Instructions: This is the first homework for CS170 (Section 003). Unlike labs, you are expected to do homeworks on your own. Future homeworks will involve programming, but this first one is mostly written, and you should turn it in on paper. This homework refers to some examples from Section 1 (“Introduction to the Computer”) of our lecture notes.

Honor Code: Like all work for this class, the Emory Honor Code applies. You should do your own work on all problems, unless you are explicitly instructed otherwise. If you get stuck or have questions, ask your instructor or a TA for help.

Initial here to indicate that you followed the Honor Code and this work is your own. ______________

1. Bits and Bytes. (Recall, for CS 'kilo' means a number that is a power of 2 that is close to 1000.)
   a) (5pts) How many bytes are in 2 megabytes? 2,097,152 (also accept appropriate math expressions)
   b) (5 pts) How many bits are in 2 megabytes? 16,777,216 (also accept appro. math expression)

2. Binary Numbering.
   Pull up the webpage: http://acc6.its.brooklyn.cuny.edu/~gurwitz/core5/nav2tool.html This is a tool which converts decimal numbers to binary and vice versa. (You are free to use other online tools for this problem, but this is a good, simple tool.)
   a) (10 pts) Convert the following decimal numbers into binary:
      • 126  ____________________________1111110_______________________
      • 127  ____________________________1111111_______________________
      • 128  ____________________________10000000_____________________
      • 129  ____________________________10000001_____________________ 
      • 130  ____________________________10000010_____________________ 

(Question 2 continued on next page.)
b) (10 pts) Do the following steps:
   Convert the decimal numbers 213 and 248 into binary.
   Remove all digits except for the last 7 digits (i.e., keep only the right-most 7 digits)
   Convert the resulting binary number into a decimal number.

   • What are the resulting decimal numbers? ______85, 120 (1pt each)____________________

   • In what way do the resulting numbers relate to the original numbers?
     213-85 = 128
     248-120 = 128
     the difference is the same when subtracted from original number

   (3 pts)

   • Explain the significance of this relation in terms of binary numbers. (Think about your answer after reading the “Exploratory stuff” example in the “Computer memory and the binary number system” lecture note.)

     (5 pts) The 8th “place” (ie bit when counting from the right) in the sequence of bits represents the quantity 128. So, 7 bits can’t represent quantities over 127. We would have an overflow trying to represent quantities >= 128 using only 7 bits. Alternate explanation: Can only store quantities of 127 in memory using 7 bits. 8th bit increases the numbers we can store. Needed to demonstrate understanding of/implications to memory of number of bits for full credit.

3. (10 pts) ASCII Conversions
   Letters in the English Alphabet are stored inside the computer as numbers. That is, each letter is encoded as a number. The encoding method used to represent the alphabet is known as the ASCII code (American Standard Code for Information Interchange). The website http://www.ascii-code.com contains ASCII code tables which shows the encoding from a decimal number to an English language character.
   a) What text is encoded by the following sequence of (decimal) byte codes?

   \[
   40 \ 72 \ 69 \ 76 \ 76 \ 79 \ 32 \ 119 \ 111 \ 114 \ 108 \ 100 \ 33 \ 41
   \]

   (HELLO world!)
   (1 pt per incorrect character/symbol)
4. (20 pts) Compute the GCD of A=70 and B=128, using Euclid's algorithm as described in the lecture notes. Trace out each step, like in the example with 28 and 36 from the notes. For example:

Initially: A=70  B=128
Step 1: A=  B=
Step 2: A=  B=
… (use as many rows as needed)

Initially: A=70  B=128
Step 1: A=70  B=58
Step 2: A=12  B=58
Step 3: A=12  B=46
Step 4: A=12  B=34
Step 5: A=12  B=22
Step 6: A=12  B=10
Step 7: A=2   B=10
Step 8: A=2   B=8
Step 9: A=2   B=6
Step 10: A=2  B=4
Step 11: A=2  B=2
Step 12: A=0  B=2

(1.5 pts. per step after initialization)

5. (10pts) Using Google or another search engine of your choice, fill in the table below by finding the minimum and maximum integer values which can be represented by the following Java datatypes. Also for each datatype, how many bits would be required to encode such an integer?

<table>
<thead>
<tr>
<th>Datatype</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
<th>No. of Bits Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) byte</td>
<td>-128</td>
<td>127</td>
<td>8 bits</td>
</tr>
<tr>
<td>b) short</td>
<td>-32768</td>
<td>32767</td>
<td>16 bits</td>
</tr>
<tr>
<td>c) char</td>
<td>'u0000' or 0</td>
<td>\uffff or 65535</td>
<td>16 bits</td>
</tr>
<tr>
<td>d) int</td>
<td>-2147483648</td>
<td>2147483647</td>
<td>32 bits</td>
</tr>
<tr>
<td>e) long</td>
<td>-9223372036854775808</td>
<td>9223372036854775807</td>
<td>64 bits</td>
</tr>
</tbody>
</table>
6. (30 pts) Algorithm Tracing
   Consider the following algorithm:

   \[
   \begin{align*}
   R &= 47; \\
   Q &= 0; \\
   D &= 9; \\
   \text{as long as } R &\geq D \text{ do} \\
   &\{
   R &= R - D; \\
   Q &= Q + 1;
   \}
   \end{align*}
   \]

   a) (20 pts) Trace out each step, like in the Euclid example:

   \[
   \begin{array}{ll}
   \text{Initially:} & R = 47 \quad Q = 0 \\
   \text{After 1 Step:} & R = \quad Q = \\
   \text{After 2 Steps:} & R = \quad Q = \\
   \ldots \text{ (use as many rows as needed)} & \\
   \end{array}
   \]

   init \quad R=47 \quad Q=0

   step1: \quad R=38 \quad Q=1

   step2: \quad R=29 \quad Q=2

   step3: \quad R=20 \quad Q=3

   step4: \quad R=11 \quad Q=4

   step5: \quad R=2 \quad Q=5

   (4 pts per step after the initialization)

   b) (10 pts) What does this algorithm accomplish? In other words:
      • What value does the algorithm compute in the variable \( R \)?
      • What value does the algorithm compute in the variable \( Q \)?

   computes \( R / D \)

   \( R \) ends w/ remainder

   \( Q \) ends w/ quotient (number of times \( D \) divides \( R \))

   \( 47 / 9 = 5 \ R \ 2 \)