(5 pts) Exercise 1-51

- 1. Program A runs in 10 seconds on a machine with a 100 MHz clock. How many clock cycles does program A require?

(5 pts) Exercise 1-52

- 2.) Our favorite program runs in 10 seconds on computer A, which has a 400 Mhz. clock. We are trying to help a computer designer build a new machine B, that will run this program in 6 seconds. The designer can use new (or perhaps more expensive) technology to substantially increase the clock rate, but has informed us that this increase will affect the rest of the CPU design, causing machine B to require 1.2 times as many clock cycles as machine A for the same program. What clock rate should we tell the designer to target?"
- 3.) Why might machine B need more clock cycles to run the program?

(10 pts) Exercise 1-53

- We wish to compare the performance of two different computers: M1 and M2. The following measurements have been made on these computers:

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

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

(10 pts) Exercise 1-56

- Consider the machines from the previous exercise, and assume the following additional measurements were made:

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

What is the instruction execution rate (instructions per second) for each computer when running program 1?

(10 pts) Exercise 1-57

- **Suppose that M1 <u>from Exercise 4-5</u> 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?**

(5 pts) Exercise 1-61: “MIPS”

- **Two different compilers are being tested for a 100 MHz. machine that has three different classes of instructions: Class A, Class B, and Class C, which require one, two, and three cycles (respectively). Both compilers are used to produce code for a large piece of software.**
  <u>Compiler #1:</u> code uses 5 million Class A instructions, 1 million Class B instructions, and 1 million Class C instructions.
  <u>Compiler #2:</u> code uses 10 million Class A instructions, 1 million Class B instructions, and 1 million Class C instructions.
- **Which sequence will be faster according to execution time?**
- **Which sequence will be faster according to MIPS?**
  MIPS = Inst. Count / (ExecutionTime * 10^6)

(5 pts) Exercise 1-62

- **Program A runs in 0.34 seconds on a 500 Mhz machine. You know that this program requires 100 million instructions of which:**
  - **10% are mult. instructions that take an unknown number of cycle**
  - **60% are other arithmetic instructions taking 1 cycle**
  - **30% are memory instructions taking 2 cycles**
- **How many cycles does a multiplication take on this machine?**

(5 pts) Exercise 1-63

- **Program A runs in 2 seconds on a certain machine. You know that this program requires 500 million instructions of which:**
  - **30% are multiplication instructions that take 10 cycles**
  - **40% are other arithmetic instructions taking 1 cycle**
  - **30% are memory instructions taking 2 cycles**
- **Suppose multiplication could be improved to take just 1 cycle. How much faster would the new machine be compared to the old?**

(10 pts) Exercise 1-66

- **Consider two different implementations, P1 and P2, of the same instruction set. There are five classes of instructions (A-E), which have the following average CPI on the two machines**

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

P1 has a clock rate of 4 GHz, P2 has a clock rate of 6 GHz.

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, how much faster is P2 than P1?

(10 pts) Exercise 1-67

- **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?

(5 pts) Exercise 1-71

- **Suppose we enhance a machine making all floating-point instructions run five times faster. If the execution time of some benchmark before the floating-point enhancement is 10 seconds, what will the speedup be if half of the 10 seconds is spent executing floating-point instructions?**

- **Formula:**
  Time after Improve. = Exec. Time Unaffected +(Exe. Time Affected / Amount of Improvement)

(5 pts) Exercise 1-72

- **We are looking for a benchmark to show off the new floating-point unit described above, and want the overall benchmark to show a speedup of 3. One benchmark we are considering runs for 100 seconds with the old floating-point hardware. How much of the execution time would floating-point instructions have to account for in this program in order to yield our desired speedup on this benchmark?**

(10 pts) Exercise 1-75 (use Amdahl's Law)

- **You are going to enhance a computer, and there are two possible improvements: either make multiply instructions run four times faster than before, or make memory access instructions run two times faster than before.**
  You repeatedly run a program that takes 100 seconds to execute. Of this time, 20% is used for multiplication, 50% for memory access instructions, and 30% for other tasks.
- **What will the speedup be if you improve only multiplication?**
- **What will the speedup be if you improve only memory access?**
- **What will the speedup be if both improvements are made?**