

# CS232 - Digital Logic Design and Computer Architecture

## Problem Set 3

14th Feb 2023

Q1. Consider the following MIPS program:

fun:	1
bne \$a1,\$zero,lbl	2
li \$v0,1	3
jr \$ra	4
lbl:	5
addi \$sp,-4	6
sw \$ra,0(\$sp)	7
addi \$a1,\$a1,-1	8
jal fun	9
mul \$v0,\$v0,\$a0	10
lw \$ra,0(\$sp)	11
addi \$sp,4	12
jr \$ra	13
main:	14
li \$t0,2	15
li \$t1,4	16
move \$a0,\$t0	17
move \$a1,\$t1	18
jal fun	19

If the program execution begins from **main** and the initial value of **\$sp** is 0xf064. Then list all the possible values of **\$sp** at:

- (a) line number 3.
- (b) line number 8.
- (c) line number 13.

Q2. Consider the previous question (Q1). For all lines of the program, specify the following:

- (a) The type of Instruction.
- (b) The addressing mode of the Instruction.

Q3. Suppose there is a system which has 32 bit instructions and 32 general purpose registers. Answer the following questions:

- What is the number of bits required for the registers?
- Is it possible to have various operations consisting of 20 three-address instructions, 22 two-address instructions and 10 one-address instructions?

Q4. Consider the following code segment:

int a, b, c, d, e, f, g, h, i, j, k, l, m, n, o;	1
a = b * c;	2
d = a - e;	3
f = d + g;	4
h = f * i;	5
k = h - l;	6
m = k + n;	7
o = m * k;	8

- If you are using temporary registers of MIPS ISA for the code segment, will there be any spill to the memory?
- If you are allowed to change the number of temporary registers, then what is the minimum number of registers required so that there is no spill to the memory for the given code segment?

Q5. Consider the following program, in which the execution starts from `main`:

fun3:	1
move \$v0, \$ra	2
jr \$ra	3
fun2:	4
addi \$sp, \$sp, -4	5
sw \$ra, (\$sp)	6
move \$t0, \$a0	7
jal fun3	8
move \$t1, \$v0	9
mul \$v0, \$t0, \$t0	10
lw \$ra, (\$sp)	11
addi \$sp, \$sp, 4	12
addi \$t1, \$t1, 0x4c	13
sw \$t1, (\$sp)	14
jr \$ra	15
fun1:	16
addi \$sp, \$sp, -4	17
sw \$ra, (\$sp)	18
jal fun2	19
addi \$v0, \$v0, 1	20
lw \$ra, (\$sp)	21
addi \$sp, \$sp, 4	22

```
        jr $ra                                23
main:                                         24
        li $t0, 5                            25
        li $s1, 0                            26
        move $a0, $t0                        27
        jal fun1                             28
        move $s1, $v0                        29
        addi $t2, $s1, 2                     30
        nop                                  31
```

What will be the value in the register **\$t2** after program execution?

Q6. Consider the following program:

```
        li $t0, 0xdecadead                   1
        li $t1, 0x00000bed                   2
        add $t3, $t0, $t1                    3
        sw $t0, 65($t3)                      4
        lb $s3, 66($t3)                     5
        lb $s4, 64($t3)                     6
```

What will be the value of the register **s3** and **s4** (with explanations), if the computer is:

- (a) big-endian
- (b) little-endian

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