UC Berkeley : CS61C (Garcia & Lustig) : Midterm Part 2 : 2014-10-17

_____ _____ cs61c-_____

Name (first last) *SID* *Login*

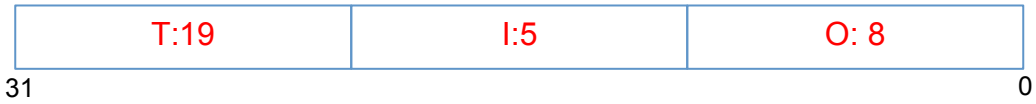
_____ _____

← *Name of person on left (or aisle)* *Name of person on right (or aisle)* →

Question 1: *Hit or Miss, it's AMAT-er of Performance* (24 min, 19 pts)

You are given a single 8 KiB direct-mapped cache with 256 B blocks and a write-back policy. Assume a 32-bit address space and byte-addressed memory. *Show your work.*

a) **Label** the fields below as Tag, Index, and Offset, and *give the # of bits for each*. (e.g. Tag:5) (3 pt)



b) Assume that `A[0]` is at the beginning of a cache block and that the cache is empty to begin with. Answer the questions below based on the following code.

```
char A[32768];    // 32768 is 2^15

for (int i = 0; i < 32768; i+=64) A[i]     = '\0';   // 1st LOOP
for (int i = 0; i < 32768; i+=64) A[i & 1] = '\0';   // 2nd LOOP
```

i. What is the exact hit rate for the *1st LOOP*? Leave your answer as a fraction. (3 pt)

3/4

ii. Which **of the following** types of misses occur in part (i)? (circle **only one**) (2 pt)

Compulsory Conflict Neither →Both←

iii. What is the exact hit rate on the *2nd LOOP*? Leave your answer as a fraction. (3 pt)

(2^9 – 1)/(2^9) = 511/512

c) Suppose we run some code and our L1 cache hits in 2 cycles and has a local hit rate of 80%. Main memory always hits in 50 cycles. What is the AMAT of this system? (3 pt)

2 + 0.2 * 50 = 12 cycles

d) Match each term with **all** letters on the right that apply (you may have multiple per blank). (5 pt)

Interpreter _____F
Compiler _____A
Assembler _____C, E
Linker _____D
Loader _____B

A) Converts C code into Assembly
B) Copies program binary to memory to prepare for execution
C) Converts from MAL to TAL
D) Computes the jump address for a jal instruction
E) Computes the offset for a beq instruction
F) Directly executes a program written in source code

Question 2: *What's that funky smell?! Oh yeah, it's potpourri…* (26 min, 20 pts)

a) We examine a word in memory and find that it holds the value `0x20707C00`.

i. If it were a TAL MIPS instruction, what would it be? (Leave immediates and jump addresses in hexadecimal form.) *Show your work.* (2 pt)

addi $s0, $v1, 0x7C00

ii. If the word held two half-precision floating point numbers (1 sign bit, 5 exponent bits, 10 significand bits, bias = 15), what would they be? Leave your answer as an expression involving powers of twos. *Show your work.* (4 pt)

`0x2070`	`0x7C00`
$(1 + 2^{-4} + 2^{-5} + 2^{-6}) * 2^{-7}$	positive infinity

b) Consider the following valid MAL MIPS code. (Note that line `6` is commented out.)

```
1 mystery: ### Below, assume $t0 is either 0x0 or between 0x61 and 0x7a inclusive
2 loop:    lbu   $t0, 0($a0)
3          beq   $t0, $0, done
4          addiu $t0, $t0, -32
5          sb    $t0, 0($a0)
6          ### jal anotherFunction
7          addiu $a0, $a0, 1
8          j loop
9 done:    jr $ra
```

i. In English, describe what effect this code has. Do NOT tell us line by line what it does! (3 pt)

Converts a lowercase string to uppercase in memory

ii. Suppose we uncomment line `6`. What changes are needed for `mystery` to follow calling conventions? Assume you're telling another 61C student over the phone. For each addition or deletion or modification, describe it and its location in the code. (4 pt)

Before 6: addi $sp $sp -8, store $a0, $ra on the stack. After 6: restore $a0, $ra and put $sp back

iii. Write a single **logical** TAL instruction that performs the same effect as line `4` (remember, `$t0` will be between `0x61` and `0x7a`). (3 pt)

`andi $t0, $t0, 0xDF`

c) Fill in the blanks to indicate when overflow occurs in 2's complement numbers: In the blanks place one of: "greater than 0", "less than 0", "greater than or equal to 0" or "less than or equal to 0" (2 pt)

Positive Number + Positive Number, overflows if result is _____.<0

Negative Number + Negative Number, overflows if result is _____.≥0

d) What is the decimal value of the `int16_t` number `0x8000`? How does it relate to the advantages of two's complement over one's complement? (2 pt)

The decimal value is -2^{15}. Two's complement has only one zero, which means that one additional negative integer can be represented.