Computer Architecture Homework1

b04902083 資工四 莊翔旭

1.7

> A 1.0E9 instructions, execution time 1.1s
>
> B 1.2E9 instructions, execution time 1.5s

1.7.a

> clock cycle time = 1ns, CPI = $\frac{(\frac{ExecutionTime}{CycleTime})}{InstructionCounts}$
>
> $CPI_A = 1.1/1.0 = 1.10$
>
> $CPI_B = 1.5/1.2 = 1.25$

1.7.b

> $ExecutionTime = CPI \times IC \times CycleTime$
> $CPI_A \times IC_A \times CycleTime_{P1} = CPI_B \times IC_B \times CycleTime_{P2}$'
>
> $\frac{CycleTime_{P1}}{CycleTime_{P2}} = \frac{CPI_B \times IC_B}{CPI_A \times IC_A} = \frac{1.25 \times 1.2 \times 10^9}{1.1. \times 1.0 \times 10^9} = 1.36$
>
> P1 is 36% slower than P2

1.7.c

> $ExecutionTime = CPI \times IC \times CycleTime$
> $IC_C = 6 \times 10^8,\ CPI_C = 1.1,\ So\ ExecutionTime_C = 0.66s$
>
> $Speedup\ C\ over\ A = 1.1/0.66 = 1.67$
>
> $Speedup\ C\ over\ B = 1.5/0.66 = 2.27$

1.9

> $CPIs => arithmetic = 1,\ load/store = 12,\ branch = 5$
> $ICs => arithmetic = 2.56 \times 10^9, load/store = 1.28 \times 10^9, branch = 256^10^6$
> $ClockFrequency = 2GHz = 0.5ns$

1.9.1

> $ExecutionTime = CycleCount \times CycleTime$
> $ExecutionTime_1 = (2.56 + 1.28 \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 9.6s$
> $ExecutionTime_2 = (2.56/(0.7 \times 2) + 1.28/(0.7 \times 2) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 7.04s$
> $ExecutionTime_4 = (2.56/(0.7 \times 4) + 1.28/(0.7 \times 4) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 3.84s$

$$ExecutionTime_8 = (2.56/(0.7 \times 8) + 1.28/(0.7 \times 8) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 2.24s$$

$$Speedup\ 2 = ExecutionTime_1/ExecutionTime_2 = 9.6/7.04 = 1.36$$
$$Speedup\ 4 = ExecutionTime_1/ExecutionTime_4 = 9.6/3.84 = 2.5$$
$$Speedup\ 8 = ExecutionTime_1/ExecutionTime_8 = 9.6/2.24 = 4.28$$

1.9.2

$ExecutionTime_1 = CycleCount \times CycleTime$ 1 :
$$ExecutionTime_1 = (2.56 \times 2 + 1.28 \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 10.88s$$
$$Speeddown\ 1 = ExecutionTime_1/ExecutionTime'_1 = 9.6/10.88 = 0.882$$

2 :
$$ExecutionTime_2 = (2.56/(0.7 \times 2) \times 2 + 1.28/(0.7 \times 2) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 7.95s$$
$$Speeddown\ 2 = ExecutionTime_2/ExecutionTime'_2 = 7.04/7.95 = 0.885$$

4 :
$$ExecutionTime_4 = (2.56/(0.7 \times 4) \times 2 + 1.28/(0.7 \times 4) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 4.29s$$
$$Speeddown\ 4 = ExecutionTime_4/ExecutionTime'_4 = 3.84/4.29 = 0.895$$

8 :
$$ExecutionTime_8 = (2.56/(0.7 \times 8) \times 2 + 1.28/(0.7 \times 8) \times 12 + 0.256 \times 5) \times 0.5ns \times 10^9 = 2.47s$$
$$Speeddown\ 8 = ExecutionTime_8/ExecutionTime'_8 = 2.24/2.47 = 0.906$$

1.9.3

$$2.56 + 1.28 \times CPI' + 0.256 \times 5 = 2.56/(0.7 \times 4) + 1.28/(0.7 \times 4) \times 12 + 0.256 \times 5$$

$$CPI' = 3$$

1.10

1.10.1

Wafer yield = $\dfrac{1}{(1 + defect\ per\ area \times \dfrac{die\ area}{2})^2}$

Wafer 1 = $\dfrac{1}{(1 + 0.020 \times \dfrac{\pi \times 7.5^2/84}{2})^2} = 0.9794$

Wafer 2 = $\dfrac{1}{(1 + 0.031 \times \dfrac{\pi \times 10^2/100}{2})^2} = 0.9535$

1.10.2

Cost per die = $\dfrac{cost\ per\ wafer}{dies\ per\ wafer \times yield}$

Wafer 1 = $12/84 = 0.1428$ Wafer 2 = $15/100 = 0.1500$

1.10.3

> Wafer 1 die area = $\pi \times 7.5^2/(84 \times 1.1) = 1.91cm^2$
>
> Wafer 1 yield = $\dfrac{1}{(1 + 0.020 \times 1.15 \times \dfrac{1.91}{2})^2} = 0.9574$
>
> Wafer 2 die area = $\pi \times 10^2/(100 \times 1.1) = 2.85cm^2$
>
> Wafer 2 yield = $\dfrac{1}{(1 + 0.031 \times 1.15 \times \dfrac{2.85}{2})^2} = 0.9056$

1.10.4

> defects per area = $(1 - \sqrt{yield})/(\sqrt{yield} \times die\ area/2)$
>
> defects per area 0.92 = $(1 - \sqrt{0.92})/(\sqrt{0.92} \times 2/2) = 0.043\ defects/cm^2$
>
> defects per area 0.95 = $(1 - \sqrt{0.95})/(\sqrt{0.95} \times 2/2) = 0.026\ defects/cm^2$