P55

1.5 (a) $t_1 = \frac{CPI_1}{C.r.1} = \frac{1.5}{3\times10^9} = 0.5\times10^{-9}$ s

$t_2 = \frac{CPI_2}{C.r.2} = \frac{1}{2.5\times10^9} = 0.4\times10^{-9}$ s

$t_3 = \frac{CPI_3}{C.r.3} = \frac{2.2}{4\times10^9} = 0.55\times10^{-9}$ s

performance $= \frac{1}{t}$

$P_1 = 2\times10^9$ $P_2 = 2.5\times10^9$ $P_3 = 1.82\times10^9$

$\therefore$ P_2 has the highest performance.

(b) P_1 cycles $= C.r.1 \times t = 3\times10^9 \times 10 = 3\times10^{10}$

P_1 ins $= \frac{P_1 \text{ cycles}}{CPI_1} = \frac{3\times10^{10}}{1.5} = 2\times10^{10}$

P_2 cycles $= C.r.2 \times t = 2.5\times10^9 \times 10 = 2.5\times10^{10}$

P_2 ins $= \frac{P_2 \text{ cycles}}{CPI_2} = \frac{2.5\times10^{10}}{1} = 2.5\times10^{10}$

P_3 ins $= \frac{C.r.3 \times t}{CPI_3} = \frac{4\times10^9\times10}{2.2} = 1.82\times10^{10}$

(c) $P_1 c.r = \frac{P_1 \text{ins} \times 1.2 CPI_1}{0.7t} = \frac{2\times10^{10}\times1.2\times1.5}{0.7\times10} \approx 5.14\times10^9 = 5.14$ GHz

$P_2 c.r = \frac{2.5\times10^{10}\times1.2\times1}{0.7\times10} \approx 4.29\times10^9 = 4.29$ GHz

$P_3 c.r = \frac{1.82\times10^{10}\times1.2\times2.2}{0.7\times10} \approx 6.86\times10^9 = 6.86$ GHz

1.6 (a). $I_A = 10^6 \times 10\% = 10^5$

$I_B = 10^6 \times 20\% = 2\times10^5$

$I_C = 10^6 \times 50\% = 5\times10^5$

$I_D = 10^6 \times 20\% = 2\times10^5$

P_1: $t_A = \frac{I_A \times CPI_A}{C.r_A} = \frac{10^5\times1}{2.5\times10^9} = 0.4\times10^{-4}$ s

$t_B = \frac{2\times10^5\times2}{2.5\times10^9} = 1.6\times10^{-4}$ s

$t_C = \frac{5\times10^5\times3}{2.5\times10^9} = 6\times10^{-4}$ s

$t_D = \frac{2\times10^5\times3}{2.5\times10^9} = 2.4\times10^{-4}$ s

$P_2: \quad t_A' = \frac{10^5 \times 2}{3\times 10^9} = \frac{2}{3}\times 10^{-4}\ s$

$t_B' = \frac{2\times10^5\times2}{3\times10^9} = \frac{4}{3}\times10^{-4}\ s$

$t_C' = \frac{5\times10^5\times2}{3\times10^9} = \frac{10}{3}\times10^{-4}\ s$

$t_D' = \frac{2\times10^5\times2}{3\times10^9} = \frac{4}{3}\times10^{-4}\ s$

$CPI_{P_1} = \frac{t\times C.r}{I} = \frac{(0.4+1.6+6+2.4)\times10^{-4}\times2.5\times10^9}{10^6} = 2.6$

$CPI_{P_2} = \frac{(\frac{2}{3}+\frac{4}{3}+\frac{10}{3}+\frac{4}{3})\times10^{-4}\times3\times10^9}{10^6} = 2$

(b) $P_{1\,c.c} = P_{1\,c.r}\times t_{P_1} = 2.5\times10^9\times1.04\times10^{-3} = 2.6\times10^6$

$P_{2\,c.c} = 3\times10^9\times\frac{2}{3}\times10^{-3} = 2\times10^6$

1.7 (a) $CPI_A = \frac{t}{c.c.t\times I} = \frac{1.1}{10^{-9}\times10^9} = 1.1$

$CPI_B = \frac{1.5}{1.2\times10^9\times10^{-9}} = 1.25$

(b) $C.C = CPI\times I = \frac{time}{c.c.t}$

$c.r = \frac{I}{t}$

$A_{c.r} = \frac{I_A}{t} = \frac{10^9}{t}$

$B_{c.r} = \frac{I_B}{t} = \frac{1.2\times10^9}{t}$

$\frac{B_{c.r}}{A_{c.r}} = \frac{1.2\times10^9}{t}\cdot\frac{t}{10^9} = 1+20\%$

So, B is 20% faster than A.

1.9.1 $time = \frac{I\times CPI}{c.r}$

1 processor: $t_{ari_1} = \frac{\frac{2.56\times10^9}{0.7}\times1}{2\times10^9} \approx 1.83s \quad t_{ls_1} = \frac{\frac{1.28\times10^9}{0.7}\times12}{2\times10^9} \approx 10.97s$

$t_{bra_1} = \frac{2.56\times10^8\times5}{2\times10^9} \approx 0.64s$

$t_1 = 1.83+10.97+0.64 = 13.44s.$

Similarly available:

2 Processors: $t_2 = 0.92+5.49+0.64 = 7.05\ s$

4 processors: $t_4 = 0.46 + 2.75 + 0.64 = 3.85s$

8 processors: $t_8 = 0.23 + 1.38 + 0.64 = 2.25s$

$Speedup_2 = \frac{t_1}{t_2} = \frac{13.44}{7.05} \approx 1 + 91\%$

$Speedup_4 = \frac{t_1}{t_4} = \frac{13.44}{3.85} = 1 + 249\%$

$Speedup_8 = \frac{t_1}{t_8} = \frac{13.44}{2.25} = 1 + 497\%$

1.15

$t_2 = 50 + 4 = 54s$ $\quad t_2' = 50s$

$t_4 = 29s$ $\quad t_4' = 25s$

$t_8 = 16.5s$ $\quad t_8' = 12.5s$

$t_{16} = 10.25s$ $\quad t_{16}' = 6.25s$

$t_{32} = 7.125s$ $\quad t_{32}' = 3.125s$

$t_{64} = 5.5625s$ $\quad t_{64}' = 1.5625s$

$t_{128} = 4.78125s$ $\quad t_{128}' = 0.78125s$

$t_1 = 100s$

$S_2 = \frac{t_1}{t_2} = \frac{100}{54} \approx 1 + 85\%$ $\quad S_2' = \frac{t_1}{t_2'} = \frac{100}{50} = 1 + 100\%$ $\quad \frac{S_2}{S_2'} = \frac{t_2'}{t_2} \approx \frac{25}{27}$

$S_4 = \frac{100}{29} \approx 1 + 245\%$ $\quad S_4' = \frac{100}{25} = 1 + 300\%$ $\quad \frac{S_4}{S_4'} = \frac{25}{29}$

$S_8 = \frac{100}{16.5} \approx 1 + 506\%$ $\quad S_8' = \frac{100}{12.5} = 1 + 700\%$ $\quad \frac{S_8}{S_8'} = \frac{25}{33}$

$S_{16} = \frac{100}{10.25} \approx 1 + 876\%$ $\quad S_{16} = \frac{100}{6.25} = 1 + 1500\%$ $\quad \frac{S_{16}}{S_{16}'} = \frac{25}{41}$

$S_{32} = \frac{100}{7.125} \approx 1 + 1304\%$ $\quad S_{32}' = \frac{100}{3.125} = 1 + 3100\%$ $\quad \frac{S_{32}}{S_{32}'} = \frac{25}{57}$

$S_{64} = \frac{100}{5.5625} \approx 1 + 1698\%$ $\quad S_{64}' = \frac{100}{1.5625} = 1 + 6300\%$ $\quad \frac{S_{64}}{S_{64}'} = \frac{25}{89}$

$S_{128} = \frac{100}{4.78125} \approx 1 + 1992\%$ $\quad S_{128}' = \frac{100}{0.78125} = 1 + 12700\%$ $\quad \frac{S_{128}}{S_{128}'} = \frac{25}{153}$

P165

2.3 sub $t0, $s6, $s0

sll $t0, $t0, 2

lw $t1, 0($t0)

sw $t1, 32($7)

2.4 B[g] = A[f+1] + A[f]

2.5 add $t0, $s6, $s0 # t0 = A[f/4]

addi $t1, $t0, 4 # t1 = A[f/4+1]

add $t2, $s7, $s1 # t2 = B[g/4]

add $t0, $t0, $t1 # t0 = A[f/4] + A[f/4+1]

sw $t0, 0($t2) # B[g/4] = A[f/4] + A[f/4+1]

P238

3.20 0x0C00 0000

turn into Binary 0000 1101 0000 0000 0000 0000 0000 0000

signed 1111 0011 0000 0000 0000 0000 0000 0000

which is $-(2^{30}+2^{29}+2^{28}+2^{25}+2^{24}) = -1929379840$

unsigned $2^{31}+2^{30}+2^{29}+2^{28}+2^{25}+2^{24} = 2147483648$

3.21 0x0C00 0000

$\Rightarrow$ $\boxed{0000\ 11}01$ 0000 0000 0000 0000 0000 0000

jal (jump and link)

3.22 0x0C00 0000

1 0000 1101 0000 0000 0000 0000 0000 0000

$+$ 26 1.0

$E = 26+127 = 153$

$\Rightarrow 1.0 \times 2^{153}$