1.2.3 [5] <1.3> If a computer connected to a 1 gigabit Ethernet network needs to send a 256 Kbytes file, how long it would take?

1.2.4 [5] <1.3> Assuming that a cache memory is ten times faster than a DRAM memory, that DRAM is 100,000 times faster than magnetic disk, and that flash memory is 1000 times faster than disk, find how long it takes to read a file from a DRAM, a disk, and a flash memory if it takes 2 microseconds from the cache memory?

Exercise 1.3

Consider three different processors P1, P2, and P3 executing the same instruction set with the clock rates and CPIs given in the following table.

Processor	Clock rate	CPI
P1	2 GHz	1.5
P2	1.5 GHz	1.0
P3	3 GHz	2.5

1.3.1 [5] <1.4> Which processor has the highest performance?

1.3.2 [5] <1.4> If the processors each execute a program in 10 seconds, find the number of cycles and the number of instructions.

1.3.3 [10] <1.4> We are trying to reduce the time by 30% but this leads to an increase of 20% in the CPI. What clock rate should we have to get this time reduction?

For problems below, use the information in the following table.

Processor	Clock rate	No. instructions	Time
P1	2 GHz	20×10^9	7 s
P2	1.5 GHz	30×10^9	10 s
P3	3 GHz	90×10^9	9 s

1.3.4 [10] <1.4> Find the IPC (instructions per cycle) for each processor.

1.3.5 [5] <1.4> Find the clock rate for P2 that reduces its execution time to that of P1.

1.3.6 [5] <1.4> Find the number of instructions for P2 that reduces its execution time to that of P3.

Exercise 1.4

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.

	Clock rate	CPI Class A	CPI Class B	CPI Class C	CPI Class D
P1	1.5 GHz	1	2	3	4
P2	2 GHz	2	2	2	2

1.4.1 [10] <1.4> 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?

1.4.2 [5] <1.4> What is the global CPI for each implementation?

1.4.3 [5] <1.4> Find the clock cycles required in both cases.

The following table shows the number of instructions for a program.

Arith	Store	Load	Branch	Total
500	50	100	50	700

1.4.4 [5] <1.4> Assuming that arith instructions take 1 cycle, load and store 5 cycles and branch 2 cycles, what is the execution time of the program in a 2 GHz processor?

1.4.5 [5] <1.4> Find the CPI for the program.

1.4.6 [10] <1.4> If the number of load instructions can be reduced by one-half, what is the speed-up and the CPI?

Exercise 1.5

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. The clock rate and CPI of each class is given below.

		Clock rate	CPI Class A	CPI Class B	CPI Class C	CPI Class D	CPI Class E
a.	P1	1.0 GHz	1	2	3	4	3
	P2	1.5 GHz	2	2	2	4	4
b.	P1	1.0 GHz	1	1	2	3	2
	P2	1.5 GHz	1	2	3	4	3

1.5.1 [5] <1.4> 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?

1.5.2 [5] <1.4> If the number of instructions executed in a certain program is divided equally among the classes of instructions except for class A, which occurs twice as often as each of the others. Which computer is faster? How much faster is it?

1.5.3 [5] <1.4> If the number of instructions executed in a certain program is divided equally among the classes of instructions except for class E, which occurs twice as often as each of the others? Which computer is faster? How much faster is it?

The table below shows instruction-type breakdown for different programs. Using this data, you will be exploring the performance tradeoffs with different changes made to a MIPS processor.

		# Instructions				
		Compute	Load	Store	Branch	Total
a.	Program 1	1000	400	100	50	1550
b.	Program 4	1500	300	100	100	1750

1.5.4 [5] <1.4> Assuming that computes take 1 cycle, loads and store instructions take 10 cycles, and branches take 3 cycles, find the execution time of each program on a 3 GHz MIPS processor.

1.5.5 [5] <1.4> Assuming that computes take 1 cycle, loads and store instructions take 2 cycles, and branches take 3 cycles, find the execution time of each program on a 3 GHz MIPS processor.

1.5.6 [5] <1.4> Assuming that computes take 1 cycle, loads and store instructions take 2 cycles, and branches take 3 cycles, what is the speed-up of a program if the number of compute instruction can be reduced by one-half?

Exercise 1.6

Compilers can have a profound impact on the performance of an application on a given processor. This problem will explore the impact compilers have on execution time.

	Compiler A		Compiler B	
	# Instructions	Execution time	# Instructions	Execution time
a.	1.00E+09	1 s	1.20E+09	1.4 s
b.	1.00E+09	0.8 s	1.20E+09	0.7 s

1.6.1 [5] <1.4> For the same program, two different compilers are used. The table above shows the execution time of the two different compiled programs. Find the average CPI for each program given that the processor has a clock cycle time of 1 nS.

1.6.2 [5] <1.4> Assume the average CPIs found in 1.6.1, but that the compiled programs run on two difference processors. If the execution times on the two processors are the same, how much faster is the clock of the processor running compiler A's code versus the clock of the processor running compiler B's code?

1.6.3 [5] <1.4> A new compiler is developed that uses only 600 million instructions and has an average CPI of 1.1. What is the speed-up of using this new compiler versus using Compiler A or B on the original processor of 1.6.1?

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, and P2 has a clock rate of 6 GHz. The average number of cycles for each instruction class for P1 and P2 are listed in the following table.

	Class	CPI on P1	CPI on P2
a.	A	1	2
	B	2	2
	C	3	2
	D	4	4
	E	5	4

	Class	CPI on P1	CPI on P2
b.	A	1	2
	B	1	2
	C	1	2
	D	4	4
	E	5	4