| CPSC 418 | Advanced Computer Architecture | Spring 1996 |
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# Homework 3: Due 23 Jan

**Problem 1** (9 Points) **Indexed and Displacement Addressing Modes**

This problem will use the following loop.

```
for i = 0x1000 to 0
  A[i] = B[i] * C[i]
```

Throughout the problem use the following register allocations. For example, the base address of array A should be stored in R8, R9 is for temporary information associated with A, and R10 is for the data in `A[i]`.

| i | R3 | | |
|---|---|---|---|
| | Base | Tmp | Data |
| A | R8 | R9 | R10 |
| B | R11 | R12 | R13 |
| C | R14 | R15 | R16 |

**1(a)** (2 Points) Write the assembly code for the loop two ways: one with an ISA that has indexed and displacement addressing modes and one with an ISA that has just displacement mode.

**1(b)** (2 Points) Find the static and dynamic instruction and memory access counts for the loop with both ISAs.

Adding an indexed addressing mode will increases the clock cycle by 10% for a particular microprocessor.

**1(c)** (1 Points) Why would adding indexed addressing increase the clock cycle?

**1(d)** (1 Points) Using the CPI data from Handout 8, on which microprocessor (with indexed and displacement, or with just displacement) will the loop execute faster, and how much faster will it execute?

**1(e)** (3 Points) Assuming that 14% of the load and store instructions could use indexed addressing mode, use the dynamic instruction count information from Handout 8 to determine which microprocessor will give higher average performance. How much faster will it be?

**Problem 2** (3 Points) **Byte Loads and Stores**

Feldman & Retter Problem 2.5

**Problem 3** (3 Points) **Superscalar and CPI**

In a superscalar machine, we can measure the CPI of each instruction pipeline as if it was a single-issue machine and then find the real CPI by dividing the average CPI of each instruction pipeline by the number of instruction pipelines.

Which of the following would be expected consequences of changing a machine from single-issue to a dual-issue machine? *Justify your answers*

- increase or decrease "single-issue CPI" of all instructions by 5 or 50%
- increase or decrease "single-issue CPI" of arithmetic instructions by 10 or 50% (in addition to any change in CPI for other instructions)
- increase or decrease "single-issue CPI" of loads and stores by 10 or 50% (in addition to any change in CPI for other instructions)
- increase or decrease design-time
- speed up or slow down the clock rate by 5 or 50%

**Problem 4** (5 Points) **Performance Growth**

Given:

- microprocessor performance doubles every year
- clock speed for a given microprocessor doubles every four years
- memory speed increases by 7% every year

**4(a)** (3 Points) What percentage performance improvement must all other changes achieve every year?

**4(b)** (2 Points) List the three to five other changes that contribute the most to performance improvements.

**Problem 5** (1 Points)

How much time did you spend total on the assignment and on each of these problems? Which problems were useful or useless? How well did the lectures and text book prepare you for this homework? Which concepts needed better explanation?