorrect because you need the addiu instruction (or, alternatively, ori) to ensure that the immediate is padded with zeros to its left, and not with its sign. A is incorrect because it uses addi for the 0x89AB part, and also because it shifts left by only 8 bits instead of 16. B is incorrect because it shifts right by 8 instead of left by 16.

3) Which of the following instructions, when encoded in binary, has a field that holds an immediate/constant value that is *NOT automatically multiplied by 4* during execution by the CPU:
   A. **`lw $4, 4($4)`**
   B. **`sll $4, $4, 2`**
   C. **`bne $4, $1, 0x0100`**
   D. **`jal 0x0100`**
   E. The **`lw`**, **`bne`** and **`jal`** instructions above
   F. The **`lw`** and **`sll`** instructions above

Correct answer is F. The lw instruction has an immediate value of 4, which is simply added to the value of register $4; there is no automatic multiplication by 4. The sll instruction has an immediate/constant value of 2, which is the number of bit positions by which the shifting takes places; there is no automatic multiplication of 2 by 4. The bne and jal instructions, on the other hand, contain an immediate that is automatically multiplied by 4 (to convert words to bytes) before being used to compute the jump/branch address. Hence, the answer is F. (Half credit if you choose only A or only B.)

4) Which of the following CANNOT be compiled as a single valid MIPS instruction:
   A. `addu $s6, $s7, $t8`
   B. `mul $2, $3, $4`
   C. `lw $2, -3($4)`
   D. `la $2, -3($4)`
   E. None of the above

   Correct answer is B. The mul instruction cannot be compiled as a single instruction. One would need a mult followed by an mflo, for example, to implement this instruction.

5) If **a** is of type **double*** in C, and each double is 8 bytes long, then which of the following C Boolean expressions is *FALSE:*
   A. `a == &a[0]`
   B. `*(a+i) == a[i]`
   C. `&a[j] == a+j`
   D. `a[4] == *(a+32)`
   E. None of the above

   Correct answer is D. When adding a number to a pointer in C, the multiplication by the size of the object being pointed to (in this case, size of a double is 8) is automatically done by the C compiler. Thus, a[4] == *(a+4). Hence, choice D is the false one.

6) Which of the following addressing modes is available in MIPS?
   A. Memory indirect
   B. Displacement
   C. Autoincrement
   D. Indexed
   E. Scaled

   Correct answer is B. None of the others are available in MIPS.

7) The following five assembly statements reserve space for five different variables/arrays, named A, B, C, D and E. Circle the one that reserves a different amount of space than the other four:
   A. `A: .byte 1, 2, 34, 45, 0, 0, 4, 8`
   B. `B: .word 0, 0`
   C. `C: .asciiz "Comp 411"`
   D. `D: .asciiz "Quiz #2"`
   E. `E: .space 8`

   Correct answer is C. The string "Comp 411" needs 9 bytes (including its terminal NULL), while all others need 8 bytes.

8) Suppose *ProcedureA* calls *ProcedureB* with six arguments (*arg[0]—arg[5]*), and that registers **`$sp`** and **`$fp`** are properly managed by the assembly code. Within *ProcedureB,* how would the code read the argument *arg[5]* into register **`$5`**?

A. `lw $5, 4($fp)`
B. `lw $5, 8($fp)`
C. `lw $5, 5($sp)`
D. `lw $5, 20($sp)`
E. `ori $5, $a5, 0`

Correct answer is B. The spillover arguments (arg[4], arg[5], etc.) are stored in memory just above the location pointed to by the frame pointer. Therefore, arg[5] is at $fp+8.

9) Suppose the **`main`** part of your assembly code occupies the range of memory locations 0 to 63 (0x00000000 to 0x0000003F). Now, suppose within **`main`** you need to call a procedure that is located at the memory address 0xFFFFFF00 (really high address). Which of the following would be a good instruction to implement this procedure call?

A. **`j`**
B. **`jal`**
C. **`jr`**
D. **`jalr`**
E. **`beq`**

Correct answer is D. Since this is a procedure call, which requires the return address to be saved, the only candidates are jal and jalr. The jal instruction has a limitation that the 4 highest bits cannot be changed from their current value (see lecture slides). Thus, jalr must be used.

10) Which of the following statements is true?

A. Noise and inaccuracy can be completely removed from a given physical system.
B. Noise limits our ability to accurately reproduce analog information.
C. A digital signal can represent much more information than an analog signal.
D. An advantage of using voltage to encode information is that it is easy to transmit wirelessly.
E. A disadvantage of using voltage to encode information is that voltage changes are very slow.

Correct answer is B. Noise cannot be completely removed; even in a digital system, there is always a non-zero chance that noise will corrupt a value. A digital signal only represents one bit, while an analog signal represents a whole lot more information (log2 of the number of distinct values, which is potentially infinite). Voltages need wires to transmit, but voltage changescan be very fast.