

1.-a

$$A = \frac{1.1s}{1.0E9 \times 1ns} = 1.1$$

$$B = \frac{1.5s}{1.2E9 \times 1ns} = 1.25$$

1.-b

$$\text{execution time} = \text{CPU time} = \frac{\text{Instructions} \times \text{CPI}}{\text{clock rate}}$$

$$\text{execution time}_1 = \text{execution time}_2$$

$$\frac{\text{Instructions}_1 \times \text{CPI}_1}{\text{clock rate}_1} = \frac{\text{Instructions}_2 \times \text{CPI}_2}{\text{clock rate}_2}$$

$$\text{clock rate}_1 = \frac{\text{Instructions}_2 \times \text{CPI}_1}{\text{Instructions}_1 \times \text{CPI}_2} \times \text{clock rate}_2$$

$$= \frac{109 \times 1.1}{1.2 \times 10^9 \times 1.25} \times \text{clock rate}_2$$

$$\therefore \text{clock rate}_1 = 0.73 \text{ clock rate}_2$$

Answer) 27%

1.-c

$$\text{new compiler} : \frac{6.0E8 \times 1.1 \times 10^{-9} s}{1s} = 0.66$$

$$A : \frac{1.1}{0.66} = 1.6666 \dots \hat{=} 1.67$$

$$B : \frac{1.5}{0.66} = 2.2727 \dots \hat{=} 2.27$$

2-a

one processor,

$$\text{clock cycles} = (2.56 \times 10^9) \times 1 + (1.28 \times 10^9) \times 12$$

$$+ (2.56 \times 10^9) \times 5 = 1.92 \times 10^{10}$$

$$\text{execution time} = \frac{1.92 \times 10^{10}}{2 \times 10^9} = 9.6s$$

$p > 1$ processors,

$$\text{clock cycles}_p = \frac{2.56 \times 10^9}{p} + 1.28 \times 10^9$$

$$\text{execution time}_p = \frac{\frac{2.56 \times 10^9}{p} + 1.28 \times 10^9}{2 \times 10^9} = \frac{12.8}{p} + 0.64$$

p	1	2	4
execution time in seconds	9.6	7.04	3.84
speed-up	1	1.36	2.5

2-b.

$$\text{execution time} = \frac{2.176 \times 10^{10}}{2 \times 10^9} = 10.88s$$

$$\text{Let } p > 1, \text{ clock cycles}_p = \frac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9$$

$$\text{execution time}_p = \frac{\frac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9}{2 \times 10^9} = \frac{14.65}{p} + 0.64$$

p	1	2	4
execution time in seconds	10.88	7.965	4.3025
slow-down	1.13	1.13	1.12

2-c.

$$\text{execution time}_{\text{new}} = 3.84s = \frac{\text{clock cycles}_{\text{new}}}{2\text{GHz}}$$

$$\therefore \text{clock cycles}_{\text{new}} = 2 \times 10^9 \times 3.84 = 7.68 \times 10^9$$

$$= 2.56 \times 10^9 + 1.28 \times 10^9 \times \text{CPI}_{2, \text{new}}$$

$$+ 2.56 \times 10^6 \times 5$$

$$\therefore \text{CPI}_{2, \text{new}} = \frac{7.68 \times 10^9 - 3.84 \times 10^9}{1.28 \times 10^9} = 3$$

3-2

Answer)

$$2004: \frac{90W}{(1.25V)^2 \times 3.6GHz} = \frac{90}{1.25^2 \times 3.6 \times 10^9} \sim 14.42nF$$

$$2012: \frac{40W}{(0.9V)^2 \times 3.4GHz} = \frac{40}{0.9^2 \times 3.4 \times 10^9}$$

3-b.

$$P_{static} + P_{dynamic} = P_{total}$$

$$2004: 10W + 90W = 100W$$

$$2012: 30W + 40W = 70W$$

Answer)

	2004	2012
P_{static}		
$\frac{P_{static}}{P_{total}}$ (percentage)	10%	$\frac{30}{70} \times 100 \div 42.8\%$

$\frac{P_{static}}{P_{dynamic}}$ (ratio)	$\frac{10}{90}$	$\frac{30}{40}$
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3-C.

$$I_L = 8A, \frac{P_{new}}{P_{old}} = \frac{V_{new} I_{new} + C_L (P_{new})^2}{100W} = 0.9$$

$$\therefore V_{new} = \frac{-8A + \sqrt{(8A)^2 - 4(57.6 \frac{A}{V}) - 90W}}{2(57.6 \frac{A}{V})}$$

$V_{new} = 1.18V$, which represents a reduction of about 5.4% over the original 1.25 volts.

the core is by Bridge, we find the $V_{new} = 0.48V$, a reduction of 6.51%.

4-2

$$0.8 \times 70s = 56s$$

$$250(70-56) = 236s$$

Answer) 236s

4-b.

$$0.8 \times 250 = 200s$$

$$200 - 70 - 85 - 40 = 5s$$

$$\frac{5}{55} = 0.09 \therefore 91\%$$

Answer) 91%.

4-C.

$$55 + 70 + 85 = 210$$

$$\frac{210}{250} = 0.84 \rightarrow 18\%$$

Answer) NO, we can't reduce the branch hours by 20% by reducing the branch hours alone.