CSE 331/503

Computer Organization

Homework 1

1. A) Wafer_X

Wafer area = $\pi R^2 = 3,14 \times \left(\frac{16}{2}\right)^2 = 3,14 \times 64 = \boxed{200,96\ cm^2}$

Die area = $\frac{\text{Wafer area}}{\text{Dies per wafer}} = \frac{200,96}{64} = \boxed{3,14\ cm^2}$

Wafer_Y

Wafer area = $\pi R^2 = 3,14 \times \left(\frac{20}{2}\right)^2 = 3,14 \times 100 = \boxed{314\ cm^2}$

Die area = $\frac{314}{100} = \boxed{3,14 cm^2}$

B) Wafer_X

Yield = $\frac{1}{\left(1 + \left(\text{Defects per area} \times \text{Die area}/2\right)\right)^2} = \frac{1}{(1 + (0,02 \times 3,14/2))^2} = \boxed{0,94}$

Cost per die = $\frac{\text{Cost per wafer}}{\text{Dies per wafer} \times \text{Yield}} = \frac{15}{64 \times 0,94} = \boxed{0,25}$

Wafer_Y

Yield = $\frac{1}{(1 + (0,03 \times 3,14/2))^2} = \boxed{0,91}$

Cost per die = $\frac{24}{100 \times 0,91} = \boxed{0,26}$

C) Wafer X

Wafer cost = $15 \times 0,8 = 12$

Dies per wafer = $64 \times 1,1 = 70,4$

Defect/cm^2 = $0,02 \times 1,15 = 0,023$

Wafer area = $\pi R^2 = 200,96 cm^2$

Die area = $\frac{\text{Wafer area}}{\text{Dies per wafer}} = \frac{200,96}{70,4} = \boxed{2,85\ cm^2}$

Yield = $\frac{1}{(1 + (0,023 \times 2,85/2))^2} = \boxed{0,9375}$

Cost per die = $\frac{12}{70,4 \times 0,9375} = \boxed{0,18} < \boxed{0,25}$ → Last year's cost

Wafer-Y

Wafer cost = $24 \times 0,8 = 19,2$

Dies per wafer = $100 \times 1,1 = 110$

Defect /cm² = $0,03 \times 1,15 = 0,0345$

Wafer area = $\pi R^2 = 314\ cm^2$

$$\text{Die area} = \frac{\text{Wafer area}}{\text{Dies per wafer}} = \frac{314}{110} = \boxed{2,8545}$$

$$\text{Yield} = \frac{1}{(1 + (0,0345 \times 2,8545 / 2))^2} = \boxed{0,9083}$$

$$\text{Cost per die} = \frac{19,2}{110 \times 0,9083} = \boxed{0,19} < \boxed{0,26} \rightarrow \text{Last year's cost}$$

2. A) P1

Clock cycle = Instruction count × CPI

$$= \underbrace{10^9 \times 0,3 \times 2}_{\text{R type}} + \underbrace{10^9 \times 0,5 \times 4}_{\text{I type}} + \underbrace{10^9 \times 0,2 \times 3}_{\text{J type}}$$

$$= 0,6 \times 10^9 + 2 \times 10^9 + 0,6 \times 10^9 = \boxed{3,2 \times 10^9}$$

P2

Clock cycle = $10^9 \times 0,3 \times 3 + 10^9 \times 0,5 \times 3 + 10^9 \times 0,2 \times 3$

$$= \boxed{3 \times 10^9}$$

B) $2 \times 0,3 + 4 \times 0,5 + 3 \times 0,2 = 3,2$ (P1)

$3 \times 0,3 + 3 \times 0,5 + 3 \times 0,2 = 3$ (P2)

C) CPU time = CPU clock cycles / clock rate

(P1) $\frac{3,2 \times 10^9}{3 \times 10^9} = 1,07$ sec.

(P2) $\frac{3 \times 10^9}{1,5 \times 10^9} = 2$ sec.

D) $\frac{2}{1,07} = 1,87$

P1 is 1,87 times faster than P2.

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