

Problem 1.6

$$(a) \text{ P1 CPU time} = \frac{10^6 * [0.1 * 1 + 0.2 * 2 + 0.5 * 3 + 0.2 * 3]}{2.5 * 10^9} = 1.04 * 10^{-3} \text{ seconds}$$

$$\text{P2 CPU time} = \frac{10^6 * [0.1 * 2 + 0.2 * 2 + 0.5 * 2 + 0.2 * 2]}{3 * 10^9} = 0.67 * 10^{-3} \text{ seconds}$$

P2 is faster than P1

$$\text{P1's Global CPI} = \frac{\text{CPI time} * \text{clock rate}}{IC} = \frac{1.04 * 10^{-3} * 2.5 * 10^9}{10^6} = 2.6$$

$$\text{P2's Global CPI} = \frac{\text{CPI time} * \text{clock rate}}{IC} = \frac{0.67 * 10^{-3} * 3 * 10^9}{10^6} = 2.01$$

$$(b) \# \text{ clock cycle P1} = \text{Global CPI} * IC = 2.6 * 10^6$$

$$(c) \# \text{ clock cycle P2} = \text{Global CPI} * IC = 2.01 * 10^6$$

Problem 1.9.1

$$\text{Execution time} = \frac{\text{Clock cycle}}{\text{Clock rate}}$$

$$1 \text{ processor: } \frac{1 * 2.56 * 10^9 + 12 * 1.28 * 10^9 + 5 * 2.56 * 10^8}{2 * 10^9} = 9.6s$$

$$2 \text{ processors: } \frac{\frac{1 * 2.56 * 10^9 + 12 * 1.28 * 10^9}{0.7 * 2} + 5 * 2.56 * 10^8}{2 * 10^9} = 7.04s \text{ (speed up 1.36 times)}$$

$$4 \text{ processors: } \frac{\frac{1 * 2.56 * 10^9 + 12 * 1.28 * 10^9}{0.7 * 4} + 5 * 2.56 * 10^8}{2 * 10^9} = 3.84s \text{ (speed up 2.5 times)}$$

$$8 \text{ processors: } \frac{\frac{1 * 2.56 * 10^9 + 12 * 1.28 * 10^9}{0.7 * 8} + 5 * 2.56 * 10^8}{2 * 10^9} = 2.24s \text{ (speed up 4.29 times)}$$

Problem 1.9.2

$$1 \text{ processor: } 9.6 + \frac{1 * 2.56 * 10^9}{2 * 10^9} = 10.88s \text{ (slow down 1.13 times)}$$

$$2 \text{ processors: } 7.04 + \frac{1 * 2.56 * 10^9}{0.7 * 2 * 2 * 10^9} = 7.96s \text{ (slow down 1.13 times)}$$

$$4 \text{ processors: } 3.84 + \frac{1 * 2.56 * 10^9}{0.7 * 4 * 2 * 10^9} = 4.3s \text{ (slow down 1.12 times)}$$

$$8 \text{ processors: } 2.24 + \frac{1 * 2.56 * 10^9}{0.7 * 8 * 2 * 10^9} = 2.47s \text{ (slow down 1.1 times)}$$

Problem 1.9.3

$$1 * 2.56 * 10^9 + X * 1.28 * 10^9 + 5 * 2.56 * 10^8 = \frac{1 * 2.56 * 10^9 + 12 * 1.28 * 10^9}{0.7 * 4} + 5 * 2.56 * 10^8$$

$$X = 3$$

$$3/12 = 0.25$$

Problem 1.12.1

$$\text{CPU time} = \frac{\text{CPI} * IC}{\text{Clock rate}}$$

$$\text{P1: } \frac{0.9 * 5 * 10^9}{4 * 10^9} = 1.125s$$

$$\text{P2: } \frac{0.75 * 1 * 10^9}{2 * 10^9} = 0.25s \text{better}$$

Problem 1.12.2

$$\text{Execution time} = \frac{IC * CPI}{\text{Clock rate}}$$

$$P1: \frac{10^9 * 0.9}{4 * 10^9} = 0.225s$$

$$P2: 0.225 = \frac{IC * 0.75}{3 * 10^9}; IC = 9 * 10^8$$

P2 has to execute $9 * 10^8$ instructions

Problem 1.14.1

$$\text{Execution time} = \frac{\text{Clock Cycles}}{\text{Clock Rate}} = \frac{50 * 10^6 * 1 + 110 * 10^6 * 1 + 80 * 10^6 * 4 + 16 * 10^6 * 2}{2 * 10^9} = 256 \text{ ms}$$

$$128 = \frac{50 * 10^6 * X + 110 * 10^6 * 1 + 80 * 10^6 * 4 + 16 * 10^6 * 2}{2 * 10^9}$$

$X = -4.12$, which is impossible

Problem 1.14.2

$$128 = \frac{50 * 10^6 * 1 + 110 * 10^6 * 1 + 80 * 10^6 * X + 16 * 10^6 * 2}{2 * 10^9}$$

$$X = 0.8$$

Problem 1.14.3

$$\text{Execution time} = \frac{\text{Clock Cycles}}{\text{Clock Rate}} = \frac{50 * 10^6 * 0.6 + 110 * 10^6 * 0.6 + 80 * 10^6 * 2.8 + 16 * 10^6 * 1.4}{2 * 10^9} = 171.2 \text{ ms}$$

$$171.2 / 256 = 1.49$$

The speed improved 1.49 times