Name : _____ **Class Number:** _____

Engr 11: Introduction to MATLAB
Student Exam 1 Questions

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:
  - 6 Free-response questions (40 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 double-sided note sheets (or 12 singled-sided 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.

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}	=	$8,192$
14	2^{14}	=	$16,384$
15	2^{15}	=	$32,768$
16	2^{16}	=	$65,536$
22	2^{22}	=	$4,194,304$
23	2^{23}	=	$8,388,608$
31	2^{31}	=	$2,147,483,648$
32	2^{32}	=	$4,294,967,296$
52	2^{52}	=	$4,503,599,627,370,496$
53	2^{53}	=	$9,007,199,254,740,992$
63	2^{63}	=	$9,223,372,036,854,775,808$
64	2^{64}	=	$18,446,744,073,709,551,616$

Table 2: Hexadecimal Nibble Chart

Decimal	4-bit binary niblbe	Lowercase Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	a
11	1011	b
12	1100	c
13	1101	d
14	1110	e
15	1111	f

Lesson 1: Introduction to the MATLAB Environment

1. When we say that MATLAB is an "array" programming language, what do we mean by that phrase? (Wesley C)

2. What are the differences between a (.m) script file and a (.mlx) live script file in MATLAB? In what situations would a live script be the preferred method of coding versus the standard script file format? Write a 3 - 4 sentence paragraph explaining your answer. (C. Taylor)

3. What is MATLAB and what can we do with MATLAB. (Seungheon L.)

4. Consider the following expression:

$$(10)^{\frac{10}{7}} - \frac{\sqrt{12} \div 10 + 2}{20\, e^2}$$

   Show how to write this command into MATLAB's Command Window to calculate the desired output value. (Jingwen P.)

5. If you have an idea of what you want MATLAB to do with your data but do not know the syntax, what resource(s) can you use to find syntax? (Kenny Q.)

6. Please write three debugging techniques you implement while you program. Include an example of how you use each technique. Also, provide at least three sentences to explain why you choose to use this technique and how this habit helps you code. (Charlotte S.)

7. When having trouble with MATLAB documentation, what are three resources you can use? Explain the benefits and drawbacks of each resource and how you use each of these tools. (James S.)

Lesson 2: Creating Arrays in MATLAB

8. Consider the matrices below:

A. $\begin{bmatrix} 5 & 0 & 0 & -4 \\ 0 & 5 & -4 & 0 \\ 0 & -4 & 5 & 0 \\ -4 & 0 & 0 & 5 \end{bmatrix}$ B. $\begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix}$ C. $\begin{bmatrix} 2 & -1 & 0 & 0 \\ -1 & 2 & -1 & 0 \\ 0 & -2 & 2 & -1 \\ 0 & 0 & -1 & 2 \end{bmatrix}$

   Create each of these matrice using a single command? (Marcus P.)

9. Write an algorithm for multiplying two $n \times n$ matrices together in pseudocode. Then, author a MATLAB function file to successfully implement this algorithm. In other words, assuming $A, B \in \mathbb{R}^{n \times n}$, create a function file to calculate the product $C = A \cdot B$. Here are some hints on how to get started:

```
function C = SquareMatrixMult( A , B , n )

end %function (SquareMatrixMult)
```

Notice that the input into our function square $n \times n$ matrices A, B and positive integer n. Output from your function the matrix C. (Michelle T.)

Lesson 3: Storing and Representing Unsigned Integers

10. Consider the following equalities:

$$(91)_{10} = (1101\ 1001)_2 = (5b)_{16} = (331)_5$$

Explain the differences between representing this number in each radix provided. Compare and contrast the features of each representation. (Adam D.)

11. By explaining your thinking and starting with first principles, please predict the output MATLAB generates when we execute each of the following lines of code:

A. `uint8(256)`

B. `dec2bin(256)`

C. `uint8(256)- uint8(255)`

What issues arise with the storage of these values? What overflow might we anticipate? (Natalie T.)

12. Consider the following unsigned binary integers:

i. $(1101)_2$

ii. $(0110\ 1001)_2$

iii. $(0111\ 0000\ 1110)_2$

iv. $(0001\ 1011\ 0010\ 1101)_2$

Using pen-and-paper analysis, convert these numbers into unsigned decimal and hexadecimal integers. Then check your work using MATLAB's `bin2dec` and `base2dec` functions. (Jonathan F.)

13. Consider the following arithmetic operations:

i. $(6fe58c)_{16} + (3add)_{16}$

ii. $(11100)_2 - (1000\ 1111)_2$

iii. $(545)_8 - (267)_8$

Using pen-and-paper analysis, calculated the output of these operations. (Chujui H.)

14. Describe the three radix r representations we have studied for unsigned integers $y \in \mathbb{N}_0$, where $r = 10, 2,$ and 16. Describe each of these radix representations in summation notation. Also, describe a specific radix conversation algorithms from radix r_1 to radix r_2 and vice versa. (C. Taylor)

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15. Generate the hexadecimal table from memory. Show the relationship between the 4-bit binary nibbles, the hexadecimal numbers 0 - f, and the unsigned decimal integers associated with each of these numbers. Then write a method to generate this table in MATLAB using the `table` data class. (Charlotte S.)

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16. Consider the following snippets of code:

```
a = uint8(11); b = uint8(9);

%Method 1
c = (a + b)/2

%Method 2: Assume a <= b
c = (a + (b - a)/ 2)

%Method 3
c = (a/2) + (b/2)

%Method 4
c = (a/2) + (b/2) - (mod(a,2) * mod(b,2))
```

In this code, we use four different methods to calculate the average of 8-bit unsigned integers `a` and `b`, then store the results as an 8-bit unsigned integer `c`. Compare and contrast each line of code. We claim that only method 4 should always produce the correct output. Methods 1 - 3 each have errors that result for different stored values of `a` and `b`. Find values of `a` and `b` that return errors for methods 1 - 3. Then, explain why method 4 does not fail. (Nick K.)

Lesson 4: Storing and Representing Signed Integers

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17. Consider the unsigned hexadecimal integer:

$$y = (\texttt{fa4c})_{16} \in \mathbb{N}_0$$

A. Convert this into an unsigned binary integer.

B. Convert this into an unsigned decimal integer.

C. What signed decimal integer would the 16 bits of the binary string you created in your answer to part A. represent if interpreted as a twos-complement signed integer.

For each answer, show your work in detail using pen-and-paper analysis. (Marcus P. and Adam D.)

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18. Consider the unsigned integer:

$$y = (3,735,928,559)_{10} \in \mathbb{N}_0$$

A. Convert this decimal integer into an unsigned hexadecimal integer.

B. Convert this decimal integer into an unsigned binary integer.

C. What signed decimal integer would the 16 least significant bits of the binary string you created in your answer to part B. represent if interpreted as a twos-complement signed integer.

Note: Historically, some software engineers wrote this value to memory locations not meant to be used by a program (aka *deallocated memory*) as a recognizable sequence for debugging purposes. (Josh H.)

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19. Consider the following assignment statements:

    A. `ans = uint16(576) * int16(-312) + uint8(1024)`

    B. `ans = int32( uint8(112/33))`

    C. `ans = int8( 729 - uint8(153)*uint32(3) + int8(117))`

    Predict the calculated output of each of these commands. (Josh H.)

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20. Consider the following raw, uninterpreted 15-bit binary word

$$B = 1001\ 1100\ 0000\ 0101$$

    What decimal value does the B have if:

    A. we interpret this number as an unsigned binary integer?

    B. we interpret this number as a signed integer in signed-magnitude representation?

    C. we interpret this number as a signed integer in twos complement representation?

    Interpret this 15-bit binary word as an unsigned binary integer. Now convert this into an unsigned hexadecimal integer. (Seungheon L. and Jingwen P.)

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21. Consider the following snippets of code:

```
format hex
x = int16(linspace(-12, 6, 4))
```

    Suppose you execute this code in the Command Prompt. Predict the output. (James S.)

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22. Consider the following snippets of code:

```
format hex
x = int16(-1201)
y = int8(-1201)
```

    Predict the output of this code and explain your answers. (Zhan B.)

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23. Find the sum

$$(-113)_{10} + (-91)_{10}$$

    Use 8-bit twos complement representation of these signed integers. (Wesley C.)

24. Subtract the following two 6-bit twos complement numbers:

$$011101 - 100111$$

Give the result in radix r representation, for any radix $r \in \{2, 3, 4, 5, ..., 16\}$. (Michelle T.)

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25. Explain the general overflow rule for twos complement arithmetic processes of addition and subtraction as if you were explaining these concepts to a five-year old. (Natalie T.)

Challenge Problem

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26. Consider each problem below:

A. $(1101101.011)_2 = (\quad x \quad)_{10} = (\quad y \quad)_8 = (\quad z \quad)_{16}$

B. $(87.64)_2 = (\quad x \quad)_2 = (\quad y \quad)_8 = (\quad z \quad)_3$

Find the appropriate values of x, y, and z. (Chujui H.)