## MA/CS 109 First Computer Science Lab

Name: ______________________________________________

1. Use moodle to navigate to the "First Computer Science Lab" page.
2. Open `binary-representation.xls`. Note that at the bottom there are two tabs — i.e., two worksheets. **Read and Carefully Follow** instructions in the worksheet called "Representing Small Numbers."

   Write down the binary representation of 1238: ______________________

   Write down the binary representation of 967: ______________________
3. When you are done, click on the tab at the bottom worksheet called "Powers of 2." **Read and Carefully Follow** instructions there.

   What is $2^{20}$? ________________ How many bytes are in a gigabyte? ________________
4. Note that 86 can be represented in binary as 1010110 and thus takes seven bits. Of course, you can always make it longer than seven bits by adding 0 bits at the front : for example, 00001010110 is also 86, represented as eleven bits. But you can't make it shorter than seven bits.

   What's the smallest number of bits it takes to represent the number $1,000$? _______
5. Observe that there are two bit strings of length one: 0 and 1. There are four bit strings of length two: 00, 01, 10, and 11.

   How many different bit strings of length three are there? ____ Length four? ____ Length ten? ____
6. In general, how many different bit strings of length $k$ are there? _______
7. Suppose everyone in a group of $1,000$ people needs a unique number assigned. That means you'll use numbers from 0 to 999. So the first person will get the number 0, the second the number 1, and so on. You will give those numbers to people in binary, and you will use the same number of bits for each person, adding zero bits to the front as needed.

   How many bits do you need per person? ____
8. Same, but for $1,000,000$ people? ____ For $1,000,000,000$ people? ____

   For the world population (about seven billion people)?____
9. How many bits would it take to represent Bill Gates' net worth (about $56 billion)?____

   The US national debt (about $14 trillion)? ____
10. In general, how many bits would it take to represent an integer $n$? ____

**Items below are less important at this point—do them if you have time, but make sure you understand the questions above first.**

Open `24-bit Color Mixer.html`. In this example, a color consists of 3 components. Each component has 256 possible values.

11. Play around with it. Try to get pink, grey, yellow, orange, your favorite color. Write down their RGB values:

    Shade of Color in English: ____________ Red: ____ Green: ____ Blue: ____
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12. How many different colors can you represent (hint: use multiplication principle)? _______________

13. How many bits does it take to represent a single color (i.e., a single pixel)? ____ (Hint: think of the maximal value for each component — how many bits does it take? Now, how many components?) How many bytes is that (a byte is 8 bits)? ____

The choice of 256 possible values for each component is somewhat arbitrary. Open `6-bit Color Mixer.html`. Here, you have only four possible values for each component.

14. Find some shades that you cannot get as well in this color mixer.

15. How many different colors can you represent (hint: use multiplication principle)? _______________

16. How many bits does it take to represent a single color (i.e., a single pixel)? ____

17. Compare two images: `Full Color Picture.bmp` and `Reduced Color Picture.bmp`. The second was obtained from the first by rounding the value of each color component of each pixel. (Note: a more careful conversion would mix pixels of different colors to give the appearance of a good color, much like mixing black pixels and white pixels gives the appearance of grey. However, the quality would still be not nearly as good as the original image.)