Computer Science 315
Spring 2016
Computer Architecture
Homework #1 Solutions

1.5

a. performance of P1 (instructions/sec) $= 3 \times 10^9/1.5 = 2 \times 10^9$
performance of P2 (instructions/sec) $= 2.5 \times 10^9/1.0 = 2.5 \times 10^9$
performance of P3 (instructions/sec) $= 4 \times 10^9/2.2 = 1.8 \times 10^9$

b. cycles(P1) $= 10 \times 3 \times 10^9 = 30 \times 10^9$ s

cycles(P2) $= 10 \times 2.5 \times 10^9 = 25 \times 10^9$ s

cycles(P3) $= 10 \times 4 \times 10^9 = 40 \times 10^9$ s

c. No. instructions(P1) $= 30 \times 10^9/1.5 = 20 \times 10^9$

No. instructions(P2) $= 25 \times 10^9/1 = 25 \times 10^9$

No. instructions(P3) $= 40 \times 10^9/2.2 = 18.18 \times 10^9$

$CPI_{new} = CPI_{old} \times 1.2$, then CPI(P1) $= 1.8$, CPI(P2) $= 1.2$, CPI(P3) $= 2.6$

$f =$ No. instr. $\times$ CPI/time, then

f(P1) $= 20 \times 10^9 \times 1.8/7 = 5.14$ GHz

f(P2) $= 25 \times 10^9 \times 1.2/7 = 4.28$ GHz

f(P1) $= 18.18 \times 10^9 \times 2.6/7 = 6.75$ GHz

1.7

a. $CPI = T_{exec} \times f/$No. instr.

Compiler A CPI $= 1.1$

Compiler B CPI $= 1.25$

b. $f_B/f_A =$ (No. instr.(B) $\times$ CPI(B))/(No. instr.(A) $\times$ CPI(A)) $= 1.37$

c. $T_A/T_{new} = 1.67$

$T_B/T_{new} = 2.27$

1.12

1.12.1 T(P1) = $5 \times 10^9 \times 0.9 / (4 \times 10^9) = 1.125$ s

T(P2) = $10^9 \times 0.75 / (3 \times 10^9) = 0.25$ s

clock rate (P1) > clock rate(P2), performance(P1) < performance(P2)

1.12.2 T(P1) = No. instr. × CPI/clock rate

T(P1) = 2.25 3 1021 s

T(P2) 5 N × 0.75/(3×10^9), then N = 9×10^8

1.12.3 MIPS = Clock rate × 10^{-6}/CPI

MIPS(P1) = $4 \times 10^9 \times 10^{-6}/0.9 = 4.44 \times 10^3$

MIPS(P2) = $3 \times 10^9 \times 10^{-6}/0.75 = 4.0 \times 10^3$

MIPS(P1) > MIPS(P2), performance(P1) < performance(P2) (from 11a)

1.12.4 MFLOPS = No. FP operations × 10^{-6}/T

MFLOPS(P1) = .4 × 5E9 × 1E-6/1.125 = 1.78E3

MFLOPS(P2) = .4 × 1E9 × 1E-6/.25 = 1.60E3

MFLOPS(P1) > MFLOPS(P2), performance(P1) < performance(P2) (from 11a)