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Homework 6, Computer Organization **March 5, 2022**

1 Question 1

a)
$3 \times \frac{1}{1.5} = 2$
$2.5 \times 1 = 2.5$
$4 \times \frac{1}{2.2} = 1.818$
b)
$3GHz \times 10 = 3 \times 10^{10}$ cycles
$2.5GHz \times 10 = 2.5 \times 10^{10}$ cycles
$4GHz \times 10 = 4 \times 10^{10}$ cycles
c)
$3GHz \times 10/1.5CPI = 2 \times 10^{10}$ instructions
$2.5GHz \times 10/1.0CPI = 2.5 \times 10^{10}$ instructions
$4GHz \times 10/2.2CPI = 1.818 \times 10^{10}$ instructions

2 Question 2

class A $= 1 \times 10^5$,class B $= 2 \times 10^5$,class C $= 5 \times 10^5$,class D $= 2 \times 10^5$
time 1 $= (1 \times 1 + 2 \times 2 + 5 \times 3 + 2 \times 3) \times 10^5/(2.5 \times 10^9)$
$= 26/2.5 \times 10^4$
$= 10.4 \times 10^{-4}$ second
time 2 $= (2 \times 1 + 2 \times 2 + 5 \times 2 + 2 \times 2) \times 10^5/(3 \times 10^9)$
$= 20/2.5 \times 10^4$
$= 6.6 \times 10^{-4}$ second
CPI 1 $= 10.4 \times 10^{-4} \times 2.5 \times 10^9/10^6 = 2.6$
CPI 2 $= 6.6 \times 10^{-4} \times 3 \times 10^9/10^6 = 2.0$

3 Question 3

A)
for one processor, the clock cycles is
$2.56 \times 10^9 \times 1 + 1.28 \times 10^9 \times 12 + 0.256 \times 10^9 \times 5 = 1.92 \times 10^{10}$ cycles
execution time is $1.92 \times 10^{10}/2 \times 10^9 = 9.6s$
if the count of processor is larger than one , the new clock cycles is
$$\frac{2.56 \times 10^9}{0.7p} \times 1 + \frac{1.28 \times 10^9}{0.7p} \times 12 + 0.256 \times 10^9 \times 5 = \frac{2.56 \times 10^{10}}{p} + 1.28 \times 10^9$$
cycles
then the new execution time is

$\frac{\frac{2.56\times10^{10}}{p}+1.28\times10^9}{2\times10^9}=\frac{12.8}{p}+0.64$
then we can know that $time_2=7.04, time_4=3.84, time_8=2.24$
and the ratio is $ratio_2=1.36, ratio_4=2.5, ratio_8=4.29$
B)
for one processor, the clock cycles is
$2.56\times10^9\times2+1.28\times10^9\times12+0.256\times10^9\times5=2.176\times10^{10}$ cycles
execution time is $2.176\times10^{10}/2\times10^9=10.88s$
if the count of processor is larger than one , the new clock cycles is
$\frac{2.56\times10^9}{0.7p}\times2+\frac{1.28\times10^9}{0.7p}\times12+0.256\times10^9\times5=\frac{2.93\times10^{10}}{p}+1.28\times10^9$
cycles
then the new execution time is
$\frac{\frac{2.93\times10^{10}}{p}+1.28\times10^9}{2\times10^9}=\frac{14.65}{p}+0.64$
then we can know that $time_2=7.965, time_4=4.303, time_8=2.47$
and the ratio is $ratio_2=1.13, ratio_4=1.12, ratio_8=1.1$
C)
from part a we can know that the execution time for 4 processor is 3.84s,then
clock cycles $=2.84\times2\times10^9=7.68\times10^9$
then $CPI_2, new=\frac{7.68\times10^9-3.84\times10^9}{1.28\times10^9}=3.$

4 Question 4

the execution time would be
$\frac{(50\times10^6\times1+110\times10^6\times1+80\times10^6\times4+16\times10^6\times2)}{2\times10^9Hz}=0.256s$
if we want to run two times faster, then
$0.128=\frac{(50\times10^6\times newCPI_1+110\times10^6\times1+80\times10^6\times4+16\times10^6\times2)\times10^6}{2\times10^9}$
then $newCPI_1$ would be $\frac{256\times10^6-462\times10^6}{50\times10^6}=-4.12$,which is impossible to achieve.

5 Question 5

the execution time would be
$\frac{(50\times10^6\times1+110\times10^6\times1+80\times10^6\times4+16\times10^6\times2)}{2\times10^9Hz}=0.256s$
if we want to run two times faster, then
$0.128=\frac{(50\times10^6\times1+110\times10^6\times1+80\times10^6\times newCPI_3+16\times10^6\times2)\times10^6}{2\times10^9}$

then $newCPI_3$ would be $\frac{256 \times 10^6 - 192 \times 10^6}{80 \times 10^6} = 0.8$. Since $0.8/4 = 0.2$, thus we can know that we have to improve 80 percent.

6 Question 6

```
sll $t0,$s3,3
add $t0,$t0,$s6
lw $t0,0($t0)
sll $t1,$s4,3
add $t1,$t1,$s6
lw $t1,0($t1)
add $t2,$t1,$t0
sw $t2,64($s7)
```

7 Question 7

f = 2 × & A[0]

8 Question 8

addi $t0, $s6, 4
i-type, opcode 8
rs:22 rd:8 immediate:4

add $t1, $s6, $0
r-type, opcode 0/20
rs:22 , rt:0 , rd:9 , immediate:4

9 Question 9

```
lw $t1 0($s1)
sll $t1, $t1,4
```

10 Question 10

```
        and $t0, $t0 , $0
LOOP1: slt $t2, $t0 , $0
        bne $t2, 1 , EXIT1
        and $t1, $t1 , $0
LOOP2: slt $t2, $t1 , $s1
        bne $t2, $t1 , EXIT2
        sll $t3, $t1 , 4
        add $t4, $s2 , $s3
        add $t5, $t0 , $t1
        sw $t5, 0($t04)
        addi$t1, $t1 , 1
        j LOOP2
EXIT2: addi $t0, $t0 , 1
        j LOOP1
EXIT1: jr $ra
```