Midterm Examination 1
In Class (50 minutes)
Friday, February 7, 2014
Weight: 17.5%

NO: BOOK(S), NOTE(S), OR CALCULATORS OF ANY SORT.

The exam has ten pages. Circle your final answers. Plan your time carefully since some problems are longer than others. You must turn in the pages 1-8.

LAST NAME: ____________________________________________________________

FIRST NAME: ____________________________________________________________

ID# _____________________________________________________________________
Problem 1  

Explain why natural languages cannot be used as programming languages?

They are ambiguous, imprecise

Problem 2  

Label the following items/terms according to their level of abstraction relative to one another. Label the most abstract term as 1 and least abstract as 6.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Code in High level language (C/C++/Java)</td>
</tr>
<tr>
<td>4</td>
<td>Instruction Set Architecture (ISA)</td>
</tr>
<tr>
<td>1</td>
<td>Problem Statement</td>
</tr>
<tr>
<td>5</td>
<td>Micro Architecture</td>
</tr>
<tr>
<td>2</td>
<td>Algorithm to solve problem</td>
</tr>
<tr>
<td>6</td>
<td>Transistors (CMOS or NMOS)</td>
</tr>
</tbody>
</table>
Problem 3  

Assume that we had a "black box," which takes two numbers as input and outputs their sum, as shown in Figure 1(a). Also assume that we had another box capable of multiplying two numbers together, as shown in Figure 1(b). We can connect these boxes together to compute $p \times (m + n)$, as shown in Figure 1(c).

![Diagram](image)

**Fig 1.** "Black boxes" capable of (a) Addition, (b) Multiplication and (c) A combination of both

Now, assume we have unlimited number of these boxes (i.e., the ones shown in Fig 1(a) and 1(b)). Show how to connect them together to compute $m \times n \times p + 50$.
Problem 4  

(2 Points)

In 1900, assume that we needed just 5 bits to uniquely represent everyone living in Madison. Also assume that the population of Madison at present is 10 times the population in 1900. What is the minimum number of bits required to uniquely represent everyone presently living in Madison?

Total population in 1990 = \(2^5 = 32\)
Total population now = \(32 \times 10 = 320\)
=> No of bits required = \(\log_2(320) = 9\)

Problem 5  

(3 Points)

Using 8 bits to represent each number, write the representations of 19, -19 in signed magnitude, 1’s complement and 2’s complement notations.

<table>
<thead>
<tr>
<th>Number</th>
<th>Signed Magnitude</th>
<th>1’s complement</th>
<th>2’s complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>00010011</td>
<td>00010011</td>
<td>00010011</td>
</tr>
<tr>
<td>-19</td>
<td>10010011</td>
<td>11101100</td>
<td>11101101</td>
</tr>
</tbody>
</table>
**Problem 6**  
(6 points)

Fill in the table below with the largest and smallest decimal numbers that can be represented with:

a) 5-bit unsigned number  
b) 5-bit signed magnitude number  
c) 5-bit 2’s complement number  

(Note: -2 is smaller than -1)

<table>
<thead>
<tr>
<th>Representation</th>
<th>Largest Decimal Number that can be represented using this representation</th>
<th>Smallest Decimal Number that can be represented using this representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-bit unsigned number</td>
<td>$2^5 - 1 = 31$</td>
<td>0</td>
</tr>
<tr>
<td>5-bit signed magnitude number</td>
<td>$-(2^{(5-1)} - 1) = -15$</td>
<td>$2^{(5-1)} - 1 = 15$</td>
</tr>
<tr>
<td>5-bit 2’s complement number</td>
<td>$-2^{(5-1)} = -16$</td>
<td>$2^{(5-1)} - 1 = 15$</td>
</tr>
</tbody>
</table>

**Problem 7**  
(2 points)

Perform binary arithmetic for the following pairs of 8-bit 2’s complement numbers

10101001
a) + 00111100
      ---------
     11100101

00010001
b) − 11100111
      ---------
     00101010
Problem 8

Perform the specified logical operations on the following 16-bit numbers expressed in hexadecimal representation. Express your result in hexadecimal (base 16).

a) NOT(xBCDE)

\[ \text{NOT}(\text{1011110011011110}) \]
\[ = 0100 0011 0010 0001 \]
\[ = 0x4321 \]

b) xBCDE

\[ \text{1011 1100 1101 1110 OR 1111 0001 0010 0011} \]
\[ = 1111 1101 1111 1111 = 0xFDFF \]

Problem 9

Represent the decimal 3.5 in fixed point notation

3 = 011

.5 = 1/2 = 2^-1 = 0.1

=> Ans: 11.1
Problem 10

Convert the decimal value -14.125 into its single-precision floating point representation. Write your answer in hexadecimal.

\[ 14 = 1110 \]
\[ .125 = 1/8 = 2^{-3} = 0.001 \]
\[ = 1110.001 = 1.110001 \times 2^{-3} \]
\[ \text{Exponent} - 127 = 3 \Rightarrow \text{Exponent} = 130 = 10000010 \]
\[ \text{Mantissa/Fraction} = 110001 \]
\[ \text{Sign} = 0 \]

\[ \Rightarrow \text{Ans: } 1\ 10000010\ 110001000000000000000000 = 0xC1620000 \]

Problem 11

Convert the ASCII string "Se7en!" to its hexadecimal representation. Only represent the characters within the quotation marks and assume it is null terminated. **Hint:** See ASCII to hexadecimal table on the last page of the exam.

Ans : 0x 53 65 37 65 6e 21 00
Extra page for handwritten work, if needed. This page is not required and will NOT affect your grade. You don’t even need to hand this page in.