High Performance Computer Architecture (CS60003)

Quiz - 1

1. Consider the execution of an object code with 200,000 instructions on a 40-MHz processor. The program consists of four major types of instructions. The instruction mix and the number of cycles (CPI - Cycles Per Instruction) needed for each instruction type are given below based on the result of a program trace experiment.

Instruction Type	CPI	Instruction Mix
Arithmetic and logic	1	60%
Load/store with cache hit	2	18%
Branch	4	12%
Memory reference with cache miss	8	10%

   (a) Calculate the average CPI when the program is executed on a uniprocessor with the above trace results.

   (b) Calculate the corresponding MIPS rate based on the CPI obtained in part (a).

   MIPS - Million Instructions Per Second (or 10^6 instructions per second)

2. A benchmark suite B_1 consists of equal proportion of class-X and class-Y instructions. Machine M_1 and M_2, with identical 1 GHz clocks, have equal performance of 500 MIPS on B_1. If we replace half of class-X instructions in B_1 with class-Y instructions to derive another benchmark suite B_2, M_1's running time becomes 70% that of M_2. If we replace half of class-Y instructions with class-X instructions to transform B_1 to B_3, M_2 becomes 1.5 times as fast as M_1. What can you say about the average CPIs of M_1 and M_2 for the two instruction classes?

3. You have a system that contains a special processor for doing floating-point operations. You have determined that 60% of your computations can use the floating-point processor. When a program uses the floating-point processor, the speedup of the floating-point processor is 40% faster than when it does not use it.

   (a) Calculate overall speedup by using the floating-point processor.

   (b) In order to improve the speedup consider two options:

   - **Option 1:** Modify the compiler so that 70% of the computations can use the floating-point processor. Cost of this option is \$50K.
   - **Option 2:** Modify the floating-point processor. The speedup of the floating-point processor is 100% faster than when it does not use it. Assume in this case that 50% of the computations can use the floating-point processor. Cost of this option is \$60K.

   Which option would you recommend? Justify your answer quantitatively.

4. Explain briefly which of these two programs would execute faster on a five stage pipelined processor as discussed in class.

Program 1	Program 2
`LW R1,0(R2)`	`SW R1,0(R3)`
`SW R1,0(R3)`	`LW R1,0(R2)`