UNIT I – Basic Structure of Computer

Functional units – Basic operational concepts – Bus Structures – Performance – Memory locations and addresses – Memory operations – Instruction and Instruction sequencing –– Addressing modes – Assembly language – Case study: RISC and CISC Architecture.

PROBLEMS IN PROCESSOR PERFORMANCE

Relative Performance

PROBLEM 1

If computer A runs a program in 10 seconds and computer B runs the same program in 15 seconds, how much faster is A than B?

Solution:

Formula

A is n times faster than B if

$$\frac{\text{Performance}_A}{\text{Performance}_B} = \frac{\text{Execution time}_B}{\text{Execution time}_A} = n$$

Calculation

Performance ratio =

A is therefore times faster than B.

Improving Performance

PROBLEM 2

Our favorite program runs in 10 seconds on computer A, which has a 2 GHz clock. We are trying to help a computer designer build a computer, B, which will run this program in 6 seconds. The designer has determined that a substantial increase in the clock rate is possible, but this increase will affect the rest of the CPU design, causing computer B to require 1.2 times as many clock cycles as computer A for this program. What clock rate should we tell the designer to target?

Solution:

First find the number of clock cycles required for the program on A:

$$\text{CPU time}_A = \frac{\text{CPU clock cycles}_A}{\text{Clock rate}_A}$$

Calculation

$$10 \text{ seconds} = \frac{\text{CPU clock cycles}_A}{2 \times 10^9 \frac{\text{cycles}}{\text{second}}}$$

CPU clock cycles $_A$ =

CPU time for B can be found using this equation:

$$\text{CPU time}_B = \frac{1.2 \times \text{CPU clock cycles}_A}{\text{Clock rate}_B}$$

Calculation

$$6 \text{ seconds} = \frac{1.2 \times 20 \times 10^9 \text{ cycles}}{\text{Clock rate}_B}$$

Clock Rate $_B$ =

Instruction Performance

PROBLEM 3

Suppose we have two implementations of the same instruction set architecture. Computer A has a clock cycle time of 250 ps and a CPI of 2.0 for some program, and computer B has a clock cycle time of 500 ps and a CPI of 1.2 for the same program. Which computer is faster for this program and by how much?

Solution:

Formula

CPU clock cycles = Instructions for a program × Average clock cycles per instruction

CPU clock cycles $_A$ = ________

CPU clock cycles $_B$ = ________

Compute the CPU time for each computer:

CPU time $_A$ = CPU clock cycles $_A$ × Clock cycle time

CPU time $_A$ =

CPU time $_B$ =

The amount faster is given by the ratio of the execution times:

$$\frac{\text{CPU performance}_A}{\text{CPU performance}_B} = \frac{\text{Execution time}_B}{\text{Execution time}_A} =$$

Computer A is ____ times as fast as computer B

PROBLEM 4

A compiler designer is trying to decide between two code sequences for a particular computer. The hardware designers have supplied the following facts:

	CPI for each instruction class		
	A	B	C
CPI	1	2	3

For a particular high-level language statement, the compiler writer is considering two code sequences that require the following instruction counts:

Code Sequence	**Instruction counts for each instruction class**		
	A	B	C
1	2	1	2
2	4	1	1

Which code sequence executes the most instructions? Which will be faster?

Sequence 1 executes ___________________ instructions.

Sequence 2 executes ___________________ instructions.

Total number of clock cycles for each sequence:

$$\text{CPU clock cycles} = \sum_{i=1}^{n} (\text{CPI}_i \times \text{C}_i)$$

CPU clock cycles1 = __________________________________= ___ cycles

CPU clock cycles2 = __________________________________= ___ cycles

Code sequence ____ is faster

What is the CPI for each sequence?

$$\text{CPI} = \frac{\text{CPU clock cycles}}{\text{Instruction count}}$$

CPI_1 =

CPI_2 =