CS 220 Exam 1 Spring 2021 Name:_____

Create a directory directly under your personal course repo named **`exam1`** (spelled exactly like that) Write all answers directly inside of this LibreOffice document and turn in both the **`.odt`** file and an exported **`.pdf`** file (File → Export As → Export As PDF). Due Monday February 22 by 1:30PM.

For the coding problems cut and paste the code into this document, nicely formatted. You will also create **`.c`** and **`.s`** files that you will also commit and push to your personal 220 course repo. Always use a `fixed-width font` for typesetting code. These are the fonts that usually include "Mono" in their name.

Like any exam, some correct answers are better than other correct answers. Full credit for the best answer. You can ask clarifying questions but I will not otherwise be able to offer assistance on the exam. You may not communicate with one another about the exam, nor anyone else outside class. You may of course use class resources, the course books, videos, and notes. You may not search for solutions on the internet. Type your initals here _____ to acknowledge that you have read this.

1. [1] The command line is also called the _____.

2. *The Linux Command Line* book describes the command **`df`**.

   a) [2] What does the **`df`** command do? Explain in your own words (do not cut-and-paste from the man page or the book, or anywhere else for that matter).

   b) [2] Explain the difference between the **`-h -H -k`** options.

   c) [2] What does the option **`–block-size=1M`** do?

3. What command would I use to provide a long listing of only the C files in the current directory, in …

   a) [2] Alphabetical order

   b) [2] Reverse alphabetical order

   c) [2] Ordered by date of last modification from most recent to least recent.

   d) [2] Ordered by date of last modificaiton so that the most recently modified C files are listsed last.

   e) [2] Ordered by size from smallest to largest.

4. [5] What gets printed by the C program below? What problem is being solved? Be precise. Rewrite the program so that it does not use division operation **`/=`** and **`%`**.

```
#include <stdio.h>
int main() {
    int n = 14;
    int c = 0;

    while (n > 0) {
        c += n % 2;
        n /= 2;
    }

    printf("%d\n", c);
    return 0;
}
```

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5. [10] Create a directory named **q5** directly under your **exam1** directory and put all of the files releated to this question in it. Write a C program that takes two command line arguments, the first argument is the speed of an internet connection in Mbps and the second argument is the size of a file in GiB. The program should compute the time it takes to download the file on that internet connection rounded to one decimal place. For example, if I wanted to know how long it would take to download a 4 GiB file on a 15 Mbps internet connection (if the executable is named **q5**) then I would run ...

```
./q5 15 4
Time (min): 38.2
```

   Create a **makefile** (see chapter 3) that compiles your program and creates an executable named **q5**. Make sure your program does not crash (Segmentation Fault) if given too few arguments and provides a nice error message.

6. Create a directory named **q6** directly under your **exam1** directory and put all files related to this question in it. Consider a function **ones** that takes a non-negative base-ten integer argument and returns the number of ones in the binary representation of the argument, **ones(15)** would be 4 because 15 is a binary 1111. The **ones(37)** is 3 because 37 is a binary 100101.

   a) [5] Write **ones** as a C function and put it in a file named **ones.c**. (Also cut and paste the function below).

   b) [5] Write **ones** as an assembly language function and put it in a file named **ones.s**. (Also cut-and paste the function below)

   c) [5] Write a **main** function that takes an integer as a command line argument a prints the number of ones in the arguments. Cut and paste the code below. Here are sample executions ...

```
ones 15
4

ones 37
3
```

   d) [5] In the **q6** directory include a **makefile** that contains <u>three targets</u>. The target named **c** builds the C version of your code in an executable named **ones**. The target named **assem** builds the assembly language version in an executable named **ones**. The target named **clean** deletes the executable file. (Cut and paste the code below)

7. [5] Explain the output of the following program and exactly why the output is what it is.

```
#include <stdio.h>
int main() {
    unsigned char x = 243, y = 66, z = x + y;
    printf("%d\n", z);
    return 0;
}
```

8. [2] Write a C expression that prints the **nth** bit of an integer x. For example, if n was 3 and x was 53 (or 0b110101) we should print 0 because the third bit is 0. Assume the least significant bit is bit 0 and the most significant bit is bit 31.

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9. [4] The 32-bit unsigned binary number 11111111101111111111111111111101 = $2^w - 2^x - 2^y - 2^z$

   What are ***w***, ***x***, ***y***, and ***z***? Make sure to explain answer.

10. [2] Express -77 as a 16-bit two's complement binary number. (Show work) What is it in hex?

11. [2] The cycle time of a processor with a 3.33 GHz clock rate is _____ ns (nanoseconds) Show work.

12. [2] A processor that has a 4ns cycle time has a frequency of _____ MHz. Show work.

13. [2] There are about 2400 SLU students. How many bits would we need to give each student a unique binary student ID?

14. [2] What does the program below print? Explain your answer.

```
if (~0 != -1)
    printf("Foo");
else
    printf("Bar");
```

15. [5] On the Linux command line, using the **`zips.csv`** file, write a command that extracts the latitude and longitude given a zip code. Hint: Day 3 January 8 class and the **`grep`** and **`cut`** commands.

16. [25] Write the **`longest_distinct`** function from **`hw2`** as an assembly langage function. Put it in the file **`longest_distinct.s`**. (Also, copy and paste the code below.)