Computer Architecture HW1

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1.5

a

P1: $\frac{3G(cycle/sec)}{1.5(cycle/instruction)} = 2G(instruction/sec)$
P2: $\frac{2.5G(cycle/sec)}{1(cycle/instruction)} = 2.5G(instruction/sec)$
P3: $\frac{4G(cycle/sec)}{2.2(cycle/instruction)} = 1.82G(instruction/sec)$
hightest performance:**P2**

b

P1:
number of cycle:$3G(cycle/sec) * 10(sec) = 30G(cycle)$
number of instruction:$2G(instruction/sec) * 10(sec) = 20G(cycle)$
P2:
number of cycle:$2.5G(cycle/sec) * 10(sec) = 25G(cycle)$
number of instruction:$2.5G(instruction/sec) * 10(sec) = 25G(cycle)$
P3:
number of cycle:$4G(cycle/sec) * 10(sec) = 40G(cycle)$
number of instruction:$1.82G(instruction/sec) * 10(sec) = 18.2G(cycle)$

c

$K(instruction) = \frac{Y(clockrate)}{Z(CPI)} * X(sec)$
$\Rightarrow Y = \frac{K*Z}{X}$
$\frac{K*1.2Z}{0.7X} = \frac{12}{7}Y$
P1: $3G * \frac{12}{7} = \frac{36}{7}G(cycle/sec)$
P2:$2.5G * \frac{12}{7} = \frac{30}{7}G(cycle/sec)$
P3:$4G * \frac{12}{7} = \frac{48}{7}G(cycle/sec)$

1.6

a

P1 average CPI: $1 * 0.1 + 2 * 0.2 + 3 * 0.5 + 3 * 0.2 = 2.6$
P2 average CPI: $2 * 0.1 + 2 * 0.2 + 2 * 0.5 + 2 * 0.2 = 2$

b

P1 total clock cycle: $2.6 * 10^6$
P2 total clock cycle: $2 * 10^6$

final

P1 needs $\frac{2.6*10^6}{2.5G} = 1.04 * 10^{-3}$ sec to finish
P2 needs $\frac{2*10^6}{3G} = 6.7 * 10^{-4}$ sec to finish
$\Rightarrow$ P2 is faster

1.7

a

$CPI = \frac{clockrate}{instruction} * \text{exec time}$
A's CPI: $\frac{10^9(cycle/sec)}{10^9(ins)} * 1.1(sec) = 1.1(cycle/ins)$
B's CPI: $\frac{10^9(cycle/sec)}{1.2*10^9(ins)} * 1.5(sec) = 1.25(cycle/ins)$

b

$clockrate = \frac{CPI*ins}{\text{exec time}}$
A processor clock rate: $\frac{1.1*10^9}{K}$
B processor clock rate: $\frac{1.25*1.2*10^9}{K}$
$\Rightarrow$ B is $\frac{15}{11}$ faster than A

c

Let original processor's clock rate:$10^9(cycle/sec)$
new compiler exec time:$\frac{6*10^8(ins)*1.1(cycle/ins)}{10^9(cycle/sec)} = 0.66(sec)$
A compiler exec time:$1.1(sec)$
B compiler exec time:$1.5(sec)$
Speed up versus A: $\frac{5}{3}$
Speed up versus B: $\frac{25}{11}$

1.11

1.11.1

$2.389 * 10^{12}(ins) * CPI(cycle/ins) * 0.333 * 10^{-9}(sec/cycle) = 750(sec)$
$\Rightarrow CPI = \frac{750}{2.389*10^{12}*0.333*10^{-9}} = 0.94(cycle/ins)$

1.11.2

$SPECratio = \frac{\text{reference time}}{\text{exec time}} = \frac{9650}{750} = 12.87$

1.11.3

$\text{exec time} = \text{ins cnt} * CPI * \text{cycle time}$
$\Rightarrow 1.1 * 1 * 1 = 1.1$
$\Rightarrow \text{CPU time will be increased by } 10\%$
$\Rightarrow 750 * 1.1$

1.11.4

$\text{exec time} = \text{ins cnt} * CPI * \text{cycle time}$
$\Rightarrow 1.1 * 1.05 * 1 = 1.155$
$\Rightarrow \text{CPU time will be increased by } 15.5\%$

1.11.5

change for 1.11.4: $SPECratio = \frac{\text{reference time}}{\text{exec time}} = \frac{9650}{750*1.155} = 11.14$

1.11.6

$\text{exec time} = \frac{\text{ins cnt}*CPI}{\text{clock rate}}$
$\Rightarrow CPI = \frac{700*4G}{2.389*10^{12}*0.85} = 1.38$

1.11.7

CPI has increased $\frac{1.38}{0.94} = 1.47$ times, while the clock rate has increasd $\frac{4}{3} = 1.33$ times
The difference between CPI increasing rate & clock rate increasing rate is due to the decreasement of instruction’s numbers

1.11.8

before CPU time: 750(sec)
after CPU time: 700(sec)
It has reduce $1 - \frac{700}{750} = 0.067 = 6.7$**% times**

1.11.9

$\text{exec time} = \frac{\text{ins cnt} * CPI}{\text{clock rate}}$
$\Rightarrow 960 * 10^{-9} * 0.9 = \frac{ins * 1.61}{4G}$
$\Rightarrow ins = 2147$

1.11.10

$\text{exec time} = \frac{\text{ins cnt} * CPI}{\text{clock rate}}$
$\Rightarrow \text{clock rate} = \frac{1}{0.9} = 1.11 \text{ times}$
$\Rightarrow \text{clock rate} = 3 * 1.11G = 3.33G(Hz)$

1.11.11

$\text{exec time} = \frac{\text{ins cnt} * CPI}{\text{clock rate}}$
$\Rightarrow \text{clock rate} = \frac{0.85}{0.8} = 1.06 \text{ times}$
$\Rightarrow \text{clock rate} = 1.06 * 3 = 3.18G(Hz)$

1.14

1.14.1

total cycle:
$50 * 10^6 * 1 + 110 * 10^6 * 1 + 80 * 10^6 * 4 + 16 + 10^6 * 2 = 512 * 10^6$
$T(\text{exec time}) = \frac{512 * 10^6}{2G} = 256 * 10^{-3}$
$\Rightarrow \frac{1}{2}T = \frac{50 * 10^6 * X + (512 - 50) * 10^6}{2G}$
$\Rightarrow 256 = 50X + 462$
$\Rightarrow X < 0, \text{ which is impossible}$

1.14.2

$\frac{1}{2}T = \frac{320 * 10^6 * X + (512 - 320) * 10^6}{2G}$
$\Rightarrow 256 = 320X + 192$
$\Rightarrow X = \frac{64}{320} = \frac{1}{5}, \text{ the CPI have to imporove from 4 to } \frac{4}{5}$

1.14.3

$\frac{(50*1*0.6+110*1*0.6+80*4*0.7+16*2*0.7)*10^6}{2G} = 171.2 * 10^{-3}(sec) = 0.66875T$
$\Rightarrow \text{reduce } 33.125\% \text{ exec time}$