HARSH MOHAN SASON.

1.] We know that CPI is given by

$$CPI = (\text{Execution time} \times \text{Clock rate}) / \text{Instruction Count}$$

Execution time of program 1 on M_1 = 90 sec

Clock rate, M_1 = 900 MHz.

Instruction Count = 500 Million or 5×10^8

$[1 MHz = 1 \times 10^6 Hz]$

$$CPI_{M_1} = \left(\frac{\cancel{90}^{4} \times 9 \times \cancel{10^8}}{\cancel{5} \times \cancel{10^8}} \right)$$

$$= \boxed{36 \text{ cycles per instruction}}$$

[Clock rate$_{M_2}$ = 800 MHz

IC = 400 Million]

$$CPI_{M_2} = \left(\frac{15 \times \cancel{8}^{2} \times \cancel{10^8}}{\cancel{4} \times \cancel{10^8}} \right)$$

$$= \boxed{30 \text{ cycles per instruction}}$$

2) $IC = (\text{Execution time} \times \text{Clock rate}) / CPI$

CPI for program 2; M_1 = 36 CPI

CPI for program 2; M_2 = 30 CPI

$$IC_{M_1} \text{prog } 2 = \frac{(\cancel{8}^{2} \times \cancel{2}^{1} \times 10^8)}{\cancel{36}\ 4}$$

$= 2 \times 10^8$ or 200 Million instructions for program 2 on Machine 1.

$$IC_{M_2} \text{prog } 2 = \frac{1\cancel{0} \times 8 \times 10^8}{3\cancel{0}}$$

$= 2.66 \times 10^8$ or $\approx$ 266 Million instructions for program 2 on Machine 2

3] For peak performance, machine will be executing the fast set of instructions.

for M_1, we execute only CPI_A.

for M_2, we execute only CPI_B and CPI_D

$\therefore$ Peak performance of $M_1 = \dfrac{(8 \times 10^8 / 1)}{}$

$$= \frac{8 \times 10^8}{10^6} = \boxed{800 \text{ MIPS}}$$

Peak performance of $M_2 = \dfrac{\text{Clock rate}}{\text{CPI} \times 10^6}$

$$= \frac{9 \times 10^8}{2 \times 10^6}$$

$$= \boxed{450 \text{ MIPS}}$$

4.] Divided equally means, we can just compute avg CPI on both

$$\text{Average CPI on } M_1 = \frac{(1+2+3+4)}{4}$$

$$= \frac{10}{4} = 2.5$$

$$\text{Average CPI on } M_2 = \frac{(3+2+4+2)}{4}$$

$$= \frac{11}{4} = 2.75$$

Thus, we know that

$$\frac{\text{Performance}_{M_2}}{\text{Performance}_{M_1}} = \frac{CPI_{M_1}}{CPI_{M_2}} \times \frac{\text{Clock rate}_{M_2}}{\text{Clock rate}_{M_1}}$$

$$= \frac{2.5}{2.75} \times \frac{9 \times \cancel{10^8}}{8 \times \cancel{10^8}}$$

$$= \frac{22.5}{22} = \boxed{1.022}$$

M_2 is faster than M_1 by a factor of $\boxed{1.022}$

5.) $$\text{Performance}_{M_2} = \frac{\text{Clock rate } M_2}{CPI\ M_2}$$

$$= \frac{9 \times 10^8}{2.75 \times 10^6}$$

$$= \frac{9 \times 10^4}{275} = 327.27$$

Since, the performance is same,

$$327.27 = \frac{\text{Clock rate } M_1}{CPI\ M_1}$$

$$327.27 = \frac{\text{Clock rate } M_1}{2.5}$$

$$\text{Clock rate } M_1 = \boxed{818.17}\ MHz$$ to get the same performance

6.]

C1: Clock rate = 2.5 GHz

CPU time = 15 sec

$$\text{Clock rate } C_2 = \frac{\text{Clock cycles } C_2}{\text{CPU Time}_B}$$

Clock cycles C_2 = 1.5 × Clock cycles C_1

Clock cycles C_1 = 15 × 2.5 GHz

$= 37.5 \times 10^9$

Since, the performance doubles, execution time will go by half, ∴ CPU time C_2 = 7.5 sec

$$\text{Clock rate } C_2 = \frac{1.5 \times 37.5 \times 10^9}{7.5}$$

$= 75 \times 10^8$ GHertz or $\boxed{7.5 \text{ GHz}}$

Scanned with CamScanner