CS220 Exam 1 Spring 2012 Name:___________________

The only outside materials you may use on this exam are the MIPS green card (see last page) and a calculator. You <u>must</u> show work or explain your answer to receive partial credit. Some correct answers are <u>better than</u> other correct answers and will receive partial or full credit.

1. [4 points] Write the decimal number -35 as an 8-bit two's complement binary number.

   -35 is -64 + 16 + 8 + 4 + 1 = 11011101

2. [4 points] What is the largest value that you can represent in 16-bit two's complement. <u>Express your answer in hexadecimal</u>.

   7FFFFFFF

3. [4 points] What is the smallest value that you can represent in 16-bit two's complement. <u>Express your answer in hexadecimal</u>.

   80000000

4. [8 points] Convert the MIPS instruction **`srl $t1,$t1,-1`** to machine code. <u>Express your answer in hexadecimal.</u>

   Bogus question. Sorry. Can't have a right shift of -1. Everyone got full credit for this.

5. [8 points] Rewrite the MIPS pseudo-instruction **`li $t0,305419896`** (where **`305419896`** is in base-10) so that it uses two <u>real</u> MIPS instructions. (In other words what two instructions would the assembler generate for the pseudo-instruction above).

   I was looking for you to realize that 305419896 cannot be represented in 16 bits. In hexadecimal this number is 12345678.

   ```
   lui $t0, 0x1234
   ori $t0, $t0, 0x5678
   ```

6. [2 points] How many bits are required to represent a register number in a MIPS instruction?

   5 because $2^5 = 32$

7. [8 points] Suppose processor $\mathbf{P_1}$ has a cycle time of .5 nanoseconds and processor $\mathbf{P_2}$ has a cycle time of 0.75 nanoseconds. Furthermore $\mathbf{P_1}$ has a CPI of 2 for a program and $\mathbf{P_2}$ has a CPI of 1.5 for the same program. Which machine is faster for the program and by how much?

CPUTime1 = CPI(IC)(CT) = 2(IC)(0.5) = IC nanoseconds

CPUTime2 = 1.5(IC)(0.75) = 1.125(IC) nanoseconds

Speedup = (Time slower)/(Time faster) = (1.125(IC))/IC = 1.125

So CPU 1 is 1.125 times faster than CPU 2.

8. [4 points] If a computer has a 10 megabit per second network connection how long would it take to send a 20MB file? (Assume 20MB is 2 X 10^6 bytes).

There was a typo on this so I allowed two answers. The type was that 20MB is <u>20</u> X 10^6 bytes not 2 X 10^6 bytes.

10 megabits/sec is 10/8 megabytes/sec = 1.25 megabytes (MB/sec).

So 20MB/1.25(MB/sec) = 16 seconds.

9. [8 points] Assume that the execution time of a program **p** on a processor is 100 seconds. Also assume that **p** spends 30% of the execution time accessing memory. What would the execution time be if we tripled the performance of memory?

p spends 30 seconds accessing memory (30% of 100). So p must spend 70 seconds in the CPU. Making memory 3 times faster means p would spend 10 seconds in memory but still 70 seconds in the CPU for a total of 80 seconds.

10. [4 points] If the clock cycle time for a processor is 5 x 10^{-10} seconds what is the clock rate? <u>Express your answer in GHz</u>.

Rate = 1/Cycle time = 1/(5 x 10^{-10}) = 2,000,000,000 = 2GHz

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11. [8] Simplify the logic expression below as much as possible using the logic laws. Show all work.

$$(\overline{\bar{A}\bar{B}})(\overline{\bar{A}B})$$

There are many ways to do this. Here's one. The original equation is $(\overline{\bar{A}\bar{B}})(\overline{\bar{A}B})$ Apply DeMorgan's to each term and we get $(A+B)(A+\bar{B})$. Distribute and we get $AA+A\bar{B}+AB+B\bar{B}$. Recall that $AA=A$ and $A\bar{B}+AB=A(B+\bar{B})=A$ and $B\bar{B}=0$ so this whole thing just equals A.

12. [30 points] Write a MIPS function **`count_fives`** that takes an address of a list of 100 integers as a parameter and returns the number of times a 5 appears in the list. Write a complete main program that calls **`count_fives`** and then prints the count to the console with a nice prompt. For the main program assume there is a label **`list`** in the data segment that refers to 100 integers.

```
        .data
list: .word 7, 2, 5, 3, 9, 4, 5, ...
```

The answer to this one is at

http://myslu.stlawu.edu/~ehar/Spring12/220/exam1q11.s

13. Consider a circuit with three inputs **A**, **B**, and **C** and one output **Out** where the **Out** is one when none or one of the three inputs are ones.

i. [4] Draw the truth table for this circuit.

A	B	C	Out
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

ii. [4] Write the sum-of-products equation for this circuit.

$$Out = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C}$$