50.002 COMPUTATIONAL STRUCTURES

INFORMATION SYSTEMS TECHNOLOGY AND DESIGN

Problem Set 8

1 Non β Architecture

A local junk yard offers older CPUs with non-Beta architectures that require several clocks to execute each instruction. Here are the specifications:

Model	Clock Rate	Avg. clocks per Instruction
x	40 Mhz	2.0
y	100 Mhz	10.0
z	60 Mhz	3.0

Table 1

You are going to choose the machine which will execute your benchmark program the fastest, so you compiled and ran the benchmark on the three machines and counted the total instructions executed:

1. x: 3,600,000 instructions executed
2. y: 1,900,000 instructions executed
3. z: 4,200,000 instructions executed

Based on the above data which machine would you choose?
Solution:
First we find out the time taken to execute those instructions:

1. x: 3.6M / (40M / 2) = 0.18 seconds
2. y: 1.9M / (100M / 10) = 0.19 seconds
3. z : 4.2M / (60M / 3) = 0.21 seconds

x is the fastest machine, hence we choose x.

2 β Assembly Language

What does the following piece of Beta assembly do? Hand assemble the beta language into machine language.

```
I = 0x5678
B = 0x1234
LD(I,R0) -- (1)
SHLC(R0,2,R0) --  (2)
LD(R0,B,R1) -- (3)
MULC(R1,17,R1) -- (4)
ST(R1,B,R0)  -- (5)
```

What is the result stored in R0?
Solution:
The machine language is:

```
I = 0x5678
B = 0x1234
LD(R31,I,R0) 011000 00000 11111 0101 0110 0111 1000 = 0x601F5678
SHLC(R0,2,R0) 111100 00000 00000 0000 0000 0000 0010 = 0xF0000002
LD(R0,B,R1) 011000 00001 00000 0001 0010 0011 0100 = 0x60201234
MULC(R1,17,R1) 110010 00001 00001 0000 0000 0001 0001 = 0xC8210011
ST(R1,B,R0) 011001 00001 00000 0001 0010 0011 0100 = 0x64201234
```

Explanation:

1. Line 1: move the content of memory address I to register R0
2. Line 2 : the content of R0 is multiplied by 4 and stored back at register R0
3. Line 3 : move the content of memory address (B + content of register R0) to register R1
4. Line 4 : The content of register R1 is multiplied by 17 and stored back at register R1
5. Line 5 : Move the content of register R1 to memory address (B + content of register R0)

The result of R0 is the content of memory address I multiplied by 4.

3 Addressing

You are given that the word at memory address 0 has a binary form of 0000 0100 0000 0011 0000 0010 0000 0001

What is the byte stored in address0, 1, 2 and 3, respectively? What are the hexadecimal forms of the bytes?
Solution:
1, 2, 3, and 4. The hex form is the word: 0x04 03 02 01.