EE 4720 **Homework 1** **Due: 3 February 1997**

The table below, used in the next two problems, gives the run times on two machines for programs being considered for a benchmark suite.

Program	A1	A2	A3	B1	B2	C1	C2	C3	C4
Base machine	54	40	17	40	71	40	3	111	7
Test machine	20	35	10	20	20	19	1	40	2

Problem 1: Find the arithmetic mean, harmonic mean, and geometric mean of the run times in the table above.

Problem 2: The programs in the table above are being considered for a benchmark suite. Three types of programs are represented: compilers (A1, A2, and A3), database programs (B1 and B2), and floating-point intensive programs (C1 through C4). Assume the programs are written using a variety of programming styles and compilers and are a good representation of programs that Real People run. Assume that the base machine used for the numbers above does not run any program particularly fast or particularly slow.

Devise a way of combining the run times of the programs on the base machine and a test machine into a number called the *TigerMark* so that:

- The TigerMark indicates how much faster the test machine is than the base machine. (*E.g.*, 2.1 times faster for a TigerMark of 2.1.)
- Each type of program (compiler, database, floating-point) is of equal importance.
- As many programs as possible are used.

What is the TigerMark rating of the test machine in the table above?

Problem 3: A new instruction is being considered for an ISA which does the same computation as a sequence of five instructions on the current version of the ISA. (That is, the five-instruction sequence can be replaced with the new instruction.) The new instruction takes nine cycles, while the five-instruction sequence takes twelve cycles.

One benefit of the new instruction is the three-cycle savings. Give another benefit and two reasons why the new instruction might not be such a good idea.

Problem 4: Computer designers are considering two implementations (A and B) and two compilers (I and II) for an ISA. Instructions are divided into three categories, 1, 2, and 3. In implementation A, instruction execution times (in cycles) are $\mathrm{CPI}_1(A) = 2$, $\mathrm{CPI}_2(A) = 2$, and $\mathrm{CPI}_3(A) = 3$. The number of executed instructions (by category) of a test program compiled using compiler I are $\mathrm{IC}_1(\mathrm{I}) = 1500$, $\mathrm{IC}_2(\mathrm{I}) = 1500$, and $\mathrm{IC}_3(\mathrm{I}) = 5000$. The number of executed instructions (by category) of a test program compiled using compiler II are $\mathrm{IC}_1(\mathrm{II}) = 900$, $\mathrm{IC}_2(\mathrm{II}) = 2500$, and $\mathrm{IC}_3(\mathrm{II}) = 5000$. For the test program compiled with each compiler, find the average instruction execution time and total run time on a system with a 1 MHz clock. Is CPI a good predictor of implementation performance in this case?

Repeat the problem for implementation B in which $\mathrm{CPI}_1(B) = 3$, $\mathrm{CPI}_2(B) = 1$, and $\mathrm{CPI}_3(B) = 3$.