CSE 490/590 Spring 2023: Quiz 1, Version B SOLUTIONS

February 27, 2023 **Duration: 40 minutes**

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[Question 1]

Consider three different classes of instructions: Class A, Class B, and Class C. The following table gives the number of cycles required to execute a single instruction from each class of instructions.

Instruction Type	Number of Cycles
Class A	5
Class B	4
Class C	6

The first code sequence has 10 instructions: 5 of A, 3 of B, and 2 of C. The second sequence has 9 instructions: 3 of A, 3 of B, 3 of C.

a. Which sequence will be faster (find the number of cycles)? By how much? Show your work.
   1st: (5*5)+(3*4)+(2*6) = 25 + 12 + 12 = 49 cycles
   2nd: (3*5)+(3*4)+(3*6) = 15 + 12 + 18 = 45 cycles
   49 - 45 = 4 cycles
   The first sequence is faster by 4 cycles.

b. What is the CPI for each sequence? Show your work.
   1st: 49 cycles / 10 instructions = 4.9 CPI
   2nd: 45 cycles / 9 instructions = 5 CPI

[Question 2]

In the following instruction sequence for a MIPS 5-stage pipelined datapath, list the data hazards:

```
lw $s1, 4($s2)
addi $s3, $s1, 8
sw $s1, 8($s4)
add $s5, $s3, $s6
```

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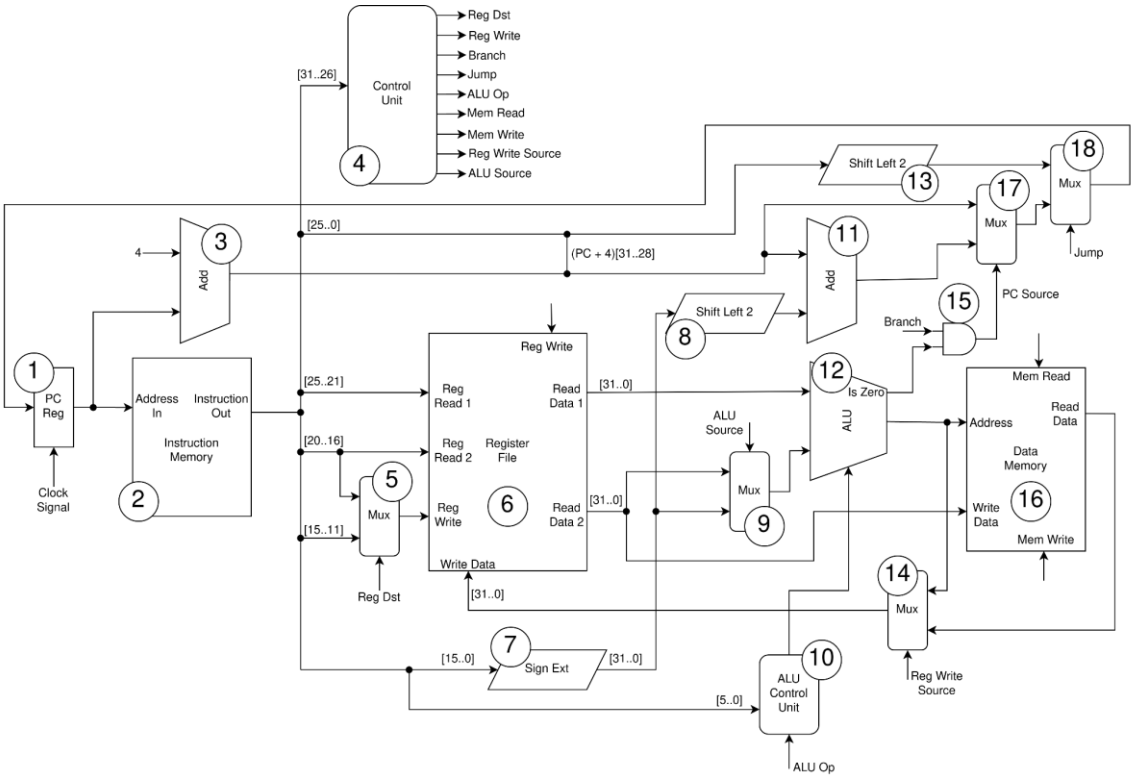
[Question 3]

Given the following single cycle MIPS datapath:



a. For each of the following instructions, list the stages that are necessary for the execution of the given instruction: (IF, ID, EX, MEM, WB)

   i. or $s5, $s5, $s6

   IF, ID, EX, WB

   ii. sw $t5, 4($t3)

   IF, ID, EX, MEM

b. For each of the following instructions, list the component numbers (as shown in the diagram above) that are required for the given instruction:

   i. or $s5, $s5, $s6

   Needed: 1, 2, 5, 6, 9, 12, 14

   Optional (Control Path, PC update): 3, 4, 10, 17, 18

   Wrong: 7, 8, 11, 13, 15, 16

   ii. sw $t5, 4($t3)

   Needed: 1, 2, 6, 7, 9, 12, 16

   Optional (Control Path, PC update): 3, 4, 10, 17, 18

   Wrong: 5, 8, 11, 13, 14, 15

[Question 4]

Given the instructions below:

```
sub $t0, $t1, $t2
add $t3, $t4, $t4
sw $t5, 4($t6)
lw $t7, 0($t3)
```

Considering data forwarding, compute the number of cycles needed and explain where data forwarding would be needed to avoid data hazard(s). Show your work.

Instruction	1	2	3	4	5	6	7	8	9	10
`sub $t0, $t1, $t2`	F	D	E	M	W					
`add $t3, $t4, $t4`		F	D	E	M	W				
`sw $t5, 4($t6)`			F	D	E	M	W			
`lw $t7, 0($t3)`				F	D	E	M	W		

[Question 5]

a. Consider a byte-addressable memory system with the following contents:

Memory Location	Value
0x4a68	0x20
0x4a69	0x7b
0x4a6a	0x15
0x4a6b	0x09
0x4a6c	0x86
0x4a6d	0xc7
0x4a6e	0x92
0x4a6f	0x65

If the following instruction is executed:

```
lw $t0, 6($t1)
```

$t1 contains the address 0x4a62. What will $t0 contain? Use Big-Endian.

0x207b1509

b. Assume that $s0 contains the value 0x34343434 and $s1 contains the address 0x3ccc3333. Assume that the memory data, starting from address 0x3ccc3333 is: 44 33 22 11. What will be the value of $s0 after the following code is executed:

```
lbu $s0, 0($s1)
```

0x00000044