Name : ____________________ **Class Number:** _____

ENGR 11: Lesson 3 Suggested Problems

Theoretic Problems: Discussed in notes

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1. **Review of essential terms and concepts**

   A. What are the most popular sets of numbers in mathematics (hint: $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R} \subset \mathbb{C}$)?

   B. What is the difference between an unsigned integer and a signed integer?

   C. What is the relationship between the position number and digit number associated with each digit of an unsigned integer representation (either binary or decimal)?

   D. What is the relationship between the position number and the corresponding power of the radix associated with each digit of an unsigned integer representation (either binary or decimal)?

   E. What does the word *bit* stand for? Compare and contrast the word *bit* to the phrase decimal digit: what are the similarities and differences between these terms?

   F. What is the relationship between bits, nibbles, bytes, and words?

   G. What do we mean when we say that the binary, decimal, and hexadecimal number systems are *positional number systems*?

   H. Given a $4-$bit string of binary digits, how many unique nibbles can be created from four bits?

   I. Generate the hexadecimal table from memory that shows the relationship between $4-$bit binary nibbles, hexadecimal numbers $0 - f$ and the decimal values associated with each of these numbers.

   J. How many data types are native to the MATLAB Environment?

   K. Name all 10 numerical data types that are native to MATLAB. In a few sentences, describe the intended use for each of these data types.

   L. What do the phrases *most significant digit* and *least significant digit* refer to?

   M. What is a *radix* and how does this word relate to the representations of numbers in this class?

   N. What does the command `format hex` do in MATLAB?

   O. How can we use each of the following data types in MATLAB: `uint8`, `uint16`, `uint32`, `uint64`?

Problems Solved in Jeff's Notes

2. Recall the general notation for an $(n+1)-$decimal digit unsigned decimal representation of the unsigned integer $x \in \mathbb{Z}$ with $x \geq 0$ given by $x = (\,d_n d_{n-1} ... d_2 d_1 d_0)_{10}$ where each decimal digit $d_i \in \{0, 1, 2, ..., 9\}$ for all $i \in \{0, 1, ..., n\}$. Also recall that

$$y = d_n \cdot 10^n + d_{n-1} \cdot 10^{n-1} + \cdots + d_1 \cdot 10^1 + d_0 \cdot 10^0 = \sum_{i=0}^{n} d_i \cdot 10^i$$

Explicitly convert each of the unsigned integers given below into this notation. When doing so, explicitly enumerate the position number and digit number of each decimal digit.

- ☐ Example 3.1: $x = (15)_{10}$
- ☐ Example 3.2: $x = (255)_{10}$
- ☐ Example 3.3: $x = (65535)_{10}$
- ☐ Example 3.4: $x = (4294967295)_{10}$
- ☐ Example 3.5: $x = (654321)_{10}$

3. Recall the general notation for an $(m+1)-$bit unsigned binary representation of the unsigned integer $x \in \mathbb{Z}$ with $x \geq 0$ given by $x = (\,b_m b_{m-1} ... b_2 b_1 b_0)_2$ where each digit b_i is either 0 or 1, if we interpreted x as an unsigned binary integer, then we could write the following sum

$$y = b_m \cdot 2^m + b_{m-1} \cdot 2^{m-1} + \cdots + b_1 \cdot 2^1 + b_0 \cdot 2^0 = \sum_{i=0}^{m} b_i \cdot 2^i$$

Explicitly convert each of the unsigned integers given below into this notation. When doing so, explicitly enumerate the position number and digit number of each decimal digit.

- ☐ Example 3.6: $x = (11)_2$
- ☐ Example 3.7: $x = (1001)_2$
- ☐ Example 3.8: Write out all possible 4−bit unsigned binary integers
- ☐ Example 3.9: $x = (110\,0100)_2$
- ☐ Example 3.10: $x = (1111\,1111)_2$

4. Create a table of the powers of 2 from 2^0 to 2^{32}. Memorize all powers of 2 from 2^0 to 2^{12}

5. Using paper and pencil analysis each of the following unsigned decimal integers into binary form:

- ☐ Example 3.11: $x = (11)_{10}$
- ☐ Example 3.13: $x = (145)_{10}$

Suggested Problems

20. Consider each of the following unsigned decimal integers:

A. $(247)_{10}$ B. $(543)_{10}$ C. $(4095)_{10}$ D. $(51203)_{10}$

i. Convert these numbers into unsigned binary integers using paper and pencils analysis
ii. Check your work using MATLAB's `dec2bin` function
iii. Convert these numbers into unsigned hexadecimal integers using paper and pencils analysis
iv. Check your work using MATLAB's `dec2hex` function

21. Consider each of the following unsigned binary integers:

A. $(1011)_2$ B. $(0110\,1001)_2$ C. $(0111\,0000\,1110)_2$ D. $(0001\,1011\,0010\,1101)_2$

i. Convert these numbers into unsigned decimal integers using paper and pencils analysis
ii. Check your work using MATLAB's `bin2dec` function
iii. Convert these numbers into unsigned hexadecimal integers using paper and pencils analysis
iv. Check your work using the `bin2hex` function that you downloaded for problem 1 of Lab 3

22. Consider each of the following unsigned hexadecimal integers:

A. $(\mathrm{e}\,3)_{16}$ B. $(\mathrm{d}\,9\,\mathrm{a})_{16}$ C. $(1\,\mathrm{a}\,4\,\mathrm{c})_{16}$ D. $(\mathrm{ffffffff})_{16}$

i. Convert these numbers into unsigned binary integers using paper and pencils analysis
ii. Check your work using the `hex2bin` function that you downloaded for problem 1 of Lab 3
iii. Convert these numbers into unsigned decimal integers using paper and pencils analysis
iv. Check your work using MATLAB's `hex2dec` function