16.482 / 16.561: Computer Architecture and Design

Fall 2013

Homework #1

Due **Monday, 9/16/13**

Notes:

- While typed submissions are preferred, handwritten submissions are acceptable.
- Any handwritten solutions that are scanned and submitted electronically must be clearly legible and combined into a single file—simply sending a picture of each scanned page is not an acceptable form of submission.

1. (30 pts) Given the following sequence of C operations, write an assembly language program for each of the four ISA classes we discussed: accumulator, stack, memory-memory, and load-store. Assume that all operands are initially in memory, and that all results must eventually be stored to memory.

```
A = F - G;
B = A - H;
C = B + E;
D = F + A;
E = C – H;
```

2. (30 points) Say we run a particular program on 4 different machines to determine which one has the best performance. Given the information below about each machine, calculate the execution time for each case. Show all work.

   Machine A: Clock cycle time of 2.0 ns, 100 million instructions, average CPI of 2.0
   Machine B: Clock frequency of 250 MHz, 50 million instructions, average CPI of 1.5
   Machine C: Same ISA as Machine A, clock frequency of 1 GHz, average CPI of 2.0
   Machine D: Same ISA as Machine B, clock frequency of 2 GHz, average CPI of 4.0

3. (15 points) Say we are given two different processors implementing the same ISA—a Pentium III running at 800 MHz, and a Pentium 4 running at 2.0 GHz. For a given program, the Pentium III has an average CPI of 1.0, while the Pentium 4 has an average CPI of 3.0. Which processor runs this program faster, and by how much?

4. (25 points) We use two different compilers to generate machine code for the same program, on the same processor. The first compiler generates a sequence of 200 instructions—50 add instructions, which take 1 cycle each, 40 branch instructions, which take 2 cycles each, 40 store instructions, which take 3 cycles each, and 70 load instructions, which take 4 cycles each. The second compiler generates a sequence of 100 instructions—20 adds, 30 branches, 10 stores, and 40 loads.

   a. (15 points) Calculate the average CPI for each code sequence, showing all work.
   b. (10 points) Which sequence runs faster? By how much?