Ques 1:-

(c)

Given,

$C/W_x = 20$	$C/W_y = 15$
$D_x = 19\,cm$	$D_y = 20\,cm$
$R_x = \frac{19}{2}\,cm$	$R_y = \frac{20}{2}\,cm$
$D/W_x = 89$	$D/W_y = 100$
$Def/A_x = 0.023$ defects/cm^2	$Def/A_y = 0.031$ defects/cm^2

$$Yield_x = \frac{1}{\left(1+\left(\text{Defects per area} \times \frac{\text{Die Area}}{2}\right)\right)^2}$$

$$= \frac{1}{\left(1+\left(0.023 \times \frac{\text{Die Area}}{2}\right)\right)^2}$$

$$= \frac{1}{\left(1+\left(0.023 \times \frac{3.1857}{2}\right)\right)^2}$$

$$\cong 0.93$$

$$D/W = \frac{\text{Wafer Area}}{\text{Die Area}}$$

$$\text{Die Area} = \frac{\text{Wafer Area}}{D/W}$$

$$= \frac{\pi \times \left(\frac{19}{2}\right)^2}{89}$$

$$= 3.1857$$

$$Yield_y = \frac{1}{\left(1+\left(\text{Defects per area} \times \frac{\text{Die Area}}{2}\right)\right)^2}$$

$$= \frac{1}{\left(1+\left(0.031 \times \frac{\text{Die Area}}{2}\right)\right)^2}$$

$$= \frac{1}{\left(1+\left(0.031 \times \frac{3.1416}{2}\right)\right)^2}$$

$$\cong 0.91$$

$$D/W = \frac{\text{Wafer Area}}{\text{Die Area}}$$

$$\text{Die Area} = \frac{\text{Wafer Area}}{D/W}$$

$$= \frac{\pi \times \left(\frac{20}{2}\right)^2}{100}$$

$$= 3.1416$$

d)

$$C/D_x = \frac{\text{Cost per wafer}}{\text{Dies per wafer} \times \text{Yield}} = \frac{20}{89 \times 0.93} = 0.24$$

$$C/D_y = \frac{\text{Cost per wafer}}{\text{Dies per wafer} \times \text{Yield}} = \frac{15}{100 \times 0.91} = 0.16$$

Ques 2:

	A	B	C	D
CPI_{PS}	7	2	3	6
CPI_{XB}	5	4	2	1
IC	$1\times10^6 \times .3$ $= 3\times10^5$	$1\times10^6\times.5$ $=5\times10^5$	$1\times10^6\times.1$ $=1\times10^5$	$1\times10^6\times.1$ $=1\times10^5$

$Rate_{PS} = 2.7\,GHz = 2.7\times10^9\,Hz$

$Rate_{XB} = 3\,GHz = 3\times10^9\,Hz$

$\text{Instruction Count} = 1\times10^6$

a) For Play Station,

$$\text{Clock Cycles} = (7\times3\times10^5 + 2\times5\times10^5 + 3\times1\times10^5 + 6\times1\times10^5$$

$$= 4\times10^6$$

$$\text{Avg. CPI} = \frac{4\times10^6}{1\times10^6}$$

$$= 4$$

For XBOX,

$$\text{Clock Cycles} = (5\times3\times10^5 + 4\times5\times10^5 + 2\times1\times10^5 + 1\times1\times10^5$$

$$= 3.80\times10^6$$

$$\text{Avg. CPI} = \frac{3.80\times10^6}{1\times10^6}$$

$$= 3.8$$

$$\text{So, Difference} = (4-3.8)$$

$$= 0.2$$

b)

$$\text{Ex time}_{PS} = \frac{\text{Instruction Count}\times CPI}{\text{Rate}}$$

$$= \frac{10^6\times4}{2.7\times10^9}$$

$$= 0.00148\,s$$

$$\text{Ex time}_{PS} = \frac{\text{Instruction Count}\times CPI}{\text{Rate}}$$

$$= \frac{10^6\times3.8}{3\times10^9}$$

$$= 0.00126\,s$$

$$\text{Difference} = (0.00148 - 0.00126)$$

$$= 0.22$$

c)

$$\text{Spec Ratio} = \frac{\text{Reference Time}}{\text{Measured Time}}$$

$$= \frac{120}{\text{Ins. Count}\times CPI\times C.C.T}$$

$$= \frac{120\times10^{-3}}{10^6\times4\times\frac{1}{2.7\times10^9}}$$

$$= 81$$

Execution time of a Reference processor

Reference time is provided by SPEC

Measured time is the Execution time of a given

Ques-3

Processor	CPI	Rate
P1	1.5	3 GHz
P2	1.0	2.5 GHz
P3	2.2	4 GHz

Instruction Count = x
[Same for all Processors]

a) $$\text{Performance (IPS)} = \frac{\text{Clock Rate}}{\text{CPI}}$$

$$P_{P1} = \frac{3\times10^9}{1.5} = 2\times10^9$$

$$P_{P2} = \frac{2.5\times10^9}{1} = 2.5\times10^9$$ ⇒ highest perf.

$$P_{P3} = \frac{4\times10^9}{2.2} \cong 1.82\times10^9$$

Rate = cycles completed per second

for P1,

3×10^9 cycles --- 1 s

∴ 1 " ... $\frac{1}{3\times10^9}$ s

∴ 1.5 " ... $\frac{1.5}{3\times10^9}$ s

[1 ins = 1.5 cycle]

So,

$$\boxed{1 \text{ ins. takes } \frac{1.5}{3\times10^9} \text{ s to complete}}$$

$\frac{1.5}{3\times10^9}$ s to complete - 1 ins

∴ 1 s " " $\frac{3\times10^9}{1.5}$ ins

Rate

CPI

$$\text{Performance (IPS)} = \frac{\text{Clock Rate}}{\text{CPI}}$$

b) $CPU_{Time} = 10s$

$$CPU_{time} = \frac{IC \times C.P.I}{Freq}$$

$$\Rightarrow IC = \frac{CPU_{time} \times Freq}{C.P.I}$$

$$IC(P1) = \frac{10\times3\times10^9}{1.5} = 2\times10^{10}$$

$$IC(P2) = \frac{10\times2.5\times10^9}{1.0} = 2.5\times10^{10}$$

$$IC(P3) = \frac{10\times4\times10^9}{2.2} = 1.8\times10^{10}$$

$$CPU_{time} = \frac{CPU_{clock\ cycles}}{Freq} = \frac{IC \times CPI}{Freq}$$

$$\Rightarrow CPU_{clock\ cycles} = IC \times CPI$$

∴ Clock Cycles $(P_1) = 2\times10^{10} \times 1.5 = 3\times10^{10}$

∴ Clock Cycles $(P_2) = 2.5\times10^{10} \times 1 = 2.5\times10^{10}$

∴ Clock Cycles $(P) = 1.8\times10^{10} \times 2.2 \cong 3.96\times10^{10}$

the more digit you take after fraction the less error you get!

c)

Processor	CPI	New CPI
P1	1.5	1.8
P2	1.0	1.2
P3	2.2	2.64

$$CPU\ Time_{new} = 10 - (10 \times .3)$$
$$= 7s$$

$$CPU_{Time} = \frac{I.C \times CPI}{Freq.}$$

$$\Rightarrow Freq. = \frac{IC \times CPI}{CPU_{Time}}$$

$$F(P_1) = \frac{IC \times CPI}{CPU_{Time}} = \frac{2 \times 10^{10} \times 1.8}{7} \simeq 5.14\ GHz$$

$$F(P_2) = \frac{IC \times CPI}{CPU_{Time}} = \frac{2.5 \times 10^{10} \times 1.2}{7} \simeq 4.28\ GHz$$

$$F(P_3) = \frac{IC \times CPI}{CPU_{Time}} = \frac{1.8 \times 10^{10} \times 2.64}{7} \simeq 6.79\ GHz$$

Ques-4 :

$$CPU_{Time} = 250\,s$$

Add	Sub	left-Shift
70 s	85 s	40 s

$= 195s$

misc. $\Rightarrow (250 - 195) = 55$

a) $T_{new} = (70 \times 0.8) + 85 + 40 + 55$
$= 236s$

time reduced $= (250 - 236) = 14s$

$= \frac{14}{250} \times 100\% \simeq 5.47\%$

b) $T_{new} = (250 \times 0.8) = 200s$

$T_{add} + T_{sub} + T_{misc} = 70 + 85 + 55 = 210s > T_{new}.$

NO

Ques 5:

Rate (P1) = 4 GHz = 4×10^9 Hz
CPI (P1) = 0.9
Ins. Count = 5×10^9

Rate (P2) = 3 GHz = 3×10^9 Hz
CPI (P2) = 0.75
Ins. Count = 1×10^9

$$\text{Mips} = \frac{\text{Clock Rate}}{\text{CPI}\times10^6}$$

$$\text{MIPS(P1)} = \frac{4\times10^9}{0.9\times10^6} = 4.44\times10^3$$

$$\text{MIPS(P2)} = \frac{3\times10^9}{0.75\times10^6} = 4\times10^3$$

$$P(P_1) = \frac{4\times10^9}{5\times10^9\times0.9} = 0.889$$

$$P(P_2) = \frac{3\times10^9}{1\times10^9\times0.75} = 4$$

Mips(P_1) > Mips(P_2)

Per. (P_1) < Per. (P_2)

False

Ques -6

$$\text{power} = C.L \times V^2 \times F$$

$$\frac{P_{new}}{P_{old}} = \frac{C_{old}\times0.857\times(V\times0.813)^2\times F\times0.813}{C_{old}\times V^2\times F}$$

$$= \frac{\cancel{C_{old}}\times0.857\times\cancel{V^2}\times0.813^2\times\cancel{F}\times0.813}{\cancel{C_{old}}\times\cancel{V^2}\times\cancel{F}}$$

$$= 0.4605$$

The new processor uses about almost Half (0.4605) power of the old processor.

Ques - 7

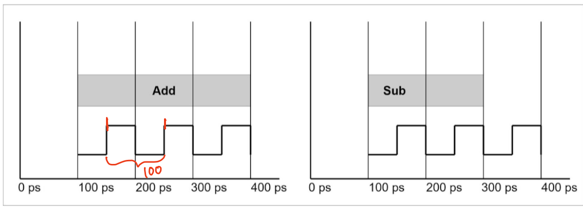


Figure 1: Represents 1 add instruction Figure 2: Represents 1 sub instruction

Figure 1: Represents 1 add instruction Figure 2: Represents 1 sub instruction

Program **A** is divided into two classes according to their **CPI** (Add and Sub). The **instruction counts** are 21 and 3 respectively. Reference for **program A** is 1080ps.

Now, answer the following questions,

a) What is the Clock period? **Hint**: follow any of the figures

→ Duration between two rising edges = 100 ps = 100×10^{-12} s

b) What is the frequency? [1]

Freq = $\frac{1}{100 \times 10^{-12}} = 10^{10}$ Hz $= 10 \times 10^{9}$ Hz $= 10$ GHz

c) What is the CPI for Add and Sub ? [2]

Clock Cycle per ins. 3 2

d) What is the Avg. CPI? [2]

2.875

e) Find out the execution time of the program? [2]

⇒ Ex/CPU time = Ins./Prog × CPI × Clock Period

(CPI → Clock Cycle)

$= 24 \times 2.875 \times 100 \times 10^{-12}$

$= 6.9 \times 10^{-9}$ s / 6900 ps

f) Find the SPEC ratio? [1]

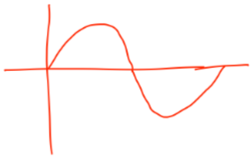
g) If you want to improve the performance by 1.2 times, what improvement do you need to include in the program's add operation? [2]

Program A

Class	Add	Sub
CPI	3	2
IC	21	3

$\frac{(21 \times 3) + (3 \times 2)}{24}$

$= 2.875$



Spec Ratio = $\frac{\text{Ref. time}}{\text{CPU time / Execution time}}$

$= \frac{1080 \text{ ps}}{6900 \text{ ps}}$

$= 0.1565$

g)

$\text{Time}_{improved} = \frac{T_{affected}}{n} + T_{unaff.}$

$\Rightarrow \frac{6.9 \times 10^{-9}}{1.2} = \frac{6.0375 \times 10^{-9}}{n} + 8.625 \times 10^{-10}$

$\Rightarrow n = 1.235$

$T_{aff.} = 21 \times 2.875 \times 100 \times 10^{-12}$

$= 6.0375 \times 10^{-9}$