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Exam 1 – CSCI 352

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# Problem 1)

*Consider two different implementations, M1 and M2, of the same instruction set. There are three classes of instructions (A, B, and C) in the instruction set. M1 has a clock rate of 80 MHz and M2 has a clock rate of 100 MHz. The average number of cycles for each instruction class and their frequencies (for a typical program) are as follows: (20 pts)*

|  |  |  |  |
| --- | --- | --- | --- |
| *Instruction Class* | *Machine M1 – Cycles/Instruction Class* | *Machine M2 – Cycles/Instruction Class* | *Frequency* |
| *A* | *1* | *2* | *60%* |
| *B* | *2* | *3* | *30%* |
| *C* | *4* | *4* | *10%* |

*Calculate the average CPI for each machine, M1, and M2.*

Clock\_Rate\_M1 = 80 MHz

Clock\_Rate\_M2 = 100 MHz

Clock\_Cycle\_Time\_M1 = 1/(80 \* 10^6)

Clock\_Cycle\_Time\_M2 = 1/(100 \* 10^6)

CPI\_M1 = (CPI\_A\_M1 \* f\_A\_M1) + (CPI\_B\_M1 \* f\_B\_M1) + (CPI\_C\_M1 \* f\_C\_M1)

CPI\_M1 = (1 \* 0.6) + (2 \* 0.3) + (4 \* 0.10)

CPI\_M1 = 1.6

CPI\_M2 = (CPI\_A\_M2 \* f\_A\_M2) + (CPI\_B\_M2 \* f\_B\_M2) + (CPI\_C\_M2 \* f\_C\_M2)

CPI\_M2 = (2 \* 0.6) + (3 \* 0.3) + (4 \* 0.1)

CPI\_M2 = 2.5

M1 will have a CPI of 1.6, while M2 will have a CPI of 2.5.

# Problem 2)

*Computer A has an overall CPI of 1.3 and can be run at a clock rate of 600MHz. Computer B has a CPI of 2.5 and can be run at a clock rate of 750 Mhz. We have a particular program we wish to run. When compiled for computer A, this program has exactly 100,000 instructions. How many instructions would the program need to have when compiled for Computer B, in order for the two computers to have exactly the same execution time for this program? (20 pts)*

CPI\_A = 1.3

Clock\_Rate\_A = 600 MHz

Instructions\_A = 100,000

CPI\_B = 2.5

Clock\_Rate\_B = 750 MHz

Instructions\_B = ?

We will be using the equation:

CPU\_Time = (Instructions \* CPI) / Clock\_Rate

CPU\_Time will be equal, which leads to the following equation:

CPU\_Time = (Instructions\_A \* CPI\_A) / Clock\_Rate\_A = (Instructions\_B \* CPI\_B) / Clock\_Rate\_B)

Simplifying this and solving for Instructions\_B, will give us the following:

Instructions\_B = (Instructions\_A \* CPI\_A \* Clock\_Rate\_B) / (CPI\_B \* Clock\_Rate\_A)

Solving with Values gives the following:

Instructions\_B = (100,000 \* 1.3 \* 600,000,000) / (2.5 \* 750,000,000)

= (78\*10^12) / (1.875\*10^9)

= 41,600

In order for Computer A and Computer B to have the same execution time for the program, when the program has 100,000 instructions on Computer A, Computer B will need 41,600 instructions.