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CS 3339.001
HW 1

Q.1: P1 → Clock: 3.5 GHz, CPIs: 1, 2, 3, 2   P2 → Clock: 2.5 GHz, CPIs: 3, 2, 1, 1

1.a) A = .15
B = .2
C = .55
D = .1

$\text{Effective } CPI_{P1} = (1 \cdot .15) + (2 \cdot .2) + (3 \cdot .55) + (2 \cdot .1) = \underline{2.4}$

$\text{Effective } CPI_{P2} = (3 \cdot .15) + (2 \cdot .2) + (1 \cdot .55) + (1 \cdot .1) = \underline{1.5}$

1.b) $\text{CPU Time}_{P1} = \dfrac{2000000 \cdot 2.4}{3.5 \cdot 10^9} = \underline{0.00137\text{s}}$

$\text{CPU Time}_{P2} = \dfrac{2000000 \cdot 1.5}{2.5 \cdot 10^9} = \underline{0.0012\text{s}}$

Processor 2 is faster

1.c) $\text{Clock Cycles}_{P1} = 2000000 \cdot 2.4 = \underline{4800000}$

$\text{Clock Cycles}_{P2} = 2000000 \cdot 1.5 = \underline{3000000}$

1.d) $\text{Performance}_{P1} = \dfrac{2000000}{0.001371429} = \underline{1.458\overline{33} \cdot 10^9}$

$\text{Performance}_{P2} = \dfrac{2000000}{0.0012} = \underline{1.\overline{66} \cdot 10^9}$

1.e) $0.00137(.7) = \dfrac{2000000 \cdot 2.4(1.25)}{\text{Clock Rate}_{P1}} \rightarrow \text{Clock Rate}_{P1} = 6.25 \cdot 10^9 = \underline{6.25\text{GHz}}$

$0.0012(.7) = \dfrac{2000000 \cdot 1.5(1.25)}{\text{Clock Rate}_{P2}} \rightarrow \text{Clock Rate}_{P2} = 4.4643 \cdot 10^9 = \underline{4.4643\text{GHz}}$

Q.2: Clock Rate $= \frac{1}{3\cdot10^{-9}} = 333333333.\overline{33}$ Hz

1) $CPI_x = \frac{1.2\cdot 333333333.\overline{33}}{8\cdot10^{8}} = \underline{0.5}$

$CPI_y = \frac{2.4\cdot 333333333.\overline{33}}{1.6\cdot10^{9}} = \underline{0.5}$

2) $\frac{0.5(8\cdot10^{8})}{\text{Clock Rate}_x} = \frac{0.5(1.6\cdot10^{9})}{\text{Clock Rate}_y} \rightarrow \text{Clock Rate}_x = \frac{1}{2}\cdot\text{Clock Rate}_y$

Clock Rate_x must be <u>twice as fast</u> as Clock Rate_y

3) $\text{Speedup}_x = {}^{1.2}/_{2.5}\cdot 3\cdot10^{-9}\cdot 1.3\cdot10^{9} = \underline{0.123077}$

$\text{Speedup}_y = {}^{2.4}/_{2.5}\cdot 3\cdot10^{-9}\cdot 1.3\cdot10^{9} = \underline{0.246154}$

Q.3: Clock Rate = 3.2 GHz Voltage = 1 V DP = 45 W

3.a) $45 = \frac{C\cdot1^2\cdot3.2\cdot10^{9}}{2} \rightarrow C = \underline{2.8125\cdot10^{-8}\,F}$

3.b) $TP = 35 + 45 = 80\,W \rightarrow ({}^{35}/_{80})\,100 = \underline{31.25\%}$

$\text{Ratio}_{SP/DP} = {}^{35}/_{45} = \underline{.\overline{77}}$

3.c) $(0.85)\,80 = 35 + \frac{2.8125\cdot10^{-8}\cdot V^2\cdot3.2\cdot10^{9}}{2} \rightarrow V = \sqrt{\frac{66}{2.8125\cdot10^{-8}\cdot3.2\cdot10^{9}}}$

$\underline{V = 0.856349}$

Q4: $IC = 4 \cdot 10^{12}$ $ET = 700$ $RT = 9000$ Clock Cycle $= 5 \cdot 10^{-10}$

4.a) $700 = CPI \cdot 4 \cdot 10^{12} \cdot 5 \cdot 10^{-10} \rightarrow \underline{CPI = 0.35}$

$SPECratio = \frac{9000}{700} = \underline{12.857143}$

4.b) $ET = .35 \cdot 4 \cdot 10^{12}(1.25) \cdot 5 \cdot 10^{-10} = \underline{875}$

$SPECratio = \frac{9000}{875} = 10.285714 \rightarrow 10.285714 - 12.857143 = \underline{-2.571429}$

4.c) $ET = .35(1.15) \cdot 4 \cdot 10^{12}(1.1) \cdot 5 \cdot 10^{-10} = \underline{885.5}$

$SPECratio = \frac{9000}{885.5} = 10.163749 \rightarrow 10.163749 - 12.857143 = \underline{-2.693394}$

4.d) $650 = CPI \cdot 4 \cdot 10^{12}(.9) \cdot 2.5 \cdot 10^{-10} \rightarrow CPI = \underline{0.7\overline{22}}$

Yes, the CPI_{new} is roughly twice CPI_{old} which is similiar to to increase in clock rate from 2GHz(.5ns) to 4GHz(.25ns)

$ET_{change} = ET_{new} - ET_{old} = 650 - 700 = \underline{-50 \text{ sec}}$

Q5: 5.a) $ET_{new} = 70(.75) + 100 + 65 + 65 = \underline{282.5}$

$ET_{change} = ET_{new} - ET_{old} = 282.5 - 300 = \underline{-17.5}$

5.b) $ET_{new} = 70 + 100(.85) + 65 + 65 = \underline{285}$

$ET_{change} = ET_{new} - ET_{old} = 285 - 300 = \underline{-15}$

5.c) No, because the 65 seconds spent on branch instructions only takes up roughly $21.\overline{66}\%$, so even if the time spent on branch instructions was completely eliminated the maximum total time reduction is 21.66%