CS 351 Exam 1, Fall 2013

Your name: ____

Rules

- You may use one handwritten 8.5 x 11” cheat sheet (front and back). This is the only resource you may consult during this exam.
- Include explanations and comments in your answers in order to maximize your partial credit. However, you will be penalized for giving extraneous incorrect information.
- You may use the backs of these pages if you need more space, but make it clear where to find your answer to each question.
- Unless otherwise specified, you do not need to work out the arithmetic on math problems. Just do enough algebra to set up an answer of the form: Answer = [arithmetic expression] [units]

Grade (instructor use only)

	Your Score	**Max Score**
Problem 1: Warmup		10
Problem 2: Comparing performance		15
Problem 3: Processor performance, power, and energy		25
Problem 4: MIPS functions		20
Problem 5: MIPS loops		15
Problem 6: MIPS arrays		15
Total		100

Problem 1: Warmup (10 points)

Answer the following questions. Be sure to explain your answers if you want to receive partial credit.

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a) [2 points] How many bits are in a byte?

b) [3 points] What's the term for 2^20 bytes?

c) [5 points] In the MIPS instruction set, how long (in bits or bytes) is the shortest instruction? What about the longest?

Problem 2: Comparing performance (15 points)

Consider the following two computers that are being used for Folding@Home:

	Time to fold 1 protein	**Time to fold 1000 proteins**
System A	2 ms	800 ms
System B	1 ms	1000 ms

[8 points]
If we are interested in the time to fold a single protein, what is the speedup of System A over System B? What does this tell us about which one is faster?

[7 points]
Contrast System A and System B in terms of latency and throughput.

Problem 3: Processor performance, power, and energy (25 points)

You have a processor with the following characteristics:

- Processor frequency: 2 GHz
- Processor operating voltage: 1.5 V
- Processor power consumption: 140 W
- CPI = 1 for integer instructions
- CPI = 2 for floating-point instructions

You have a workload with the following characteristics:

- 1 billion dynamic instructions
- 75% of instructions are integer instructions; the rest are floating point

INCLUDE UNITS IN ALL ANSWERS TO THIS PROBLEM.

[6 points]
How long will your processor take to execute this workload?

[6 points]
How much energy will your processor use to execute this workload?

[6 points]
Your processor has a low-power mode, in which the voltage is set to 1 V and the frequency is set to 1 GHz. How long will your program take to run in this low-power mode?

[7 points]
Assume that, magically enough, your processor has 0 static power consumption. That is, the 140 W consumed in the high-power mode consists entirely of dynamic power.

How much energy will your program consume in the low-power mode?

Problem 4: MIPS functions (20 points)

Translate the following C code to MIPS. Obey all MIPS conventions about functions, registers, and stack usage.

[10 points]

```
int f(int a, int b) {
     return a + b - 1;
}
```

[10 points]

```
int g(int x) {
     if (f(x, 12) < 20) return x;
     else return 2;
}
```

Problem 5: MIPS loops (15 points)

Translate the following C code to MIPS. Obey all MIPS conventions about functions, registers, and stack usage.

Assume the following:

- The variable *a* is in $s0 (which is OK – we'll assume that subsequent code restores the $s0 register).
- The variable *a* is an int.
- The standard C++ libraries have been included.

```
while (a > 0)
     a -= rand();
```

Problem 6: MIPS arrays (15 points)

Translate the following C code to MIPS. Obey all MIPS conventions about register and stack usage.

Assume that the character array B is at the top of the stack when your code begins, but you will need to make room for the array A.

```
char A[10];
for (int i=0; i < 10; i++)
     A[i] = B[0];
```
