113 Computer Organization - Homework 1

1.

	clock rate	CPI	instructions / second
P_1	3.2G	1.6	$(1/1.6) \times 3.2G = 2G$
P_2	1.5G	1	$1 \times 1.5G = 1.5G$
P_3	4.2G	2.1	$(1/2.1) \times 4.2G = 2G$
	↑ cycles/second	↑ cycles/instruction	

(a) P_1 and P_3 #

(b)
$P_1 \rightarrow 2G \times 10 = 20G$
$P_2 \rightarrow 1.5G \times 10 = 15G$ instructions #
$P_3 \rightarrow 2G \times 10 = 20G$

$P_1 \rightarrow 3.2G \times 10 = 32G$
$P_2 \rightarrow 1.5G \times 10 = 15G$ cycles #
$P_3 \rightarrow 4.2G \times 10 = 42G$

(c)
$$\text{execution time} \downarrow_{20\%} = \text{instructions} \times \frac{CPI \uparrow 30\%}{\text{clock Rate} \uparrow 50\%}$$

$P_1 \rightarrow 3.2G \times 1.5 = 4.8G$
P_2 clock Rate $\rightarrow 1.5G \times 1.5 = 2.25G$ Hz #
$P_3 \rightarrow 4.2G \times 1.5 = 6.2G$

2.

	clock rate	CPI (A, B, C)
P_1	1.8G	5, 3, 3
P_2	1.2G	3, 2, 3

class A $= \times 0.3 = 3 \times 10^5$
B $= 10^6 \times 0.3 = 3 \times 10^5$
C $= \times 0.4 = 4 \times 10^5$

$$\text{execution time} = \frac{CPI_A}{\text{clock Rate}} \times \text{class}A + \dots = \frac{1}{\text{clock Rate}}(CPI_A \times \text{class}A \dots)$$

(a) P_1 #

P_1 execution time $= \frac{1}{1.8G} \times (\overset{15}{5 \times 3 \times 10^5} + \overset{12}{3 \times 4 \times 10^5} + \overset{9}{3 \times 3 \times 10^5}) = 20$ seconds

P_2 $\frac{1}{1.2G} \times (\overset{9}{3 \times 3 \times 10^5} + \overset{8}{2 \times 4 \times 10^5} + \overset{9}{3 \times 3 \times 10^5}) \fallingdotseq 21.7$

(b) P_1 / P_2 clock cycles

	class A		class B		class C		
P_1	$5 \times 3 \times 10^5$	+	$3 \times 3 \times 10^5$	+	$3 \times 4 \times 10^5$	=	36×10^5 #
P_2	$3 \times 3 \times 10^5$	+	$2 \times 3 \times 10^5$	+	$3 \times 4 \times 10^5$	=	27×10^5

3.

	clock rate	voltage	power static	dynamic
MIT processor	3.8G	1.4	20	70
Core i9 Bridge	3.7G	1.1	40	60

7.448

(a)
MIT processor $\Rightarrow 70 = (1.4)^2 \times \text{Capacitive\_load} \times 3.8G$
Capacitive_load $\fallingdotseq$ 9.4nF #

Core i9 Bridge $\Rightarrow 60 = (1.1)^2 \times \text{Capacitive\_load} \times 3.7G$
Capacitive_load $\fallingdotseq$ 13.4nF #

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(b) MIT. processor $\frac{\text{static power}}{\text{dissipated power}} = \frac{20}{90} \doteqdot 22.2\%$
core i7 Bridge $= \frac{40}{100} = 40\%$ #

MIT_processor $\frac{\text{static power}}{\text{dynamic power}} = \frac{20}{70} \doteqdot 28.5\%$
core i7 Bridge $= \frac{40}{60} \doteqdot 66.6\%$ #

(c) $(P_{s\,new} + P_{D\,new})/(P_{s\,old} + P_{D\,old}) = 0.8$

$P_{D\,new} = C \times (V_{new})^2 \times f \Rightarrow V_{new} = \sqrt{P_{new}/Cf}$

$P_{D\,new} = 0.8(P_{s\,old} + P_{D\,old}) - P_{s\,new} = 72 - V_{new} \times I$ $\quad I = \frac{P_{s\,old}}{V_{old}} = \frac{20}{1.4} = 14.2$

$= 72 - 14.2 \times V_{new}$

$(V_{new})^2 \times \underbrace{C \times f}_{35.7} = 72 - 14.2 V_{new}$

$(V_{new})^2 \times 35.7 + 14.2 V_{new} - 72 = 0$

$\frac{-14.2 \pm \overset{102.4}{\sqrt{201.64 + 10281.6}}}{71.4}$

$V_{new} \doteqdot 1.235$ #
MIT_processor

$P_{D\,new} = 0.8(P_{s\,old} + P_{D\,old}) - P_{s\,new} = 80 - V_{new} \times I$ $\quad I = \frac{P_{s\,old}}{V_{old}} = \frac{40}{1.1} = 36.4$

$(V_{new})^2 \times \underbrace{C \times f}_{49.6} = 80 - 36.4 V_{new}$

$(V_{new})^2 \times 49.6 + 36.4 V_{new} - 80 = 0$

$\frac{-36.4 \pm \overset{131.1}{\sqrt{1325 + 15872}}}{99.2}$

$V_{new} \doteqdot 0.96$ #
Core i7 Bridge

4.
(a) $150 + 250 \times 75\% + 200 + 100 = 637.5$ (sec) #

(b) $700 \times 10\% = 70$ 70s #

(c) $700 \times 30\% = 210$ $210 > 200$ can't #

5.
(a)

	A	B	C	D	
compiler X ⇒	2500×3	+ 1800×4	+ 2300×2	+ 900×6	= 24700 # cycles
compiler Y ⇒	2200×3	+ 2000×4	+ 2300×2	+ 1000×6	= 25200

(b) $25200 - 24700 = 500$ cycles ⇒ 0.4s
$500/0.4 = 1250$ (Hz) #

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6. $$\frac{1}{(1-35\%)+35\%/2} = \frac{1}{(1-y)+y/1.6}$$

$$82.5\% = 1-\frac{1.6}{1.6}y+\frac{1}{1.6}y = 1-\frac{0.6}{1.6}y$$

$$\frac{3}{8}y = 17.5\% \Rightarrow y = 46.7\%$$ #

7. $$\frac{1}{(1-45\%)+45\%/6} = \frac{100}{62.5}$$

$$\wedge$$

$$\frac{1}{(1-55\%)+55\%/4} = \frac{100}{53.75}$$ (b) #

13.75%

8. (a) throughput ↑ ⇐ the speed of a work became faster ⇐ faster processor
response time ↓ ⇐ the time of a work become less ⇐
Both #

(b) throughput ↑ ⇐ can handle multiple works per unit of time ⇐ multi-processor
response time { ↑ the work meaning process
• have parallel processing
the work meaning instruction ⇒ no change
Only throughput #

9. Average CPU score : 952
Average Clock speed : 3.3GHz
Core Count : 12
CPU name : Intel Core i7-9750HF

Using Novabench for testing
SIMD benchmark : 1494 GFLOPS
Scalar CPU benchmark : 540 GFLOPS
Conclusion : suitable for application scenarios of parallel computing with large amounts of data, but weak for high-load calculations.

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