CMPE 110 Homework #1

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1. Question #1 - Power

   (a) Question #1A : '...However, we discussed that nowadays power density and heat has become an issue preventing scaling of frequency. Discuss why power and temperature are becoming an issue'. **Answer :**

   (b) Question #1B : Given the rough formulations governing power and frequency for each voltage region, discuss which region (consider Near and Super-threshold only) is more energy efficient. **Answer :**
   To start, we will make the following assumptions.

$$\text{Near-threshold voltage } = V_{nth} = k, \text{ Super-threshold voltage } = V_{sth} = 2k : k \in \mathbb{R}^+$$

$$\text{Power} \propto V^3, \text{ Delay } \propto \frac{1}{V}, \text{ Energy } \propto \text{ Power } \times \text{ Delay}$$

$$\text{Energy Efficiency } \propto \text{ Energy } \times \text{ Delay } = \text{ Power } \times \text{ Delay}^2$$

   The energy efficiency can then be calculated for both the near and super threshold voltage levels, as shown below.

Near-Threshold	Super-Threshold
$P_{nth} = V_{nth}^3 = k^3$	$P_sth = V_{sth}^3 = (2k)^3 = 8k$
$D_{nth} = \frac{1}{V_{nth}} = \frac{1}{k}$	$D_{sth} = \frac{1}{2k}$
$E_{nth} = P_{nth} * D_{nth} = \frac{k^3}{k} = k^2$	$E_{sth} = P_{sth} * D_{sth} = \frac{8k^3}{2k} = 4k^2$
$EE_{nth} = E_{nth} * D_{nth} = \frac{k^2}{k} = k$	$EE_{sth} = E_{sth} * D_{sth} = \frac{4k^2}{2k} = 2k$

   Thus voltage levels that are near the threshold are more energy efficient.

2. Question #2 Computing ISA's

Table 1: Question #2 Answers

Architecture	Bytes in Program	Bytes Fetched	Bytes Loaded	Bytes Stored
x86	13	89	40	40
MIPS				
Stack ISA				

Exaplanation - There are 13 bytes in the program, we know this by summing the 6 instructions by there byte count. 89 bytes fetches is determined by tracing the routine through 10 iterations plus the intitializing instructions. Bytes loaded and Bytes stored all come from the `inc(ra, rb, imm)` instruction, which loads and stores 4 bytes for each of the 10 calls.

   (a) Question #2A x86 CISC ISA
   Fill out the first row of the above table (from the handout), but assume 32-bit data values.
   Answer : (See Table #1, row #1)

(b) Write the assembly code that would generate if the C code were compiled on a machine that uses the MIPS ISA. Fill out the second row of the above table. **Answer :**

`r1` is the counter variable. `r2` contains the size variable (10). `r3` contains the address of the first item in the array.

```
                subu r1, r1, r1     # intialize counter to zero
                j COMPARE           # jump to comparison
        loop :  lw r4, r3           # load current array value
                addiu r4, r4, #1    # increment current array value
```

3. Provide the output for each of the following code statements.

4. For each of the following items, identify whether the caller fucntion or the callee function performs the actions.

5. TODO

6. Write a C program that computes the pig-latin translation of an english word.