Chapter 4

4.1 [5] <§4.1> We wish to compare the performance of two different computers: M1 and M2. The following measurements have been made on these computers:

Program	Time on M1	Time on M2
1	2.0 seconds	1.5 seconds
2	5.0 seconds	10.0 seconds

Which computer is faster for each program, and how many times as fast is it?

4.2 [5] <§4.1> Consider the two computers and programs in Exercise 4.1. The following additional measurements were made:

Program	Instructions executed on M1	Instructions executed on M2
1	5×10^9	6×10^9

Find the instruction execution rate (instructions per second) for each computer when running program 1.

4.3 [5] <§4.1> Suppose that M1 in Exercise 4.1 costs $500 and M2 costs $800. If you needed to run program 1 a large number of times, which computer would you buy in large quantities? Why?

4.6 [5] <§4.1> Another user has the following requirements for the computers discussed in Exercise 4.1: P1 must be executed 1600 times each hour. Any remaining time is used to run P2. If the computer has enough performance to execute program 1 the required number of times per hour, then performance is measured

by the throughput for program 2. Which computer is faster for this workload? Which computer is more cost-effective?

4.7 [10] <§4.2> Suppose you wish to run a program P with 7.5×10^9 instructions on a 5 GHz machine with a CPI of 0.8.

a. What is the expected CPU time?

b. When you run P, it takes 3 seconds of wall clock time to complete. What is the percentage of the CPU time P received?

4.8 [10] <§4.2> Consider two different implementations, P1 and P2, of the same instruction set. There are five classes of instructions (A, B, C, D, and E) in the instruction set.

P1 has a clock rate of 4 GHz. P2 has a clock rate of 6 GHz. The average number of cycles for each instruction class for P1 and P2 is as follows:

Class	CPI on P1	CPI on P2
A	1	2
B	2	2
C	3	2
D	4	4
E	3	4

Assume that peak performance is defined as the fastest rate that a computer can execute any instruction sequence. What are the peak performances of P1 and P2 expressed in instructions per second?

4.14 [5] <§4.2> The table below shows the number of floating-point operations executed in three different programs and the runtime for those programs on three different computers:

Program	Floating-point operations	Execution time in seconds		
		Computer A	Computer B	Computer C
Program 1	5×10^9	2	5	10
Program 2	20×10^9	20	20	20
Program 3	40×10^9	200	50	15

Which computer is fastest according to total execution time? How many times as fast is it compared to the other two computers?

4.45 [5] <§4.3> Assume that multiply instructions take 12 cycles and account for 15% of the instructions in a typical program, and the other 85% of the instructions require an average of 4 cycles for each instruction. What percentage of time does the CPU spend doing multiplication?

4.46 [5] <§4.3> Your hardware engineering team has indicated that it would be possible to reduce the number of cycles required for multiplication to 8 in Exercise 4.45, but this will require a 20% increase in the cycle time. Nothing else will be affected by the change. Should they proceed with the modification?