CMPS 3240 **Name (Print):** _____
Fall 2017
Midterm I
9/26/2017
Time Limit: 150 minutes Instructor A. Cruz

This exam contains 6 pages (including this cover page) and 7 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

You may *not* use your books, notes, or any computer/cell phone/tablet/etc. on this exam.

You are required to show your work on each problem on this exam (except multiple choice). The following rules apply:

- **You are allowed to have one cheat sheet**. You may write on both sides. The paper must be 8.5x11 inches. You must turn in your cheat sheet at the end of the test. It must have your name on it.
- **An ID is required**. You will not be able to turn in the test unless you show a photo ID.
- **Mysterious or unsupported answers will not receive full credit**. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- If you need more space, use the back of the pages; clearly indicate when you have done this.

Do not write in the table to the right.

Problem	Points	Score
1	3	
2	9	
3	5	
4	6	
5	10	
6	10	
7	3	
Total:	46	

Please circle your major (if applicable). This is for ABET accreditation purposes only and will not affect your grade in any way.

1. Computer Engineering
2. Computer Science
3. Computer Information Systems
4. Information Security
5. Electrical Engineering

1. (3 points) In your own words, explain the leaky faucet problem.

2. A given program has three instruction types. Microprocessor A operates at 1.28GHz and microprocessor B operates at 960MHz. *Hint: This is in cycles/sec.*

Type	# Instructions for the Program	CPI for Microprocessor A	CPI for Microprocessor B
A	400	2	4
B	200	4	4
C	800	8	2

   (a) (4 points) Give the total number of seconds it would take for both microprocessors to run the program.

   (b) (2 points) How much faster/slower is microprocessor A vs. microprocessor B?

   (c) (2 points) Assume that parallelization alters the CPI by a factor of $(1/0.5p)$ for instruction type B and C, where p is the number of cores. Give an equation describing the run time of the program in terms of p.

   (d) (1 point) Consider a multi-core Microprocessor A with 8 cores. How much quicker is the execution time for the program?

3. The following question pertains to dynamic energy of a microprocessor.
   (a) (3 points) The Intel Core i3-7350K has a dynamic power of 60W, a frequency of 4.2GHz and has a core voltage of 1.52V. What is the capacitive load?

   (b) (2 points) Consider the case where we overclock the microprocessor, increasing the frequency to 4.5GHz and increasing the core voltage to 1.55V. Assume the capacitive load does not change. By how much percent has the dynamic power increased?

4. The following questions pertain to MIPS instructions.
   (a) (3 points) Give a MIPS code snippet to load the value 0xF000F000 into register `$a0`.

   (b) (3 points) With a MIPS-32 J-type operation, the program counter is modified as follows:

$$\text{PC} \leftarrow (\text{PC}_{31-26})\,(\text{Immidiate}_{25-0})\,00$$

   Explain why there are two zeros.

5. (10 points) Give MIPS assembly code for a function that computes the n-th Fibonacci number using recursion. It should take the value n as input in register `$a0` and place the result in `$v0`.

   For reference, here is a C implementation of the code:

```
int fib( n ) {
   if ( n == 0 )
      return 0;
   else if ( n == 1 )
      return 1;
   else
      return fib( n - 2 ) + fib( n - 1 );
}
```

   You do not need to add any input validation beyond the two base cases.

6. (10 points) The following MIPS code to compute change is broken. It takes an integer m as input, and outputs two values. m is an amount of currency in cents (For example if given \$1.12, m contains the integer 112). The two outputs should be the number of dollar bills and the number of quarters in that order. The values are rounded down if there is not enough cents to make a full quarter. Fix the code.

```
change:


div $a0, 100


mfhi $v0


div $a0, 25


mfhi $v0
```

7. (3 points) Consider a fictitious arithmetic operation "foo". Foo has two inputs, an output, a carry in and a carry out (similar to an addition). A certain microprocessor has a very large multimedia register of 100 bits, and the word-length is normally 20 bits. Describe how sub-word parallelization can reduce the number of instructions for multiple foo operations.

Space left blank for work.