PRACTICE MIDTERM EXAM FOR COMPSCI/ECE 250

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These questions are pasted in from various sources; ignore the question numbers and point values. Answers to SOME questions are provided in blue.

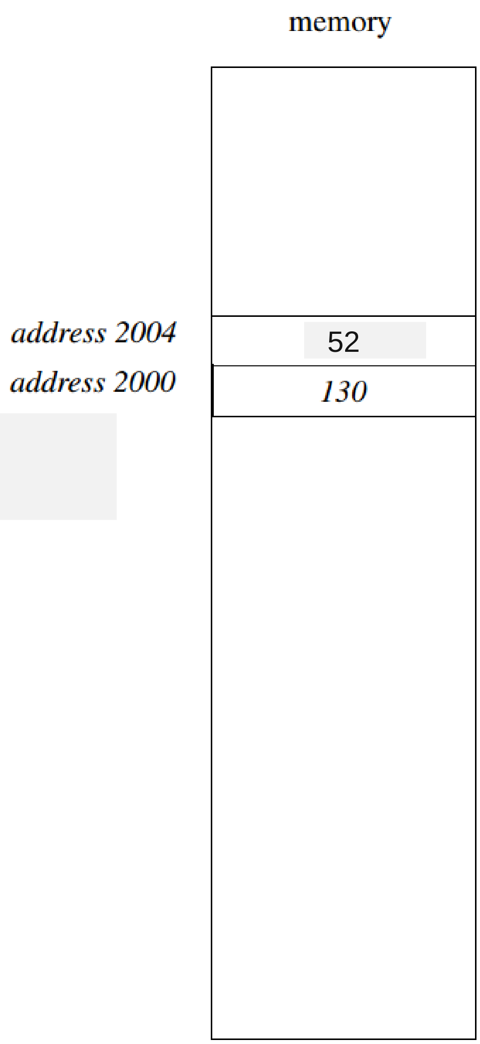
Practice question 1

1) [10 points]

(a) Add the following base-10 numbers using **6-bit** 2s complement math: -3, -4. **Show your work!**

Practice question 2

2) Assume that $2 = 2000 and $3=12. Assume that memory holds the values at the addresses shown on the left. “lw” = load word, and “sw” = store word.



(a) If the computer executes sw $3, 4($2), then what is the value of $3 after this instruction?

(b) If, after the instruction in part (a), the computer executes lw $3, 0($2), what is the value of $3 after this instruction?

(c) What single instruction could you use to write the value in $5 into address 2008?

(d) What single instruction could you use to read the word of memory at address 1996 and put the result in $8?

Practice question 3

3) [10] The IEEE 754 floating point standard specifies that 32-bit floating point numbers have one sign bit, an 8-bit exponent (with a bias of 127), and a 23-bit significand (with an implicit "1"). Represent the number -11.75 in this format.

Practice question 4

4) [10] The following questions are based on the following code snippet.

(a) What is *(array+7) ? Please give its datatype and its value.

(b) On a MIPS machine, how big (how many bytes) is the variable array?

(c) On a MIPS machine, how big (how many bytes) is array[2]?

(c) What is the datatype of fun?

```
int* array = (int*) malloc(42*sizeof(int));
int** fun = &array;
for (int i=0; i<42; i++){
    array[i] = i*i;
}
free (array);
```

Practice question 5

5) [25] Convert the following C code for the function foo() into MIPS code. **Use appropriate MIPS conventions for procedure calls**, including the passing of arguments and return values, as well as the saving/restoring of registers. Assume that there are 2 argument registers ($a0-$a1), 2 return value registers ($v0-$v1), 3 general-purpose callee-saved registers ($s0-$s2), and 3 general-purpose caller-saved registers ($t0-$t2). Assume $ra is callee-saved. The C code is obviously somewhat silly and unoptimized, but YOU MAY NOT OPTIMIZE IT -- you must simply translate it as is.

```
int foo (int num){
 int temp = 0; //temp MUST be held in $t0
 if (num <0) {
     temp = num + 2;
 }else{
     temp = num - 2;
 }
 int sumA = bar(temp); // sumA MUST be held in $s0
 int sumB = sumA + temp + num;// sumB MUST be held in $s1
return (sumB + 2);
}

int bar (int arg){
```

line(s) of C	instruction(s)	what code MUST do (if not obvious from C code)
1		create stack frame large enough for callee-saved and caller-saved registers; save callee-saved registers (ONLY necessary ones)
2		
3-7		
8		save caller-saved registers (ONLY necessary ones); call bar() with appropriate arguments
after line 8		restore caller-saved registers; get value returned from bar() and put it in appropriate place
9		
10		pass return value back to whoever called foo(); restore callee-saved registers; destroy stack frame; return to caller

Practice question 6

1) [10 points] Write the truth table for the output of the following boolean expression that has three inputs (a, b, c): output = $abc + \bar{a}c + b\bar{c}$

Practice question 7

2) [10 points] Convert the following truth table into a boolean expression in product-of-sums format. Note that there are three inputs (a,b,c) and one output. Do NOT simplify or optimize in any way.

a	b	c	output
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

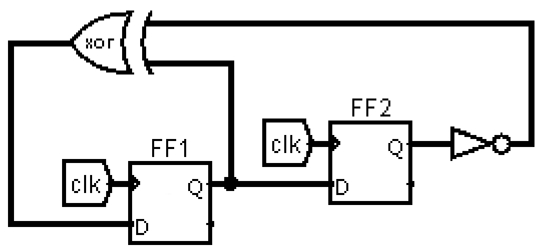
Practice question 8

Simplify this expression; axioms are provided ->
(!A & B & C) | (A & B & !C) | (A & B & C)

Name	Definition
Identity law	1 & A = A 0 | A = A
Null law	0 & A = 0 1 | A = 1
Idempotent law	A & A = A A | A = A
Inverse law	A & !A = 0 A | !A = 1
Commutative law	A & B = B & A A | B = B | A
Associative law	(A&B) & C = A & (B&C) (A|B) | C = A | (B|C)
Distributive law	A | (B&C) = (A|B) & (A|C) A & (B|C) = (A&B) | (A&C)
Absorption law	A & (A|B) = A A | (A&B) = A
De Morgan's law	!(A&B) = !A | !B !(A|B) = !A & !B
Double negation law	!!A = A

<u>Practice question 9:</u> Sketch a circuit representation of the expression (A | B) ^ (A & !C)

<u>Practice question 10</u>: Consider the circuit below. Assuming the two flip flop start with a value of zero, what will the state of the flip flips be for the clock cycles shown? The initial state is done for you.

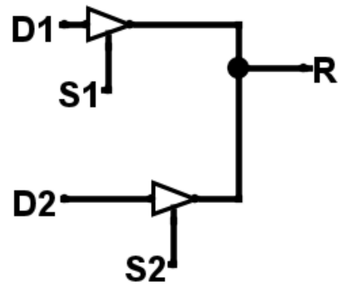


Clock cycle	FF1	FF2
0	0	0
1		
2		
3		

Same exercise, but with a different starting condition:

Clock cycle	FF1	FF2
0	1	1
1		
2		

Practice question 11: The circuit below shows two tri-state buffers.



(a) How could you make D1's value appear on output R?

(b) How could you make D2's value appear on output R?

(c) How could you make the output R be in the high-impedance ("Z") state?

(d) How could you cause a short circuit?

Practice question 12: Draw a finite state machine that will output a 1 if and only if a sequence of characters of the following form is received: exactly one 'D', *zero* or more 'O's, and exactly one 'G'. (If you happen to know regular expression notation, this is the expression /DO*G/.) Examples of matching inputs include: "DG", "DOG", "DOOOOG". Your machine can be of the Mealy or Moore variety. It doesn't matter what your machine does after it outputs 1.