Homework #1

Due Date:  End of class on Monday, February 15, 2016

Name:  ..................................................
1. (12 points)

Consider the following 6 cards containing 6-bit numbers

<table>
<thead>
<tr>
<th>Card</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>011100</td>
</tr>
<tr>
<td>B</td>
<td>111000</td>
</tr>
<tr>
<td>C</td>
<td>110000</td>
</tr>
<tr>
<td>D</td>
<td>011000</td>
</tr>
<tr>
<td>E</td>
<td>110101</td>
</tr>
<tr>
<td>F</td>
<td>110010</td>
</tr>
</tbody>
</table>

(i) Treating the numbers as **unsigned**, give their ordering from largest to smallest. You can just refer to the cards as A..F. (6 points)

(ii) Treating the numbers as **signed** (assume the 2’s complement system), give their ordering from smallest to largest. Again, just refer to the numbers as A..F. (6 points)

2. (24 points)

Consider the six 8-bit operations in the table below (the operands are in hexadecimal). Fill in the table showing the effect of the operation on each of the 4 status bits NZVC. Possible table entries are

- The operation sets the bit to 1 – show this as Y
- The operation sets the bit to 0 – show this as N
- The operation can have no effect on this bit – show this as NA

<table>
<thead>
<tr>
<th>Operation</th>
<th>N</th>
<th>Z</th>
<th>V</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arithmetic shift right of (8F_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AA_{16}) EXOR (3F_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7F_{16} + AA_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A5_{16}) AND (5A_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(AA_{16}) OR (3F_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arithmetic shift left of (7F_{16})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. (12 points)

The DEC PDP-15 was an 18-bit machine that used the 2’s complement system for representing integers

(a) Consider the largest positive integer that could be stored

(i) Give its representation in octal

(ii) Give its representation in hexadecimal

(b) Consider the most negative number that could be stored

(iii) Give its representation in octal

(iv) Give its representation in hexadecimal

4. (12 points)

Express the result of each of the following operations as a 2-digit hexadecimal number.

(a) $67_{16}$ EXOR $69_{16}$

(b) $AB_{16}$ AND $CD_{16}$

(c) $3C_{16}$ OR $A9_{16}$
5. (20 points)

In Swamp County only 6 different vehicle colors are allowed:

White, Red, Green, Blue, Silver, Yellow

The Department of Transportation wants to transmit information about the color of vehicles passing a monitoring station.

(a) If they use a fixed-length code, how many bits are needed for each color? (3 points)

(b) Suppose that the colors occur with the frequencies shown in the following table.

<table>
<thead>
<tr>
<th>Color</th>
<th>% of vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>24</td>
</tr>
<tr>
<td>Red</td>
<td>20</td>
</tr>
<tr>
<td>Green</td>
<td>8</td>
</tr>
<tr>
<td>Blue</td>
<td>16</td>
</tr>
<tr>
<td>Silver</td>
<td>28</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
</tr>
</tbody>
</table>

Devise a Huffman code and fill in the following table showing your codes (12 points)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td></td>
</tr>
</tbody>
</table>

(c) What is the Average Weighted Code Length of your answer to (b)? (5 points)
6. (20 points)

Assume that a device on Santa Rosa Island measures, once per minute,

- Temperature (range 0..100)
- Humidity (0..100)
- Wind direction (0..359)
- Wind speed (0..110)
- Solar strength (0..3)

It records values in binary.

(a) How many bits per minute does it need to store? Show your calculations for possible partial credit.

(b) How many bytes per hour must be stored?

(c) Assuming the memory card on the device can store 1 Megabyte \( (2^{20} \text{ bytes}) \). How many days of data can be stored?