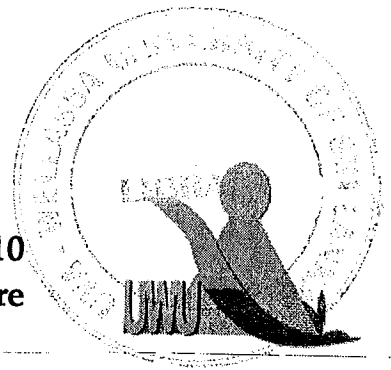


Uva Wellassa University, Sri Lanka
End Semester Examination – January 2010
CST303-2 Computer Systems Architecture



Time: Two (02) hours

Total 04 Questions. Answer all questions.

- 01) The C function given below searches for a given element in an array of integers $v[]$, which contains n items and returns true if the element is found.

```
boolean search (int v[ ], int soughtKey) {  
    int i;  
    for (i = 0; i < n; i++)  
        if (v[i] == soughtKey)  
            return true;  
    return false;  
}
```

- I. This function is translated into MIPS as shown below. Registers $\$s2$, $\$s3$ and $\$s5$ correspond to $V[]$, $soughtKey$ and n respectively. The values 0, 1 and 4 are stored in $\$s0$, $\$s1$ and $\$s4$ registers and they are fixed through the program. $\$t1$ is used to store the variable 'i'. The output '1' for 'true' or '0' for 'false' is stored in $\$t7$ as the return value. Find the errors, write their line number on your answer script and correct them.

```
1 search :  
2     lw $t0, 0($s0)  
3     addi $t1, $0, 1  
4 loop :  
5     beq $t1, $s5, exitiffalse  
6     mul $t2, $t1, $s4  
7     add $t2, $t2, $s0  
8     lw $t2, 0($t2)  
9     beq $t2, $s3, exitiftrue  
10    addi $t1, $t1, 1  
11    j loop  
12 exitiffalse :  
13    add $t7, $s0, $s0  
14    j exit  
15 exitiftrue :  
16    add $t7, $s0, $s1  
17 exit :
```

(05 marks)

- II. Assume you run this program on a 500 MHz processor, with a clock cycle time 2 ns. The CPI for different types of MIPS instructions are given below;

Instruction Type	CPI
Arithmetic and logical	4
Multiplication	10
Loads	5
Branches and jumps	3

- a. Assume that an array with the numbers from 101 to 1 in descending order (101, 100, 99, ..., 3, 2, 1) is passed to the search method. What would be the exact CPU time for the function call?

(10 marks)

- b. It is possible to replace `mul $t2, $t1, $s4` by the following two instructions.

`add $t2, $t1, $t1`

`add $t2, $t2, $t2`

What would be the exact CPU time (in ns) if we made this modification to the original (corrected) code, and called the search function with the same input array 101, 100, 99, ..., 3, 2, 1?

(10 marks)

- c. What is the performance increase or decrease of the modified code in Part b. compared to the original (corrected). You may leave your answer as a fraction. You have to mention whether it is a performance increase or a decrease.

(5 marks)

- 02) I. What do you understand by the term 'Principle of Locality'?

(04 marks)

- II. Briefly state how caches take advantage of principle of locality.

(05 marks)

- III. Briefly state the methods used to eliminate memory inconsistencies due to the presence of cache, identifying advantages and disadvantages in each method.

(06 marks)

- IV. What is 'Virtual Memory'? State the main advantages of virtual memory.

(05 marks)

- V. Briefly describe the two methods used in address translation in virtual memory environment.

(05 marks)

03)

Assume that you are working at Intel™ as the lead designer of a new processor. You have already designed the processor and now you should decide whether to produce the current design or an improved version of it. The hardware engineering team has given you the following points.

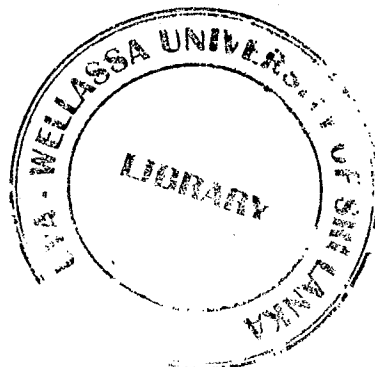
Point 1 : The current design (we call it Machine A), has a clock rate of 4000 MHz and the following measurements have been taken using a simulator.

Operation	Frequency	Clock Cycles
ALU	40%	1
Load	30%	5
Store	20%	3
Branch	10%	2

Point 2 : The hardware team claims that the current design can be improved to give a clock rate of 4200 MHz (we call it Machine B), and the following measurements have been taken using a simulator.

Operation	Frequency	Clock Cycles
ALU	40%	1
Load	30%	4
Store	20%	3
Branch	10%	2

- I. What is the overall CPI for each machine?
(06 marks)
- II. Using the calculated CPI values, on average how much faster does an instruction execute in Machine A than in Machine B.
(06 marks)
- III. If your program has 100 billion (100×10^9) instructions, how much time would you save?
(08 marks)



03) I. What is 'Pipelining'? (05 marks)

II. Briefly describe the main three types of pipeline hazards. (06 marks)

III. Briefly describe the solutions for each of the hazard. (06 marks)

IV. Identify the hazards in the following code sequence using the multiple clock cycle representation.

```
sub $S2, $S1, $S3
add $S12, $S2, $S5
or $S13, $S6, $S2
add $S2, $S2, $S2
sw $S15, 100($S2)
```

(08 marks)