[컴퓨터 구조] Homework 1

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Chap 2.

Review questions

2.4) Amdahl's law deals with the potential speedup of a program using multiple processors compared to a single processor. The law indicates the amount of speedup as a function of the fraction of code that can be executed in parallel.

2.6) MIPS : millions of instruction executions per second

FLOPS : floating point operations per second.

Problems

2.1) $$CPI = \frac{(\text{Instruction count}) \times (\text{Cycles per second})}{\text{Number of instructions the executed program consists}}$$

$$\therefore CPI = \frac{(45000 \times 1) + (32000 \times 2) + (15000 \times 2) + (8000 \times 2)}{100000}$$

$$= \frac{45000 + 64000 + 30000 + 16000}{100000} = \frac{155000}{100000} = 1.55$$

$$MIPS = \frac{I_c}{T \times 10^6} \quad [T = I_c \times CPI \times \tau]$$

$$= \frac{I_c}{I_c \times CPI \times \tau \times 10^6} = \frac{1}{CPI \times \frac{1}{f} \times 10^6} = \frac{f}{CPI \times 10^6} \quad [\text{Given} : f = 40MHz]$$

$$= \frac{40 \times 10^6}{1.55 \times 10^6} = \frac{40}{1.55} = 25.8$$

$$T = I_c \times CPI \times \tau = I_c \times CPI \times \frac{1}{f}$$

$$= 100000 \times 1.55 \times \frac{1}{40 \times 10^6} = \frac{155000}{40000000} = 0.003875 = 3.875\,ms$$

$\therefore$ CPI : 1.55 / MIPS : 25.8 / T : 3.875 ms

2.2) a. [Machine A]

$$\circ\ CPI = \frac{\Sigma CPI_i \times I_i}{I_c} = \frac{(8\times1+4\times3+2\times4+4\times3)\times10^6}{(8+4+2+4)\times10^6} = 2.22$$

$$\circ\ MIPS = \frac{f}{CPI\times10^6} = \frac{200\times10^6}{2.22\times10^6} = 90$$

$$\circ\ T = \frac{I_c\times CPI}{f} = \frac{18\times10^6\times2.2}{200\times10^6} = 0.2S$$

[Machine B]

$$\circ\ CPI = \frac{\Sigma CPI_i \times I_i}{I_c} = \frac{(10\times1+8\times2+2\times4+4\times3)\times10^6}{(10+8+2+4)\times10^6} = 1.92$$

$$\circ\ MIPS = \frac{f}{CPI\times10^6} = \frac{200\times10^6}{1.92\times10^6} = 104$$

$$\circ\ T = \frac{I_c\times CPI}{f} = \frac{24\times10^6\times1.92}{200\times10^6} = 0.23S$$

b. Although machine B's MIPS is higher than machine A's MIPS, it requires a longer CPU time to execute the same set of benchmark programs.

2.3) a. We know that, $\frac{(\text{MIPS rate})}{10^6} = \frac{I_c}{T}$ $\therefore I_c = T\times\frac{\text{MIPS rate}}{10^6}$

Given, The VAX required 12 times longer than the IBM measured in CPU time. So, we can let x, $12x$.

$\therefore$ The ratio of the instruction count of IBM to VAX is

$$\frac{x\times18}{12x\times1} = 1.5.$$

b. We know that, $\text{MIPS rate} = \frac{f}{CPI\times10^6}$. $\Rightarrow CPI = \frac{f}{(\text{MIPS rate})\times10^6}$

[VAX] $CPI = \frac{5\times10^6\ Hz}{(1\ MIPS)\times10^6} = 5$.

[IBM] $CPI = \frac{25\times10^6\ Hz}{(18\ MIPS)\times10^6} = 1.39$.