EXPERIMENT 2: MATRICES AND PLOTS

Name of the Student : VISHWAS VASUKI GAUTAM
ID No. : 2019A3PS0443H

Note: (1) Write your answers only in the space provided below against each question.

(2) Use Help / Search Documentation option of Matlab

Objectives:

(i) Generate a Matrix and perform basic operations on Matrices using Matlab

(ii) Understanding how to plot different signals & different plot options available in Matlab

Run #01: Generate a matrix

Q1.Generate a matrix of 3×4 using parenthesis definition.

Answer :

```
zeros(3,4)

ans =

   0   0   0   0

   0   0   0   0

   0   0   0   0
```

Q2. Given matrix **A** below

$$A = \begin{matrix} 3 & 4 & 6 \\ 8 & 56 & 34 \\ 11 & 15 & 21 \end{matrix}$$

(i) Find the **size** and **length** of the matrix A.

(ii) What is the difference between **size** and **length**?

Answer :

(i)

```
>> A = [3, 4, 6; 8 56, 34; 11, 15 21]
A =
    3     4     6
    8    56    34
   11    15    21
>> length(A)
ans =
    3
>> size(A)
ans =
    3     3
```

(ii) The length returns the length of the largest array dimension (row/column) in the matrix, whereas size returns the dimensions of the matrix.

Run #02: Operations on matrices

Q3. Write a matlab code in Command window that performs the following operations on given two matrices/single matrix.

A = [1 2 3;4 5 6;7 8 9] and B = [10 20 20;40 50 60;70 80 90]

(i) Addition
(ii) Subtraction
(iii) Multiplication
(iv) Transpose
(v) Determinant

Answer :

```
>> A = [1 2 3;4 5 6;7 8 9];
>> B = [10 20 20;40 50 60;70 80 90];
>> A+B
 ans =
   11    22    23
   44    55    66
   77    88    99
>> A-B
ans =
   -9   -18   -17
  -36   -45   -54
  -63   -72   -81
>> A*B
ans =
       300       360       410
       660       810       920
      1020      1260      1430
>> A'
ans =
    1    4    7
    2    5    8
    3    6    9
>> B'
ans =
   10   40   70
   20   50   80
```

```
   20    60    90
>> det(A)
ans =
  -9.5162e-16
>> det(B)
ans =
   3.0000e+03
```

Q4.Perform the following operations in the Command window on the given matrix A

A = [1 2 10;4 5 6;7 8 9;3 11 12]

(i) Calculate the **sum** of all the elements of each column
(ii) Calculate the **sum** of all the elements of a each row
(iii) Calculate the **sum** of the entire matrix elements
(iv) Find the **min**imum, **max**imum and their **Index** (position) of the elements in each column of the matrix
(v) Add a constant value of 3 to the element (3,2) of the above matrix A

Answer :

```
>> A = [1 2 10;4 5 6;7 8 9;3 11 12];
>> sum(A)
ans =
    15    26    37
>> sum(A')
ans =
    13    15    24    26
>> sum(A,'all')
ans =
    78
```

```
>> [M,I] = min(A)
M =

   1    2    6

I =

   1    1    2

>> [M2,I2] = max(A)

M2 =

   7   11   12

I2 =

   3    4    4

>> A(3,2) = 3 + A(3,2)

A =

   1    2   10

   4    5    6

   7   11    9

   3   11   12
```

Q5. (i) Consider the complex matrix A = [1+i 1- i 1- 3i; 2+7i 3+9i 2 - 5i; 6 - 9i - i 2i]. Write a matlab program in the Editor window to find the conjugate and the transpose of the given matrix A

NOTE : It is compulsory to use the following commands as first three lines in any Matlab program you write in editor window as it can clear out the garbage/previous values if any stored in the variables :

```
clc;
close all;
clear all;
```

(ii) Using single matlab command, find the conjugate transpose of the above

matrix.

Answer :

(i)

Code:

```
A = [1+i,  1- i,  1- 3i;  2+7i,  3+9i,  2 - 5i;  6-9i,  -i,   2i]
A'
conj(A)
```

Output:

```
A =

   1.0000 + 1.0000i   1.0000 - 1.0000i   1.0000 - 3.0000i
   2.0000 + 7.0000i   3.0000 + 9.0000i   2.0000 - 5.0000i
   6.0000 - 9.0000i   0.0000 - 1.0000i   0.0000 + 2.0000i

ans =

   1.0000 - 1.0000i   2.0000 - 7.0000i   6.0000 + 9.0000i
   1.0000 + 1.0000i   3.0000 - 9.0000i   0.0000 + 1.0000i
   1.0000 + 3.0000i   2.0000 + 5.0000i   0.0000 - 2.0000i

ans =

   1.0000 - 1.0000i   1.0000 + 1.0000i   1.0000 + 3.0000i
   2.0000 - 7.0000i   3.0000 - 9.0000i   2.0000 + 5.0000i
   6.0000 + 9.0000i   0.0000 + 1.0000i   0.0000 - 2.0000i
```

(ii)

```
>> ctranspose(A)
```

```
ans =

  1.0000 - 1.0000i   2.0000 - 7.0000i   6.0000 + 9.0000i
  1.0000 + 1.0000i   3.0000 - 9.0000i   0.0000 + 1.0000i
  1.0000 + 3.0000i   2.0000 + 5.0000i   0.0000 - 2.0000i
```

Run #03:Row and Column Operations:

Q6.Generate the matrix, A = $\begin{bmatrix} -1 & 5 & 7 \\ 3 & 1 & 9 \\ 12 & 0 & 23 \end{bmatrix}$.

Write a program using **find** function to replace the value '3' [i.e in the (2,1) element] in the matrix A to '-5'.

Answer :

```
>> A = [-1 5 7; 3 1 9; 12 0 23]
A =
   -1    5    7
    3    1    9
   12    0   23
>> [x,y] = find(A==3)
x =
    2
y =
    1
>> A(2,1) = -5
A =
```

```
-1   5   7

-5   1   9

12   0   23
```

Q7. Take a 3×3 matrix A of your choice. Use Command window to perform the following operations on the matrix A

(i) Get (display) all the elements of column 3 of the matrix, A (The display should be a column vector containing all the 3 elements of the 3rd column).

(ii) Get (display) all the elements of row 2 of the matrix, A (The display should be a row vector containing all the 3 elements of the 2nd row).

(iii) Insert this given column vector $\begin{bmatrix}1\\2\\3\end{bmatrix}$ in the 3rd column of matrix A.

(iv) Remove the 3rd row of the modified matrix A in part (iii) and name this matrix as B. Then from the matrix 'B' remove the 2nd column of the resultant matrix.

Answer :

```
>> A = magic(3)

A =

   8   1   6

   3   5   7

   4   9   2

>> A(:,3)

ans =

   6

   7

   2

>> A(2,:)
```

```
ans =

   3    5    7


>> A(:,3) = [1;2;3]

A =

   8    1    1

   3    5    2

   4    9    3

>> B = A(3,:)

B =

   4    9    3

>> B = B(1, [1 3])


B =

   4    3
```

Q8.Given the matrix A = [1 2 3 11 12 13; 4 5 6 14 15 25; 7 8 9 45 32 23; 5 34 65 12 19 26].

(i) Create a row vector from the matrix A, consisting of first three elements of the 2nd row and all the elements of 4th column.

(ii) Obtain the diagonal elements and the upper off –triangular elements of the original matrix A.

Answer :

```
>> A = [1 2 3 11 12 13; 4 5 6 14 15 25; 7 8 9 45 32 23; 5 34 65 12 19 26]

A =

   1    2    3   11   12   13

   4    5    6   14   15   25

   7    8    9   45   32   23

   5   34   65   12   19   26

>> X = [A(2,[1,2,3]), A(:,4)']
```

```
X =
   4    5    6   11   14   45   12
>> D = diag(A)
D =
    1
    5
    9
   12
>> T = triu(A)
T =
    1    2    3   11   12   13
    0    5    6   14   15   25
    0    0    9   45   32   23
    0    0    0   12   19   26
```

Run #04: Special Matrices

Q9. Generate a 3 × 3 identity matrix using **eye** function.

Q10.Generate a 3 × 3 null matrix using **zeros** function.

Q11. Generate a 3 × 3 unity matrix using **ones** function.

Answer :

```
>> eye(3,3)
ans =
    1    0    0
    0    1    0
    0    0    1
>> zeros(3,3)
```

```
ans =

   0   0   0

   0   0   0

   0   0   0

>> ones(3,3)

ans =

   1   1   1

   1   1   1

   1   1   1
```

Run #05: Keywords for plotting a figure

Q12. Write comments (i.e. what is the purpose/what is its functionality) on the following keywords related to plotting a figure in MATLAB

(i) plot ( );
(ii) stem ( );
(iii) Subplot ( );
(iv) x-label ( );
(v) y-label ( );
(vi) title ( );
(vii) legend ( );
(viii) figure ( );
(ix) grid ( );
(x) axis ( );
(xi) hold on;
(xii) hold off;

Answer :

(i) used to create a 2-D plot of the data
(ii) stem(Y) plots the data sequence, Y, as stems that extend from a baseline along the *x*-axis
(iii) subplot(m,n,p) divides the current figure into an m-by-n grid and creates axes in the position specified by p
(iv) Allows you to name the x axis of the subplot/plot
(v) Allows you to name the y-axis of the subplot/plot
(vi) Allows you to give a heading/name to your subplot/plot
(vii) Gives a description of the labels used in the subplot/plot along with colors, labels etc.

(viii)	figure creates a new figure window using default property values or you can specify the name and value of the window as parameters
(ix)	Used to display major grid lines on the axes of the plots
(x)	specifies the limits for the current axes
(xi)	hold on retains plots in the current axes so that new plots added to the axes do not delete existing plots
(xii)	hold off sets the hold state to off so that new plots added to the axes clear existing plots

Q13. Write a matlab program using editor window to plot the function y = cos(t). Define a time vector 't' from 0 to 10 sec with an increments/steps of 0.1. Use x-label, y-label, title commands to name the x-axis, y-axis and figure title.

Answer :

```
t = [0:0.1:10];
y = cos(t);

plot(t, y);
xlabel('samples'), ylabel('output')
title('Cos function')
```

Q14.Write a MATLAB program to define a time vector 't' from 0 to 2π with an increment/steps of $\pi/100$. Using the generated 't' values calculate the signals X1, X2 and X3 as given below

$$X_1(t) = \sin(t) \quad ; \qquad X_2(t) = \sin(t - 0.25) \quad ; \qquad X_3(t) = \sin(t - 0.5)$$

Plot $X_1(t)$, $X_2(t)$, $X_3(t)$ on same figure window (1) using hold on. Use different the plotting features like (a) linewidth (b) color and (c) different markers. (2) Without using 'hold on' now divide the figure window into subplots and plot X1, X2 and X3 in three separate subplots.

Answer :

1)

```
t = [0:pi/100:2*pi];
x1 = sin(t);
x2 = sin(t-0.25);
x3 = sin(t-0.5);
```

```
plot(t,x1, 'g')
hold on
plot(t, x2, 'r--')
hold on
plot(t, x3, 'b.')
xlabel('samples'), ylabel('output')
title('Cos function')
```

2)

```
t = [0:pi/100:2*pi];
x1 = sin(t);
x2 = sin(t-0.25);
x3 = sin(t-0.5);

clf
subplot(311);
plot(t, x1, 'g')
subplot(312);
plot(t, x2, 'r--')

subplot(313);
plot(t, x3, 'b.')
```

Link to submit your observation : https://forms.gle/FK1AKRTRWV2c77EWA

For Thursday Batch, Deadline to submit your observations is on or before Feb 7th Sunday 5 PM.

For Tuesday Batch, after performing this experiment 2 during the week of Feb 8th to Feb 14th Submit your observations on or before Feb 14th Sunday 5 PM

Try yourself

Q15. Write a MATLAB program to plot $x(t) = A_0 \exp(a*t)$ where $A_0 = 0.5$, $a = -2$ and $0 \leq t \geq 25$. Plot the function x(t) with respect to time 't' in the x-axis.. Use x-label, y-label, title commands to name the x-axis, y-axis and figure title.

Q16. Repeat the problem and plot $X_1(t)$, $X_2(t)$, $X_3(t)$ in different plot but in same figure using **subplot** keywords.

Q17. Generate a matrix using **rand, randn, randi** matlab functions/commands. Write the differences you observe between the elements generated for these matrices.

Q18. Perform the following operations using the matrix generated by **rand** function in Q. 17.

(i) floor (ii) ceil (iii) round (iv) fix

Q19. Consider the following system of equations. Write a matlab program using Cramer's rule find the solution for the systems of equations.

$$x-2y+3z = 7$$

$$2x+y+z = 4$$

$$-3x+2y-2z = -10$$

Q20. Consider a matrix A of order 6×6 of your choice. Reshape it into matrix of order 9×4.Write the condition for using **reshape** command/function

Q 21. Consider a matrix A = [5 -3 2; -3 8 4; 4 2 -9]. Calculate its eigen values and eigen vectors.

Q22. Plot the function $r(\theta) = 1 + 2\sin^2(2\theta)$ where $0 \leq \theta \leq 2\pi$. Plot this function in polar form.

Q23. Define the vector $0 \leq t \leq 2\pi$.Plot the functions x(t) = t*cos(3*pi*t), y(t) = t*sin(3*pi*t), z(t) = t using plot3 command/function.

****