Name : ____________________ © Jeffrey A. Anderson **Class Number**: ______

Engr 11: Introduction to MATLAB
SAMPLE Exam 1

How long is this exam?

- This exam is scheduled for a 110 minute period.
- Make sure you have 5 sheets of paper (10 pages front and back) including this cover page.
- There are a total of 7 separate questions on this exam including:
  - 7 Free-response questions (50 points)
  - 1 Optional, extra credit challenge problem (5 points)

How will your written work be graded on these questions?

- Your work should show evidence of original thought and deep understanding. Work that too closely resembles the ideas presented in Jeff's lesson notes will likely NOT earn top scores. Work that does not demonstrate individualized, nuanced understanding will likely NOT earn top scores.
- Read the directions carefully. Your work will be graded based on what you are being asked to do.
- In order to earn a top score, please show all your work. In most cases, a correct answer with no supporting work will NOT earn top scores. What you write down and how you write it are the most important means of getting a good score on this exam.
- Neatness and organization are IMPORTANT! Do your best to make your work easy to read.
- You will be graded on accurate use of the notation we studied in this class.

What can you use on this exam?

- You may use less-than or equal to SIX note sheets.
- Each note sheet is to be no larger then 11-inches by 8.5-inches (standard U.S. letter-sized paper).
- You may write on both sides of your note sheets.
- Your note sheet must be handwritten.
- PLEASE SUBMIT ALL OF YOUR NOTE SHEETS WITH YOUR EXAM.
- You are allowed to use calculators for this exam. Examples of acceptable calculators include TI 83, TI 84, and TI 86 calculators. You are not allowed to use any calculator with a Computer Algebra System including TI 89 and TI NSpire. If you have a question, please ask your instructor about this.

What other rules govern your participation during this exam?

- PLEASE DO NOT TURN THIS PAGE UNTIL TOLD TO DO SO!
- It is a violation of the Foothill Academic Integrity Code to, in any way, assist another person in the completion of this exam. Please keep your own work covered up as much as possible during the exam so that others will not be tempted or distracted. Thank you for your cooperation.
- No notes (other than your note sheets), books, or classmates can be used as resources for this exam.
- Please turn off your cell phones during this exam. No cell phones will be allowed on your desk.

Below are two tables that might be useful for you as you work through problems on this exam.

Exam 1, Table 1: Various Powers of Two

n	2^n	=	Decimal
0	2^0	=	1
1	2^1	=	2
2	2^2	=	4
3	2^3	=	8
4	2^4	=	16
5	2^5	=	32
6	2^6	=	64
7	2^7	=	128
8	2^8	=	256
9	2^9	=	512
10	2^{10}	=	1,024
11	2^{11}	=	2,048
12	2^{12}	=	4,096
13	2^{13}	=	8192
14	2^{14}	=	16,384
15	2^{15}	=	32,768
16	2^{16}	=	65,536
32	2^{32}	=	4,294,967,296
64	2^{64}	=	18,446,744,073,709,551,616

Exam 1, Table 2: Hexadecimal Nibble Chart

Decimal	4-bit binary niblbe	Lowercase Hexadecimal
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

1. Consider the following snippet of code:

```
1       x = [64:-8:8];
2       y = linspace(4,32,8);
3       I8 = eye(9,9); I8(:,9) = []; I8(9,:) = [];
4       A = [zeros(1,8); ones(1, 8); linspace(2,2,8)];
5       B = I8(:, [4, 8]);
6       C = [y;  A(3,:); B; x];
```

When we execute the code above in MATLAB, we produce an error.

A. (1 points) Which line of this code causes the error? What is the problem with this line?

B. (1 points) Modify the line of code that contains the error using a single transpose operator `'` so that when we execute this code, the matrix $C \in \mathbb{R}^{5\times 8}$ is successfully saved in memory without errors.

C. (2 points) Assuming you've corrected the error, write the entry-by-entry definition of C.

2. Consider the following decimal number

$$x = 2^0 + 2^2 + 2^3 + 2^5 + 2^6 + 2^9 + 2^{10} + 2^{12} = (5741)_{10}$$

A. (3 points) Convert this number into an unsigned binary representation. Explain your work.

B. (3 points) While explaining your thinking, please predict the output of the following code:

```
x = 5741;
format hex
y = uint16(x)
```

3. (14 points) Please fill out the following table of values. The first row of the table is completed for you.

Exam 1, Problem 3: Bounds for Integer data types in MATLAB

Data Type	Lowerbound in hexadecimal	Lowerbound in decimal	Upperbound in decimal	Upperbound in hexadecimal
`uint8`	`00`	0	$2^8 - 1 = 255$	`ff`
`uint16`				
`uint32`				
`uint64`				
`int8`				
`int16`				
`int32`				
`int64`				

4. (4 points) Convert the unsigned hexadecimal integer $x = (abcd)_{16}$ into the unsigned binary and decimal equivalents. Show your work and explain your steps.

5. Consider the following lines of code:

```
x = int16(151); y = int16(-151);
format hex
x, y
```

A. (6 points) Write the output that is generated by this code.

B. (2 points)Suppose we attempt to store `x` using MATLAB's `int8` data class. What happens? Why?

6. What decimal value does the raw, uninterpreted 10−bit binary string 10 1011 1101 have if:

   A. (3 points) we interpret this number as an unsigned binary integer?

   B. (3 points) we interpret this number as a signed integer in signed-magnitude representation?

   C. (3 points) we interpret this number as a signed integer in twos complemment representation?

7. (5 points) Suppose $x = -1305$. Let $m \in \mathbb{N}$ be the smallest number of bits that can store x in twos complement, where m can be any positive integer and is not necessarily a power of 2. With this in mind, find m. Explain your reasoning.

Challenge Problem

8. (Optional, Extra Credit, Challenge Problem: 5 points) Recall that in Lesson 4, we stated that to negate a signed integer $x \in \mathbb{Z}$ that is stored in twos complement, we take the bitwise complement of each bit of the twos complement representation of x and then add 1. With this in mind, determine if the following statement is true or false. Explain your reasoning and be sure to use the Lesson 4 notation for twos complement representation.

   Conjecture: For a signed integer $x \in \mathbb{Z}$ that is stored using an $m-$bit twos complement representation given by

   $$x = (b_{m-1}b_{m-2}...b_2b_1b_0)_{2C}$$

   we can negate x by treating the bit string $b_{m-1}b_{m-2}...b_2b_1b_0$ as an unsigned integer and calculating the difference

   $$2^m - b_{m-1}b_{m-2}...b_2b_1b_0.$$

   The resulting binary string is the twos complement representation of $-x$.