# COMP2120B Computer organization

Tutorial 1 Performance benchmark - Worksheet

1. A benchmark program is run on a 40 MHz processor. The executed program consists of 100,000 instruction executions, with the following instruction mix and clock cycle count.

| Instruction Type | Instruction Count | Cycles per Instruction |
|---|---|---|
| Integer arithmetic | 45,000 | 1 |
| Data transfer | 32,000 | 2 |
| Floating point | 15,000 | 2 |
| Control transfer | 8,000 | 2 |

   Determine the effective $CPI$, $MIPS$ rate, and execution time for this program.

2. Consider two different machines, with two different instruction sets, both of which have a clock rate of 200 MHz. The following measurements are recorded on the two machines running a given set of benchmark programs.

| Instruction Type | Machine A | | Machine B | |
|---|---|---|---|---|
| | Instruction Count (millions) | Cycles per Instruction | Instruction Count (millions) | Cycles per Instruction |
| Arithmetic and logic | 8 | 1 | 10 | 1 |
| Load and store | 4 | 3 | 8 | 2 |
| Branch | 2 | 4 | 2 | 4 |
| Others | 4 | 3 | 4 | 3 |

   Determine the effective CPI, MIPS rate, and execution time for each machine. Comment on the results.

3. Early examples of CISC and RISC design are the VAX 11/780 and the IBM RS/6000, respectively. Using a typical benchmark program, the following machine characteristics result.

| Processor | Clock Frequency (MHz) | Performance (MIPS) | CPU Time (secs) |
|---|---|---|---|
| VAX 11/780 | 5 | 1 | $12x$ |
| IBM RS/6000 | 25 | 18 | $x$ |

   The final column shows that the VAX required 12 times longer than the IBM measured in CPU time. What is the relative size of the instruction counts of the machine code for this benchmark program running on the two machines?

   What are the CPI values for the two machines?

4. Four benchmark programs are executed on three computers with the following results.

| | Computer A | Computer B | Computer C |
|---|---|---|---|
| **Program 1** | 1 | 10 | 20 |
| **Program 2** | 1000 | 100 | 20 |
| **Program 3** | 500 | 1000 | 50 |
| **Program 4** | 100 | 800 | 100 |

   The table shows the execution time in seconds, with 100,000,000 instructions executed in each of the four programs. Calculate the MIPS values for each computer for each program.

   Then calculate the arithmetic and harmonic means assuming equal weights for the four programs, and rank the computers based on arithmetic mean and harmonic mean.