Name:
TAMU 312 Worksheet 16

1. Practice with ***lb***
Hint: a = 97, A = 65, ~ = 126
a.) Write out the C or Java code for the following function:
char toUpper(char c);
The function converts a character to upper case.
You may not use the function toupper() in C - or the equivalent in Java.

b) Write out MIPS code for char toUpper(char c).

c) Write out the C code for the following function:
C header: char * toUpperWord(char * s);
Java header: String toUpperWord(String s);
The function converts a string to upper case using the function toUpper.

d) Write out the MIPS code for toUpperWord.

2. Convert the following pseudoinstruction to MIPS code without any pseudoinstructions:
bge $s0, $s1, label

3. Programs P1 and P2 are run on computers A, B, and C and have the following execution times: (approximations fine)

P1: 1, 10, 20
P2: 1000, 100, 20

a) [5] Find the arithmetic mean when the two programs are weighted equally. (You should get three values one for A, B, and C.) (Don't normalize).

b) [5] same as a, but now P1 is weighted 90%, and P2 10%

c) [5] Find the arithmetic mean when the values are normalized to A. (using the weights specified in a).

d) [5] Find the geometric mean when the values are normalized to A.

4. Supposed a cache is 10 times faster than main memory, and suppose that the cache can be used 90% of the time. How much speedup do we gain by using the cache?

5. After graduating, you are asked to become the lead computer designer at Hyper Computers, Inc. Your study of usage of high-level language constructs suggest that procedure calls are one of the most expensive operations. You have invented a scheme that reduces the loads and stores normally associated with procedure calls and returns. The first thing you do is run some experiments with and without this optimization. Your experiments use the same state-of the art optimizing compiler that will be used with either version of the computer. These experiments reveal the following information:

* The clock rate of the unoptimized version is 5% higher.
* Thirty percent of the instructions in the unoptimized version are loads and stores.
* The optimized version executes two-thirds as many loads and stores as the unoptimized version. For all other instructions the dynamic execution counts are unchanged.
* All instructions (including loads and stores) take one clock cycle.

a) What percentage of time does the optimized version take in comparison to the original version? (i.e., assuming the original version takes 100% of the time, how much time does the optimized version take?)
b) Which is faster? Justify your decision quantitatively.

6. What is the parity of the following datum: 00101010?

7. The figure below shows the forwarding control for a MIPS pipeline. You can see that there is one forwarding unit and one hazard detection unit.

Complete the ForwardA signal function in the forwarding unit.

```
if(EX/MEM.RegWrite && (EX/MEM.RegisterRd != 0) &&
        (EX/MEM.RegisterRd = ID/EX.RegisterRs) )
```

ForwardA = 10;

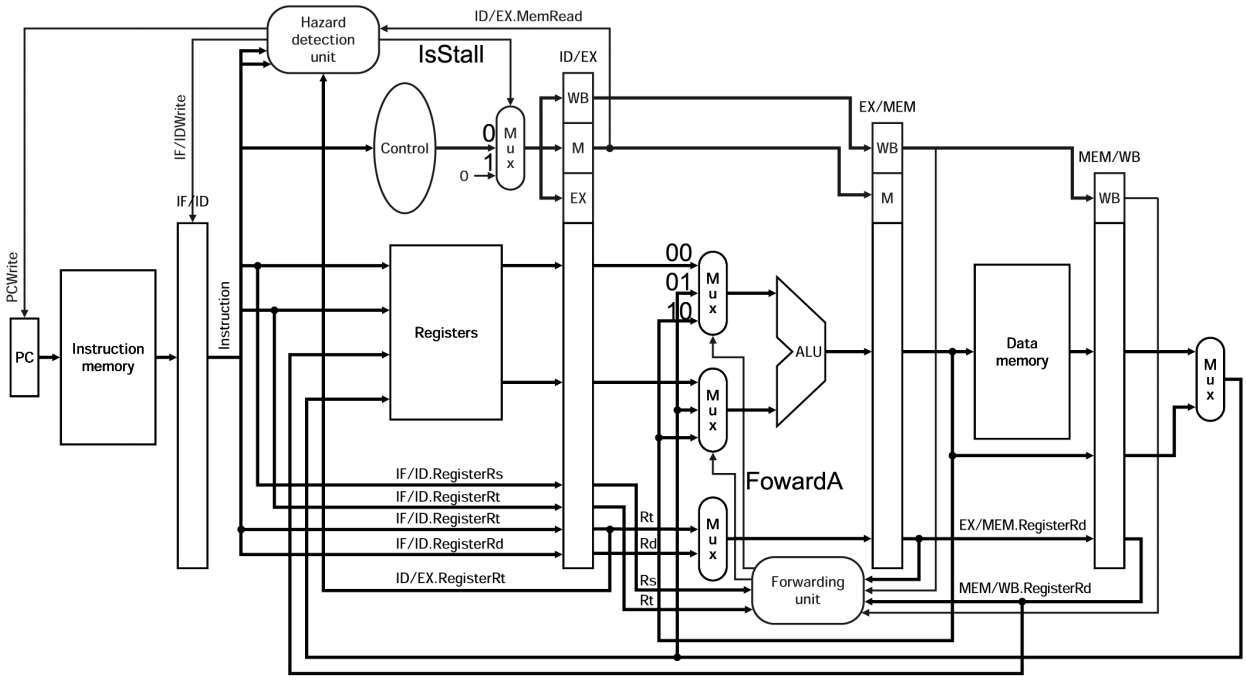
else if (_____)
ForwardA = 01;
else
ForwardA = 00;

Complete the IsStall signal function in the hazard detection unit.

if(_____)

IsStall = _____
else

IsStall = _____



8. Let's try to show how you can make unfair benchmarks. Here are two machines with the same processor and main memory but different cache organizations. Assume the miss time is 10 times a cache hit time for both machines. Assume writing a 32-bit word takes 5 times as long as a cache hit (for the write-through cache) and that writing a whole 32-byte block takes 10 times as long as a cache-read hit (for the write-back cache). The caches are unified; that is they

contain both instructions and data. Cache A: 128 sets, two elements per set, each block is 32 bytes, and it uses a write through and no-write allocate Cache B: 256 sets, one element per set, each block is 32 bytes, and it uses write back and does allocate on write misses.

a) Describe a program that makes machine A run as much faster as possible than machine B. (Be sure to state any further assumptions you need. if any.)

b) Describe a program that makes machine B run as much faster as possible than machine A. (Be sure to state any further assumptions you need, if any.)

c) Approximately how much faster is the program in part a on machine A than machine B?

d) Approximately how much faster is the program in part b on machine B than machine A?

9. Here is a series of address references given as word addresses:
5 3 2 9 16 3 4 24 34 54 93 1 29 3 2 84 2 1 9
For each cache type below:

- Assume that the cache is initially empty.
- Assume the cache contains 16 words.
- A block consists of one word.
- Draw the cache.
- Label each reference in the list as a hit or miss.
- Show the final contents of the cache.

a) Direct Mapped Cache

b) Fully Associative

c) 4-way associative

10. For MIPS, the byte address of the memory is 32 bits. Assume the cache has 2^8 blocks and each block has 8 words. (A word is 4 bytes.)

a) When direct mapping memory organization is used, determine the width of each field, (i.e., the width of tag, block and word field).

b) For fully associative?...

c) For 2-way associative?...

11. What is the 12 bit Hamming ECC (error correcting code) code for the number 10101111

12. Is there an error in the following Hamming EEC code? If so what should the number be?
a) 0010 1011 0111

b) 1111 1000 1110