NWEN242 Homework Assignment

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Question 1

Part A

If you improved the run time of divide by three times in, a $100ms$ total time execution of the program given that the divide take 20% of that time thus $20ms$. The improvement would yield:

$$20ms \div 3 = 6\frac{2}{3}ms$$

A decrease in time for the division from $20ms$ to $6\frac{2}{3}ms$ making a total improvement of 1.15 (rounded 2.d.p) times faster than before.

$$\frac{100ms}{80ms + 6\frac{2}{3}ms} = 1.1538...$$

If you improved the run time of divide by three times in, a $100ms$ total time execution of the program given that the divide take 50% of that time thus $50ms$. The improvement would yield:

$$\frac{50ms}{8} = 6.25ms$$

A decrease in time for the division from $50ms$ to $6.25ms$ making a total improvement of 1.78 (rounded 2.d.p) times faster than before.

$$\frac{100ms}{50ms + 6.25ms} = 1\frac{7}{9}$$

This shows that the target of a 1.4 times faster program is possible. But to get 1.4 time exactly the multiply operation would have to be below the maximum improvement of 8 times better:

Let x be the target time for multiply needs to make the total execution time 1.4 times faster

$$1.4 = \frac{100ms}{50ms + x}$$
$$70ms + 1.4x = 100ms$$
$$1.4x = 30ms$$
$$x = \frac{150}{7}ms$$

Let t be the target improvement to multiple needed to achieve the target time x

$$\frac{50}{t} = x$$
$$x * t = 50$$
$$t = \frac{50}{x}$$
$$t = 50 \div \frac{150}{7}$$
$$t = \frac{7}{3} = 2.33(2.d.p)$$

To make the improvements Management wants it would take a 2.33 times improvement to the multiply operation to achieve the overall goal of 1.4 times faster program.

Part B

Applying both the 8 times and 3 time improvements for the multiply and divide operations respectfully would get:

$$\frac{100ms}{30ms + 6.25ms + 6\frac{2}{3}ms} = 2.33(2.d.p)$$

A 2.33 times improvement relative to the original machine in total execution time.

Question 2

Part A

$$IPS_{P1} = \frac{3GHz}{1.5} = 2,0000,00$$
$$IPS_{P2} = \frac{2.5GHz}{1.0} = 2,5000,00$$
$$IPS_{P3} = \frac{4GHz}{2.2} = 1,818,181$$

Processor $P2$ has the highest instructions per second

Part B

$$Total\ Instructions_{P1} = 10 * IPS_{P1} = 10 * 2,0000,00 = 20,000,000$$
$$Total\ Instructions_{P2} = 10 * IPS_{P2} = 10 * 2,5000,00 = 25,000,000$$
$$Total\ Instructions_{P3} = 10 * IPS_{P3} = 10 * 1,818,181 = 18,1818,18$$

Part C

$$\frac{Freq_{pre}}{CPI_{pre}} * 10 = Total\ Instructions = \frac{Freq_{post}}{CPI_{post}} * 7$$
$$let\ CPI_{post} = CPI_{pre} * 1.2$$
$$\frac{Freq_{pre}}{CPI_{pre}} * 10 = \frac{Freq_{post}}{CPI_{pre} * 1.2} * 7$$
$$Freq_{pre} * 12 = Freq_{post} * 7$$
$$\frac{Freq_{pre} * 12}{7} = Freq_{post}$$

$$Freq_{P1post} = \frac{3Ghz * 12}{7} = 5.14GHz(2d.p)$$
$$Freq_{P2post} = \frac{2.5Ghz * 12}{7} = 4.29GHz(2d.p)$$
$$Freq_{P3post} = \frac{4Ghz * 12}{7} = 6.86Ghz(2d.p)$$

Question 3

1. Input: The input data from sensors like touch screens, keyboard and mice with the data written to memory by the devices
2. Output: The output of data such as a GPU to a monitor or a printer with the output devices reading the data sent to them.
3. Memory: The storage of data, be it cache, RAM or a hard drive
4. Datapath: Controls the flow of data in and out of the processor
5. Control: sends signals that determine the operation of other components

Question 4

```
B[g] = A[f + 1] + A[f];
```

Question 5

```
sll $t0, $s3, 2    # $t0 = i * 4
add $t0, $s6, $t0  # $t0 = &A[i]
sll $t1, $s4, 2    # $t1 = j * 4
add $t1, $s6, $t1  # $t1 = &A[j]
addi $t2, $zero, 8 # $t2 = 8
sll $t2, $t2, 2    # $t2 = 8 * 4
add $t2, $s7, $t2  # $t2 = &B[8]
lw  $t0, 0($t0)    # $t0 = A[i]
lw  $t1, 0($t1)    # $t1 = A[j]
add $t0, $t0, $t1  # $t0 = $t0 + $t1
sw  $t0, 0($t2)    # B[8] = $t0
```

Question 6

Part A

The most appropriate instruction format would be the I-Format as it is like a Conditional branch.

Part B

```
subi $at, $t2, 1 # $t2 = $t2 - 1
beq $at, $zero, loop # Loop breaks on #at == 1 which is the same as $t2 == 0.
# PC=PC+4+BranchAddr
```