Ho Chi Minh City University of Technology
Faculty of Computer Science and Engineering

Computer Architecture

Practical session - Week 1, Semester 1 2020

Notice

- The main purpose of this week is to review the first chapter (Computer Technology & Abstraction) of the course. The following exercises mainly focus on performance evaluation and execution time calculation.
- **Students are requested to submit your answers (in one pdf file) to the elearning system.**
- Deadline: 1 week.

Question 1. Given three processors, P1, P2, and P3 executing the same instruction set with associated parameters as shown in Table 1:

Processor	Clock rate	Average CPI
P1	3 GHz	1.5
P2	2.5 GHz	1.0
P3	4.0 GHz	2.2

Table 1: Information for Question 1

a. Which processor has the highest performance expressed in instruction per second?

b. If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

c. We are trying to reduce the time by 30% but this lead to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

Question 2. For problems below, use the information in the following table (Table 2):

Processor	Clock rate	No. Instruction	Time
P1	3 GHz	20×10^9	7 s
P2	2.5 GHz	30×10^9	10 s
P3	4.0 GHz	90×10^9	9 s

Table 2: Information for Question 2

a. Find the IPC (instructions per cycle) for each processor.

b. Find the clock rate for P2 that reduces its execution time to that of P1.

c. Find the number of instructions for P2 that reduces its execution time to that of P3.

Question 3. Consider two different implementations of the same instruction set architecture. There are four classes of instructions, A, B, C, and D. The clock rate and CPI of each implementation are given in the following table (Table 3).

a. Given a program with 10^6 instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which implementation is faster?

Processor	Clock rate	CPI A	CPI B	CPI C	CPI D
P1	2.5 GHz	1	2	3	3
P2	3 GHz	2	2	2	2

Table 3: Information for Question 3

b. What is the global CPI for each implementation?

c. Find the clock cycles required in both cases.

Question 4. A program consists of 1000 instructions in which 20% loadstore instructions, 10% jump instructions, 20% branch instructions, and arithmetic instructions. Assume that CPIs for those instructions are 2.5, 1, 1.5, and 2, respectively. The program is executed on a 2 GHz processor.

- What is the execution time of the above program?
- What is the average CPI of the above the program?
- Assume that we are trying to improve the loadstore instructions such that the execution time for this instructions type is reduced by a factor of 2. What is the speed-up of the program?

Question 5. Suppose we have made the following measurements:

- Frequency of FP operations = 25%
- Average CPI of FP operations = 4.0
- Average CPI of other instructions = 1.33
- Frequency of FPSQR= 2%
- CPI of FPSQR = 20

Assume that the two design alternatives are to decrease the CPI of FPSQR to 2 or to decrease the average CPI of all FP operations to 2.5. Compare these two design alternatives using the processor performance equation.

Question 6. Assume a program requires the execution of:

- 50×10^6 FP instructions,
- 110×10^6 INT instructions,
- 80×10^6 L/S instructions,
- and 16×10^6 branch instructions.

The CPI for each type of instruction is 1, 1, 4, and 2, respectively. Assume that the processor has a 2 GHz clock rate.

a. By how much must we improve the CPI of FP instructions if we want the program to run two times faster?

b. By how much must we improve the CPI of L/S instructions if we want the program to run two times faster?

c. By how much is the execution time of the program improved if the CPI of INT and FP instructions is reduced by 40% and the CPI of L/S and Branch is reduced by 30%?

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