

CSC3420 Computer System Architectures  
 2<sup>nd</sup> Term, Year 2008-2009 Quiz 3  
Suggested Solution

**Q1) Recursive Procedural Call**

[45 marks]

a) [25 marks: 2 for main(9). (2+3)\*4 for the four ipow calls(cycle + reason). 3 for correct total]

<i>Parts</i>	<i>Value of n</i>	<i>Cycles Needed</i>	<i>Reason (if applicable)</i>
Starting segment		9	Goes through 0x1000 to 0x1020
ipow(3,5)	5	18	5 is odd, goes through 0x00C8 to 0x010C
ipow(3,2)	2	16	2 is even, goes through 0x00C8 to 0x0100, and 0x010C
ipow(3,1)	1	18	1 is odd, goes through 0x00C8 to 0x010C
ipow(3,0)	0	5	0 is base case, goes through 0x00C8 to 0x00D0, and 0x0110 to 0x0114
<b>Total</b>		<b>66</b>	

b) [20 marks: 2 for \$sp. (1+1)\*9 for the nine rows]

<b>\$sp</b>	0xFFC4
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Stack:

<i>Address</i>	<i>Value</i>	<i>Content</i>
0xFFBC		
0xFFC0		
<b>0xFFC4</b>	3	a
0xFFC8	0	n
0xFFCC	0x00EC	ra
0xFFD0	3	a
0xFFD4	1	n
0xFFD8	0x00EC	ra
0xFFDC	3	a
0xFFE0	2	n
0xFFE4	0x101C	ra
0xFFE8	<b>3</b>	<b>a</b>
0xFFEC	<b>5</b>	<b>n</b>
0xFFFF0	?	<b>Old \$ra</b>

**Q2) Control Signal**

[40 marks]

[10 marks for 1st lw hazard, 10 marks for 2nd lw hazard, 5 marks for bubbles, 5 marks for each forwarding, -10 for wrong bubble positions, -5 for extra bubbles]

Intr. \ Clock cycle	CC1	CC2	CC3	CC4	CC5	CC6	CC7	CC8	CC9	CC10	CC11	CC12
lw \$s1, 1000(\$s0)	IF	ID	EX	MEM	WB						IF	ID
lw \$s3, 1000(\$s1)		IF	ID	IF	EX	MEM	WB					IF
add \$s4, \$s4, \$s3			IF	IF	ID	IF	EX	MEM	WB			
add \$s4, \$s4, \$s3					IF	IF	ID	EX	MEM	WB		
addi \$s0, \$s0, 4							IF	ID	EX	MEM	WB	
bne \$t1, \$s0, LOOP								IF	IF	ID	EX	MEM
sub \$s0, \$s0, \$s0										IF		

**Q3) 64-bit word addition**

[15 marks]

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add $s5, $s1, $s3           # $s5 = $s1 + $s3
add $s6, $s2, $zero        # $s6 = $s2
addi $s1, $zero, 1         # $s1 = 1
N_CMP  bne $s4, $zero, DO
      bne $s1, $zero, N_OVF # $s4 = 0, Not Overflow
DO     addi $s6, $s6, 1
      addi $s4, $s4, -1
      bne $s6, $zero, N_CMP # $s6 = 0, Overflow
      addi $s5, $s5, 1      # $s5 = $s5 + 1
N_OVF  add $s6, $s6, $s4    # Add the reminding to $s6
    
```

(Most complete solution adopted from Yip Tsz Hong)

[7 marks for reasonable overflow detection, 5 marks for detected handling, 3 marks for handling all cases]