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

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

Label Here

[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	3
Class B	2
Class C	5

The first code sequence has 12 instructions: 3 of A, 2 of B, and 7 of C. The second sequence has 11 instructions: 5 of A, 4 of B, 2 of C.

a. Which sequence will be faster (find the number of cycles)? By how much? Show your work.
   1st: (3*3)+(2*2)+(7*5) = 9 + 4+ 35 = 48 cycles
   2nd: (5*3)+(4*2)+(2*5) = 15 + 8 + 10 = 33 cycles
   48 - 33 = 15 cycles
   The second sequence is faster by 15 cycles.

b. What is the CPI for each sequence? Show your work.
   1st: 48 cycles / 12 instructions = 4 CPI
   2nd: 33 cycles / 11 instructions = 3 CPI

[Question 2]

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

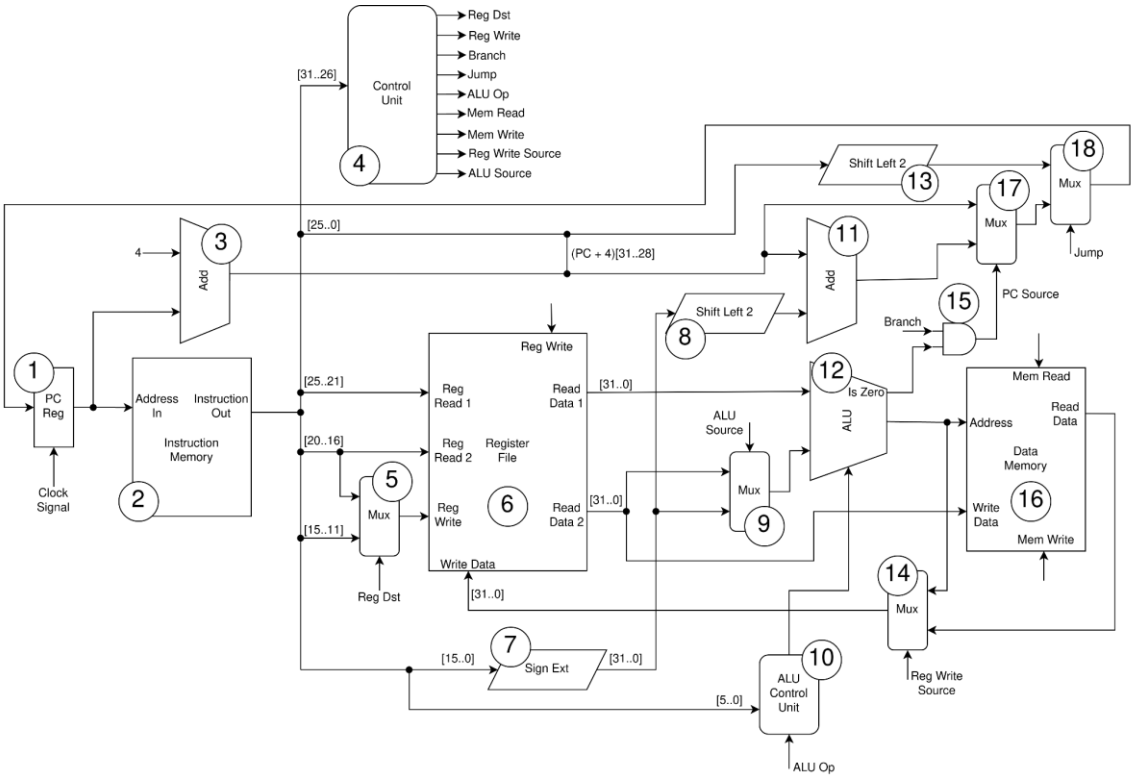
```
add $s2, $s1, $s1
sub $s3, $s3, $s2
sw $s3, 16($s4)
or $s5, $s5, $s3
```

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

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

[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. sw $s3, 24($s1)

   IF, ID, EX, MEM

   ii. addi $t0, $t1, 12

   IF, ID, EX, WB

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. sw $s3, 24($s1)

   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

   ii. addi $t0, $t1, 12

   Needed: 1, 2, 5, 6, 7, 9, 12, 14

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

   Wrong: 8, 11, 13, 15, 16

[Question 4]

Given the instructions below:

```
sub $s3, $s1, $t1
addi $t2, $t3, 4
sub $s4, $t0, $s3
sw $s5, 0($t4)
```

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 $s3, $s1, $t1	F	D	E	M	W					
addi $t2, $t3, 4		F	D	E	M	W				
sub $s4, $t0, $s3			F	D	E	M	W			
sw $s5, 0($t4)				F	D	E	M	W		

[Question 5]

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

Memory Location	Value
0x1246	0x56
0x1247	0xa2
0x1248	0x93
0x1249	0x53
0x124a	0x21
0x124b	0x19
0x124c	0x67
0x124d	0x83

If the following instruction is executed:

```
lw $t0, 4($t1)
```

$t1 contains the address 0x1244. What will $t0 contain? Use Big-Endian.

0x93532119

b. Assume that $s0 contains the value 0x34343434 and $s1 contains the address 0x3ccc3333. Assume that the memory data, starting from address 0x3ccc3333 is: 99 88 77 66. What will be the value of $s0 after the following code is executed:

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

0x00000099