

CMPUT 229 - Quiz # 2 - Fall 2011

Name:

Question 1 (100 points): Two machines M_A and M_B implement the same instruction set architecture. A computer program, compiled with a compiler C_A , executes in 10 seconds in a machine M_A . The same program, compiled by a different compiler C_B , executes 1.25 times slower in machine M_B . The number of instructions executed in M_B is twice the number of instructions executed in M_A . The clock frequency of M_B is 1.6 faster than the clock frequency of M_A . If the average number of clock per instructions (CPI) of M_B is 2 clocks per instruction, what is the CPI of M_A ? Remember that the execution time of a program can be expressed by the following relation:

$$\text{Execution Time} = \# \text{ of instructions} \times \text{CPI} \times \frac{1}{\text{Clock Frequency}}$$

$$\text{Execution Time}_B = 1.25 \times \text{Execution Time}_A \quad (1)$$

$$\# \text{ of instructions}_B = 2 \times \# \text{ of instructions}_A \quad (2)$$

$$\text{Frequency}_B = 1.6 \times \text{Frequency}_A \quad (3)$$

$$\text{CPI}_B = 2 \frac{\text{clocks}}{\text{instruction}} \quad (4)$$

$$\text{Execution Time}_A = 10 \text{ seconds}$$

$$\text{Execution Time}_A = \# \text{ of instructions}_A \times \text{CPI}_A \times \frac{1}{\text{Frequency}_A} \quad (5)$$

$$\text{CPI}_A = \text{Execution Time}_A \times \frac{\text{Frequency}_A}{\# \text{ of instructions}_A} \quad (6)$$

$$\text{Execution Time}_B = \# \text{ of instructions}_B \times \text{CPI}_B \times \frac{1}{\text{Frequency}_B} \quad (7)$$

Substituting (1), (2), (3), and (4) into (7):

$$1.2 \times \text{Execution Time}_A = 2 \times \# \text{ of instructions}_A \times 2 \times \frac{1}{1.6 \times \text{Frequency}_A} \quad (8)$$

$$\frac{\text{Frequency}_A}{\# \text{ of instructions}_A} = \frac{2 \times 2}{1.6 \times 1.25 \times \text{Execution Time}_A} \quad (9)$$

$$\frac{\text{Frequency}_A}{\# \text{ of instructions}_A} = \frac{2 \times 2}{1.6 \times 1.25 \times 10} = \frac{1}{5} = 0.2 \quad (10)$$

Substituting (10) into (6):

$$\text{CPI}_A = \text{Execution Time}_A \times \frac{1}{5} = \frac{10}{5} = 2 \frac{\text{clocks}}{\text{instruction}} \quad (11)$$