



United International University
Department of CSE
CSE 313: Computer Architecture
Midterm Examination
Summer 2022

Time: 1 hour and 45
minutes

Full Marks: 30

[Any examinee found adopting unfair means will be expelled from the trimester / program as per UIU disciplinary rules.]

[N.B.: Answer all the questions. Assume any data if it is not mentioned explicitly.]

1. a) Suppose, there are three classes of instructions A, B, and C in a particular instruction set architecture with CPIs 1.2, 2, and 2.5 respectively. The number of instructions from each class in two separate programs is as follows: [5]

Programs	Instruction classes		
	A	B	C
P1	40	10	16
P2	12	13	40

If both the programs are run on the same device with a clock frequency of 2GHz, then find out which program is faster and by how much.

- b) Assume that a processor with a 4GHz clock rate is executing a program that requires the following instruction types.

Instructions	FP	INT	L/S	Branch
Instruction count (10^6)	160	110	10	16
CPI	2	1	5	2

If you want to run the program two times faster than now, then how much should you improve the CPI of FP instructions?

$$\text{CPU Time} = \text{C.C} \times \text{CCT} \\ = \frac{\text{CC}}{\text{CR}}$$

$$\text{CC} = \text{IC} \times \text{CPI}$$

$$\text{IC} \cdot \text{CPI} = \text{CC} \rightarrow \text{CPU Ti} \\ = \frac{\text{CC}}{\text{CR}} \rightarrow \text{CPU Time}$$

$$= \text{C.C} = ?$$

$$\text{CC} = \text{IC} \times \text{CPI} \\ \text{CPU Time} = \frac{\text{CC}}{\text{CR}} \\ \text{Total Time} = \frac{\text{CPU Time}}{5} \\ \text{impr} = 2$$

$$T_{\text{imprsed}} = \frac{\text{affected}}{n} + \text{unaffected}$$

c) Explain Amdahl's law with an example. Also, write in brief about the parameters in Amdahl's law. *power wall*

[2]

2. Consider the following C function that accepts two arguments, **an integer array** and the **length of the array n**. This function doubles the value of the positive integers in the array and returns the sum of the updated positive integers. The starting MIPS assembly instruction address is 1000.

```
int pos_sum(int a[], int n) {
    int sum = 0, i = 0;
    while (i < n) {
        if (a[i] > 0) {
            a[i] = 2 * a[i];
            sum += a[i];
        }

        i++;
    }
    return sum;
}
```

Handwritten notes:

13
6
1110 ≥ 14
4
1110 ≥ 14
M = 1101
-M = 0010
L = 0110
R = 0000 0110
R - L = 0110
R = 0110 1101
R - L = 1110 1012

Assume that the variable **sum** corresponds to the register **\$s1** and the variable **i** corresponds to **\$s2**.

- Convert the code to the corresponding MIPS assembly instructions. [6]
 - Convert the first 8 lines of your assembly instructions to the corresponding machine code. No need to convert it to binary. [5]
 - Consider an array **A**, whose base address is in **\$s3**. The ISA is **double word addressable**, that is the memory can contain double words. What will be the corresponding MIPS assembly code for accessing the **address** of the 9th element of the array, i.e **A[9]**. (Write in a single line) [2]
3. a) Simulate the division algorithm to divide B by A, where A = 0100 and B = 1110. Show all the iterations and steps required to complete this division. [3]
- b) Draw the flowchart of above simulation. [2]

MIPS Machine Codes

Instruction	Opcode	Function Code
add	0	32
sub	0	34
lw	35	
sw	43	
and	0	36
or	0	37
nor	0	39
andi	12	
ori	13	
sll	0	0
srl	0	2
beq	4	
bne	5	
slt	0	42
j	2	
jr	0	8
jal	3	
addi	8	

MIPS Registers

Name	Register Number
\$zero	0
\$at	1
\$a0-\$a4	2-3
\$a0-\$a3	4-7
\$t0-\$t7	8-15
\$s0-\$s7	16-23
\$t8-\$t9	24-25
\$k0-\$k1	26-27
\$gp	28
\$sp	29
\$fp	30
\$ra	31