CHAITANYA BHARATHI
INSTITUTE OF TECHNOLOGY (A)
Kokapet(Village), Gandipet, Hyderabad, Telangana-500075. www.cbit.ac.in

Affiliated to | NBA | Re-accredited by NAAC | 100th Rank in NIRF | ISO 9001:2015

COMMITTED TO RESEARCH, INNOVATION AND EDUCATION

41 years

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

is Offering a Two Week Online Training/Internship Course

VIDYUT PRASIKSHANA (VIPRA)

on

SIMULATION TOOLS FOR ELECTRICAL & ELECTRONICS ENGINEERING

08th June – 20th June, 2020

For II Semester Electrical & Electronics Engineering Students

- **No Registration Fee**
- **Use the following Link for Registration**
  https://docs.google.com/forms/d/e/1FAlpQLSduqLEE1X6MSx_HDlejTtmxlccCSgb6viMVjYP0Czt25tBLHA/viewform?usp=sf_link

Objectives of the Course

- To introduce various simulation softwares used in Electrical & Electronics Engineering.
- To provide a platform to know about modeling of Electrical & Electronic circuits.
- To improve the preparation and presentation skills of doing their mini-project/project.
- To make the student to visualize the concepts of Electrical & Electronics Engineering using simulation.

Expected Course Outcomes

After successful completion of the Program, the Student should be able to

- Model Electrical & Electronic circuits using different softwares.
- Generate the graphs for the analysis of data.
- Identify the bug in the program and also knows the procedure to debug the same.
- Infer various logical operations.
- Identify and use suitable software appropriately for validation the concepts.

Department of EEE :: CBIT(A)

Two week inhouse-ONLINE training/Internship Program

VIdyut PRAsikshana

VIPRA

Day:1 08.06.2020

Minute-to-Minute Schedule [**Repertoire**]

Time	Part of Program
10.00 AM	Dr NVPB welcomes the participants and Dignitaries
Over to HoD-EEE	
10.05AM	Salient features of VIPRA
Over to Principal CBIT	
10.10AM	Address by Prof.P.Ravinder Reddy
Over to Director –I&I	
10.15AM	Greetings by Prof.U.K.Choudhury
Over to Director -Academics	
10.20AM	Address by Prof.K.Krishna veni
Over to Controller of Examinations	
10.25 AM	Address by Prof.P V Prasad
Over to Co-Convener	
10.30 AM	Vote of thanks : Dr T.Murali Krishna

Dept. of EEE * CBIT (A), Hyd. *

Training/Internship Course Schedule

Day	Date	Timings & Activity	
		Fore Noon	After Noon
1	08/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
2	09/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
3	10/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
4	11/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
5	12/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
6	13/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
7	15/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
8	16/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
9	17/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
10	18/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
11	19/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers
12	20/6/2020	10:00 AM to 11:30 AM - Lecture 11:30 AM to 12:00 PM - Question & Answers	02:00 PM to 03:30 AM - Lecture 03:30 PM to 04:00 PM - Question & Answers

Topics to be Covered

- ✓ Basic MATLAB Programming
- ✓ Plots
- ✓ Matrices
- ✓ Logical operators
- ✓ Circuit Analysis
- ✓ Simple Power system
- ✓ Control Systems
- ✓ PSpice
- ✓ Inverters Design
- ✓ PWM Analysis
- ✓ Converter design using MATLAB
- ✓ Evaluation of Performance parameters
- ✓ Multi Level Inverter Topologies

CHIEF PATRON

Kavi Kireeti Dr. V. Malakonda Reddy, President, CBITS

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Secretary & Correspondent, CBES

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Prof. G. Suresh Babu, Head, Department of **Electrical and Electronics Engineering**

Co-Convener

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Coordinators

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Dept. of EEE * CBIT (A), Hyd-75 *

Department of EEE :: CBIT(A)

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VIdyut PRAsikshana

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Valedictory: 20.06.2020

Minute-to-Minute Schedule **[Repertoire]**

Time	Part of Program
03.00 PM	Inviting Dignitaries on to the online
Over to HoD	
03.05PM	Brief Report of VIPRA by Sri. C. Harish
Over to HoD	
03.10PM	Feedback from the Participants
Over to HoD	
03.15PM	Response to the Feedback by HoD Prof. G. Suresh Babu
Over to HoD	
03.20PM	Address by Prof. U.K. Choudhury, Director I & I
Over to HoD	
03.25 PM	Presidential Remarks by Prof. P. Ravinder Reddy Principal, CBIT(A)
Over to HoD	
03.30 PM	Vote of thanks by Sri. D. Harsha

Dept. of EEE ★ CBIT (A) Hyd-75 ★

Structures

UNIT-2

STEE

Structures

❑Structures are cell arrays in that they allow you to group collection of dissimilar data into a single variable.

❑However, instead of addressing elements by number, structure elements are addressed by names called **fields.**

❑Whereas cell arrays use curly braces to access data, structures use dot notation to access data in fields.

❑Structures are arrays whose names have **dot-separated parts.** They can be used to store information of different kinds together in a hierarchical structure.

Structures

- Structures are like cell arrays in the sense they also allow grouping of different data types in a single variable called structure variable.
- **Creation of a structure**
- There are two common ways to create a structure. The first way is using the keyword **struct, which takes a pair of field names** and corresponding field values.
- Another way is to assign values to the fields of a structure variables.

Structures

```
>> staff.name ='John Smith'
staff =
   name: 'John Smith'
>> staff.age = 43
staff =
   name: 'John Smith'
    age: 43
>> staff.favourites = [1 42 37]
staff =
        name: 'John Smith'
         age: 43
  favourites: [1 42 37]
```

Structures

```
>> whos
Name      Size      Bytes  Class   Attributes

staff     1x1         580  struct

>> staff

staff =

        name: 'John Smith'
         age: 43
  favourites: [1 42 37]
```

Structures

```
>> staff(2).name = 'Jane Smythe';
staff(2).age = 30;
staff(2).favourites = [pi eps realmax realmin NaN Inf];
>> staff(2)
ans =
       name: 'Jane Smythe'
        age: 30
  favourites: [3.1416  2.2204e-16  1.7977e+308  2.2251e-308  NaN
Inf]
```

Structures

- Using **struct Keyword**
- A structure variable is created using **struct *function as follows***
- **Strvar = struct ('Field1',data1, 'Field2',data2, 'Field3',data3............., 'FieldN',dataN);**
- For example, suppose we want to store the information of a friend the following information, Name, age and address.

- >> Friends = struct('Name','Dilip','Age',35,'Address','Roorkee')

```
Friends =
      Name: 'Dilip'
       Age: 35
   Address: 'Roorkee'
```

- The values of a structure can be retrieved using field names in association with the structure variable name

Structures

- Using **struct Keyword**
- The values of a structure can be retrieved using field names in association with the structure variable name

```
Friend.Name will give the name of the Friend, 'Karambi' here.
Friend.Age will give 35, the value of the field Age.
Friend.Address will give 'Saiton', the value of the field Address.
```

- Suppose, Karambi has another name called Ibema and we want to store it in the Name field, we can do so as

```
>>Friend=struct ('Names',{'Karambi', 'Ibema'}, 'Age', 35,
'Address', 'Saiton');
>>Friend
Friend =
1x2 struct array with fields:
   Names
   Age
   Address
```

Multidimensional Arrays

Multidimensional matrices are natural extensions of the normal two dimensional matrices for cases where the data represent more than two dimensions. Examples are

- Medical tomography, where three-dimensional volumetric data are built up from a series of two-dimensional images;
- Temperature measurements taken at a three-dimensional grid in a room;
- Temperature measurements taken at a three-dimensional grid in a room and at a sequence of times, leading to a four-dimensional data set;
- Red, green and blue components of a two-dimensional image, an $M \times N \times 3$ matrix; and
- Acoustic measurements of sound spectra as a function of frequency, direction of arrival, and time (sonar).

Multidimensional Arrays

- A multidimensional array in MATLAB® is an array with more than two dimensions.
- In a matrix, the two dimensions are represented by rows and columns.

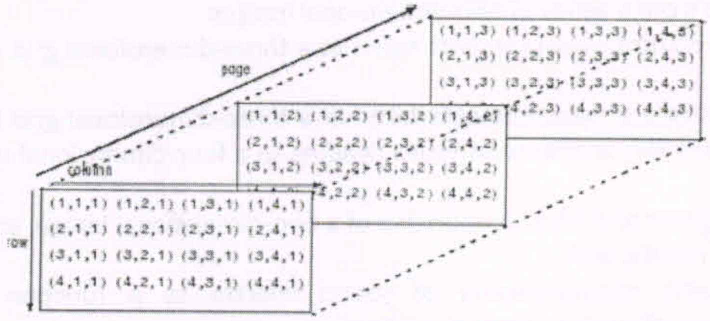
column → ; row ↓

(1,1)	(1,2)	(1,3)	(1,4)
(2,1)	(2,2)	(2,3)	(2,4)
(3,1)	(3,2)	(3,3)	(3,4)
(4,1)	(4,2)	(4,3)	(4,4)

- Each element is defined by two subscripts, the row index and the column index.
- Multidimensional arrays are an extension of 2-D matrices and use additional subscripts for indexing.

Multidimensional Arrays

- A 3-D array, for example, uses three subscripts. The first two are just like a matrix, but the third dimension represents pages or sheets of elements.



Multidimensional Arrays

```
>> a = [1 2 3 ;4 5 6;7 8 9]
a =
   1   2   3
   4   5   6
   7   8   9
>> a(:,:,2) = a*2
a(:,:,1) =
   1   2   3
   4   5   6
   7   8   9
a(:,:,2) =
   2   4   6
   8  10  12
  14  16  18
```

```
>> a(:,:,3) = eye(3)
a(:,:,1) =
   1   2   3
   4   5   6
   7   8   9
a(:,:,2) =
   2   4   6
   8  10  12
  14  16  18
a(:,:,3) =
   1   0   0
   0   1   0
   0   0   1
```

Multidimensional Arrays

Multidimensional arrays must be full *N-rectangles; that is, they must* have the same number of elements in parallel dimensions: all rows must have the same number of columns, all "pages" must have the same number of rows and columns, etc.

If you assign a single value to a matrix, matlab expands the definition as you would expect:

Multidimensional Arrays

```
>> a(:,:,3) = 3
a(:,:,1) =
        1 2 3
        4 5 6
        7 8 9
a(:,:,2) =
        2 4 6
        8 10 12
        14 16 18
a(:,:,3) =
        3 3 3
        3 3 3
        3 3 3
```

Multidimensional Arrays

Indexing for multidimensional arrays works in the same way as two dimensional arrays;

```
>> a(2,:,1)
ans =
4 5 6
>> a(2,:,2)
ans =
8 10 12
>> a(2,:,:)
ans(:,:,1) =
4 5 6
ans(:,:,2) =
8 10 12
ans(:,:,3) =
3 3 3
```

Data can be removed from multidimensional arrays by using the empty matrix:

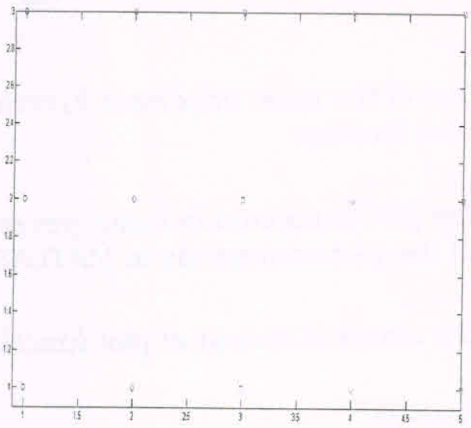
```
>> a(:,:,2) = []
a(:,:,1) =
1 2 3
4 5 6
7 8 9
a(:,:,2) =
3 3 3
3 3 3
3 3 3
```

Multidimensional Arrays

Elements can be columnarly extracted from multidimensional arrays in the same way as they are from two-dimensional arrays:

```
>> a(:)'
ans =
Columns 1 through 12
1 4 7 2 5 8 3 6 9 3 3 3
Columns 13through 18
3 3 3 3 3 3
```

```
>> clf
plot(x,y,'o')
axis([0.9 5 0.9 3])
```



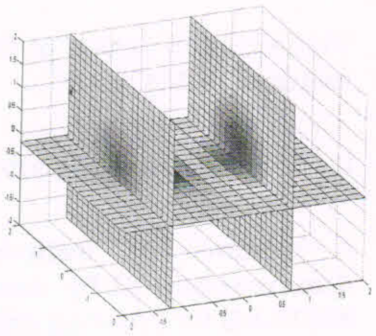
Plotting

- Why should we learn graphics and visualization in Matlab? Why not use Excel?
- Visualization is one of the most important and powerful features of MATLAB.
- It facilitates ease of plotting the data at any time.
- A number **of built-in functions** for **both two-dimensional (2-D) and 3-D plots** are available in **MATLAB** for creating different types of plots.
- **MATLAB has a rich collection of graphics and plotting** commands to suit a wide range of applications.

Plotting

- One of the most important functions in MATLAB is the ***plot*** function.
- The plot command is basic, yet most widely used among all the plot commands in MATLAB.
- The simplest format of plot function for a linear plot is:
- Plot(x,y)

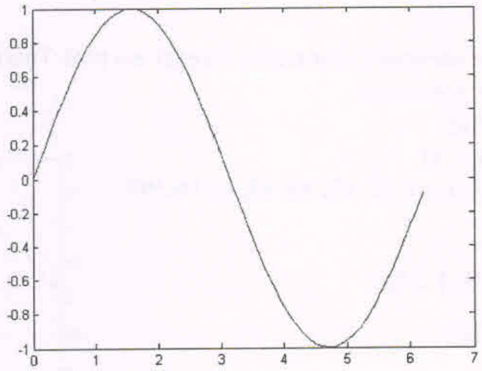
```
>> [x1,x2,x3] = ndgrid(-2:.2:2, -2:.25:2, -2:.16:2);
z = x2 .* exp(-x1.^2 - x2.^2 - x3.^2);
>> slice(x2,x1,x3,z,[-1.2 .8],[], -.2)
view(-24,28)
```



Basic Graphics

Plot command

```
>> x = 0:.1:2*pi;
y = sin(x);
plot(x,y)
```



Basic Graphics

Plotting Functions

FUNCTION	DESRIPTION
axis	freezes the axis limits
bar	plots bar chart
contour	performs contour plots
ginput	puts cross-hair input from mouse
grid	adds grid to a plot
gtext	does mouse positioned text
histogram	gives histogram bar graph
hold	holds plot (for overlaying other plots)
loglog	does log versus log plot
mesh	performs 3-D mesh plot
meshdom	domain for 3-D mesh plot
pause	wait between plots
plot	performs linear x-y plot
polar	performs polar plot
semilogx	does semilog x-y plot (x-axis logarithmic)
semilogy	does semilog x-y plot (y-axis logarithmic)
shg	shows graph screen
stairs	performs stair-step graph
text	positions text at a specified location on graph
title	used to put title on graph
xlabel	labels x-axis
ylabel	labels y-axis

Basic Graphics

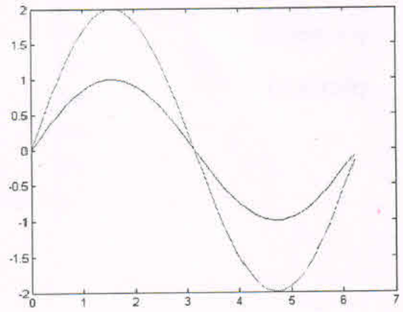
The plot command generates a linear x-y plot. There are three variations of the plot command.

(a) **plot(x)**

(b) **plot(x, y)**

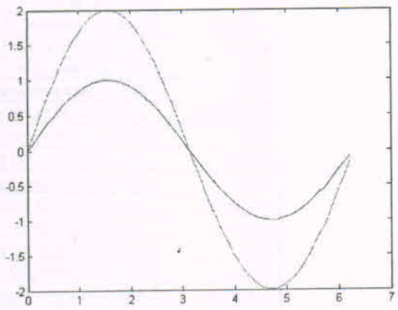
(c) **plot(x1, y1, x2, y2, x3, y3, ..., xn, yn)**

```
>> x = 0:.1:2*pi;
y = sin(x);
plot(x,y)
>> plot(x,y,x,2*y)
```



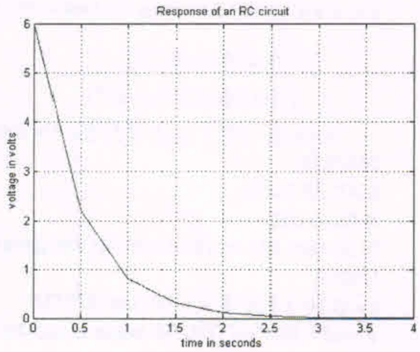
Basic Graphics

```
>> x = 0:.1:2*pi;
y = sin(x);
plot(x,y)
>> plot(x,y,x,2*y)
>> plot(x,y,x,2*y,'--')
```



Basic Graphics

```
>> clear all
>> t = 0:0.5:4;
y = 6*exp(-2*t);
plot(t, y)
title('Response of an RC circuit')
xlabel('time in seconds')
ylabel('voltage in volts')
grid
```



Basic Graphics

LINE-TYPES	INDICATORS	POINT TYPES	INDICATORS
solid	-	point	.
dash	--	plus	+
dotted	:	star	*
dashdot	-.	circle	o
		x-mark	x

COLOR	SYMBOL
red	r
green	g
blue	b
white	w
invisible	i

Basic Graphics

For an R-L circuit, the voltage $v(t)$ and current $i(t)$ are given as

$$v(t) = 10\cos(377t)$$
$$i(t) = 5\cos(377t + 60^0)$$

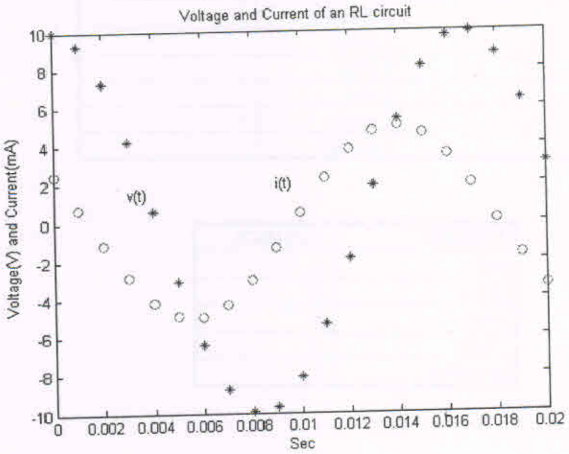
Sketch $v(t)$ and $i(t)$ for $t = 0$ to 20 milliseconds.

Solution

MATLAB Script

```
% RL circuit
% current i(t) and voltage v(t) are generated; t
is time
t = 0:1E-3:20E-3; v = 10*cos(377*t);
a_rad = (60*pi/180); % angle in radians
i = 5*cos(377*t + a_rad);
plot(t,v,'*',t,i,'o')
title('Voltage and Current of an RL circuit')
xlabel('Sec')
ylabel('Voltage(V) and Current(mA)')
text(0.003, 1.5, 'v(t)');
text(0.009,2, 'i(t)')
```

Basic Graphics



LOGARITHMIC AND POLAR PLOTS

loglog(x, y) - generates a plot of log10(x) versus log10(y)

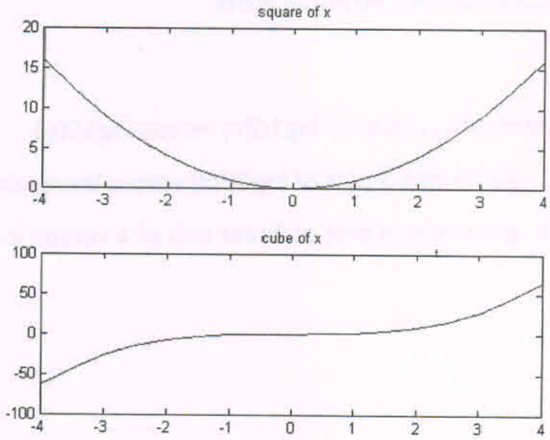
semilogx(x, y) - generates a plot of log10(x) versus linear axis of y

semilogy(x, y) - generates a plot of linear axis of x versus log10(y)

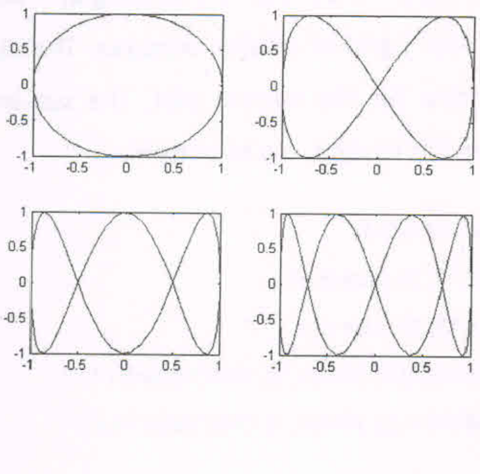
subplot(i j k)

The digits i and j specify that the graph window is to be split into an i-by- j grid of smaller windows. The digit k specifies the k th window for the current plot. The sub-windows are numbered from left to right, top to bottom.

```
>> x = -4:0.5:4;
y = x.^2; % square of x
z = x.^3; % cube of x
subplot(211), plot(x, y), title('square of x')
subplot(212), plot(x, z), title('cube of x')
```




```
t = 0:.1:2*pi;
subplot(2,2,1)
plot(cos(t),sin(t))
subplot(2,2,2)
plot(cos(t),sin(2*t))
subplot(2,2,3)
plot(cos(t),sin(3*t))
subplot(2,2,4)
plot(cos(t),sin(4*t))
```



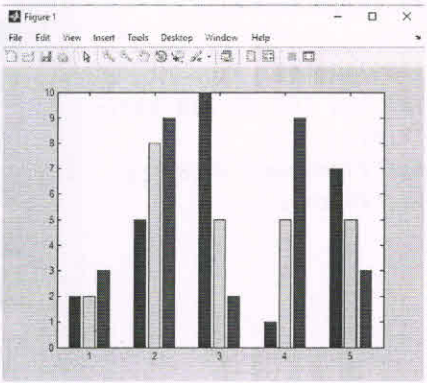
2-D plots: Bar Chart

- bar(X,Y) draws the columns of the M-by-N matrix Y as M groups of N vertical bars.
- bar(Y) uses the default value of X=1:M
- For vector inputs, bar(X,Y) or bar(Y) draws LENGTH(Y) bars. The colors are set by the colormap.
- bar(X, Y, WIDTH) or bar(Y, WIDTH) specifies the width of the bars.
- Values of WIDTH > 1, produce overlapped bars. The default value is WIDTH=0.8

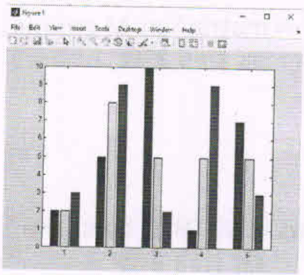
2-D plots: Bar Chart

- Display one bar for each row of the matrix. The height of each bar is the sum of the elements in the row.

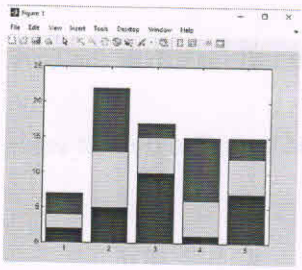
```
>> y=[2 2 3;5 8 9; 10 5 2;1 5 9;7 5 3]
y =
   2   2   3
   5   8   9
  10   5   2
   1   5   9
   7   5   3
>> bar(y)
>> bar(y,'grouped')
```

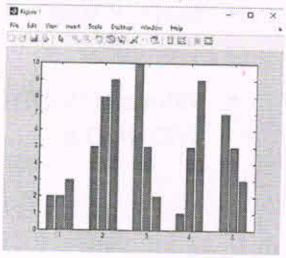


2-D plots: Bar Chart



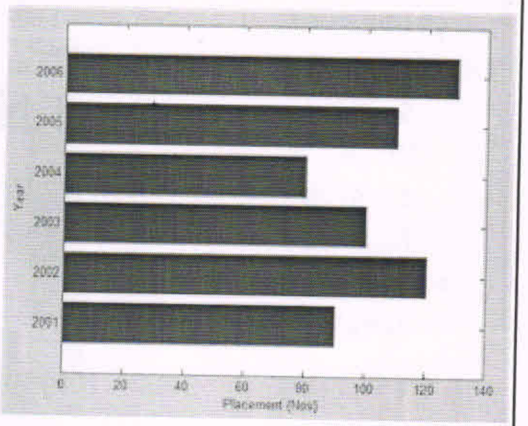
```
>> y
y =
    2   2   3
    5   8   9
   10   5   2
    1   5   9
    7   5   3
>> bar(y,'grouped')
>> bar(y,'stacked')
>> bar(y,'r')
```





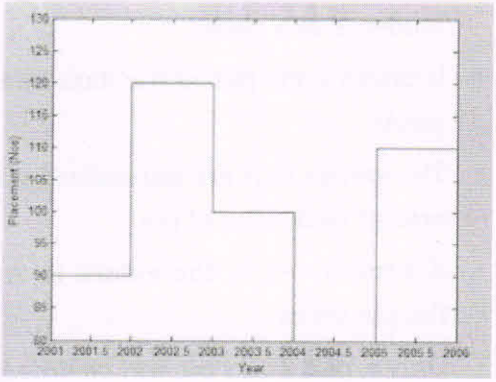
2-D plots: Bar Chart

```
% Horizontal Bar Plot

Y = [2001:2006];
P = [90 120 100 80 110 130];
barh(Y,P);
xlabel('Placement (Nos)');
ylabel('Year');
```



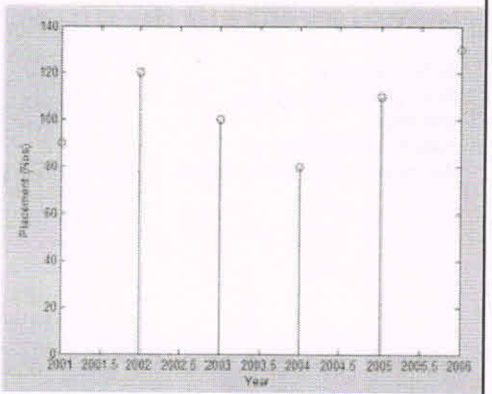
2-D plots

```
% % Stairs Plot

Y = [2001:2006];
P = [90 120 100 80 110 130];
stairs(Y,P);
xlabel('Year');
ylabel('Placement (Nos)');
```



2-D plots

```
% % Stem Plot

Y = [2001:2006];
P = [90 120 100 80 110 130];
stem(Y,P);
xlabel('Year');
ylabel('Placement (Nos)');
```

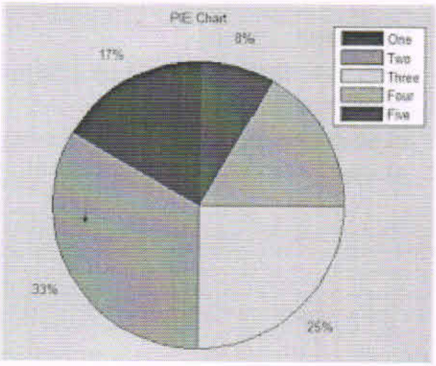


2-D plots: Pie Chart

- A pie chart is used for visualizing different but related quantities relatively, for example, grades assigned to the students of a class.
- It draws a pie plot of the data in a given vector A using syntax pie(A).
- The values in A are normalized via A/sum(A) to determine the area of each slice of pie.
- If sum(A) <=1.0, the values in A directly specify the area of the pie slices.
- Only a particular pie will be drawn if sum(A)<1.
- Example: A=[1 2 3 4], then pie(A) will evaluate the elements A(1) as 1/10 or 10%, A(2) as 2/10 .. etc.

2-D plots: Pie Chart

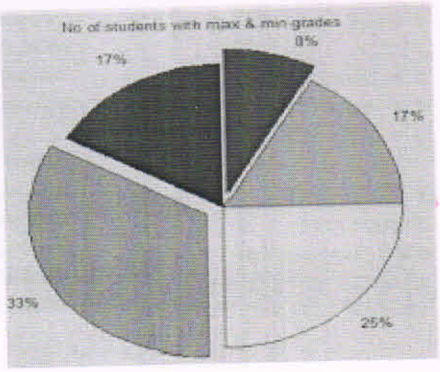
```
% % PIE Plot
A = [10 20 15 10 5];
pie(A);
title('PIE Chart');
legend('One','Two','Three','Four','Five');
```



2-D plots: Pie Chart

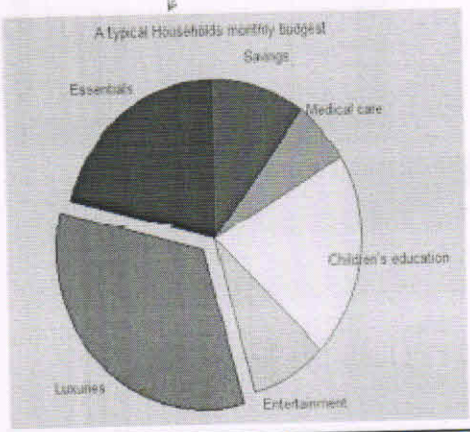
```
% % PIE Plot with explode
A = [10 20 15 10 5];
explode = [0 1 0 0 1];
pie(A,explode);
title('No of students with max & min grades');
```

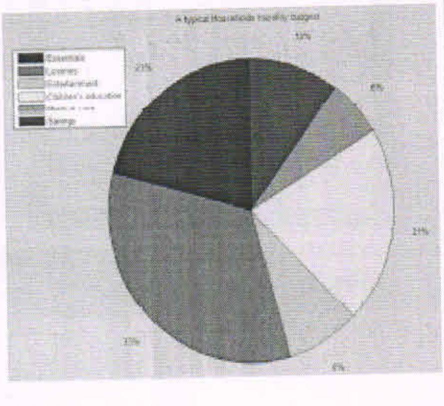
❖ The pie(A, explode) command is Used to specify slices that should be Pulled out from the pie.



2-D plots: Pie Chart

```
x=[5000 8000 2000 5000 1500 2500];
labels={'Essentials', 'Luxuries', 'Entertainment', 'Children's education', 'Medical care', 'Savings'}
explode=[0 1 0 0 0 0 ]
% vector explode is set to 1, for the slice that you want to highlight
pie(x, explode, labels)
title(' A typical Households monthly budgest')
```





```
pie(x)
legend('Essentials', 'Luxuries', 'Entertainment', 'Children's education', 'Medical care', 'Savings', 2)
```

3-D plots

- Plot the decaying oscillations of a mechanical system which can be represented as a function of independent variable time $t = 0 \le t \le 10$ using both 2-D and 3-D plots $x(t) = \sqrt{t}\cos 2t$; $y(t) = \sqrt{t}\sin 2t$

```
% plot command
% File name Example_4_9.m

t = 0:0.1 : 10;
x = sqrt(t).* cos(2*t);
y = sqrt(t).* sin(2*t);

% 2-D Plots
figure(1);
plot(x,y);grid;
xlabel('x');ylabel('y');
title('\bf 2-D Plot');

figure(2);
plot(t,x,t,y);grid;
xlabel('t');ylabel('x,y');
title('\bf 2-D Plot');

% 3-D Plot of decaying oscillations of a
% mechanical system using plot3 command
figure(3);
plot3(x,y,t);grid;
xlabel('x');ylabel('y');zlabel('time');
title('\bf 3-D Plot');
```

3-D plots

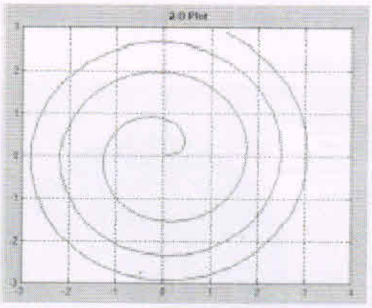


Fig. 1

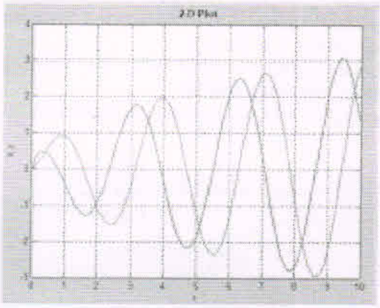


Fig. 2

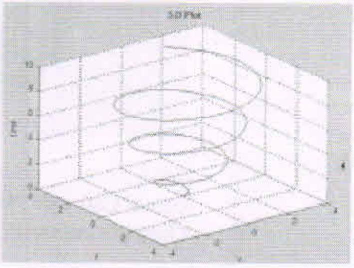
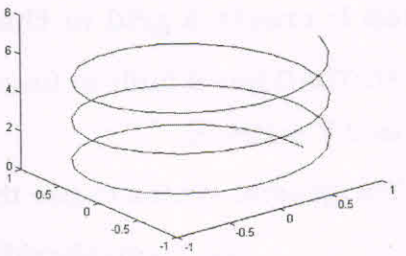


Fig. 3

Three-Dimensional Plots

The plot3 command is the 3-c

```
t = 0:.1:2*pi;
plot3(cos(3*t),sin(3*t),t)
```



rotate3d

If you click the mouse button down on the plot and drag, you can move the axes and view the plot from any angle. Release the mouse button to redraw the data. Type rotate3d again to turn off this behaviour.

3-D plots: Mesh and surface plot

- Mesh and surface plots are 3-D plots, generally used to plot the functions with two independent variables.
- For example z=f(x, y).
- Mesh and surface plots are created in three steps:
- Step I: create a grid in the x-y plane converting the domain of the function.
- Step II: Calculate the value of z at every point of the grid.
- Step III: Create the plot

3-D plots: Mesh and surface plot

Step I: create a grid in the x-y plane

- MATLAB has a built-in function **meshgrid** *to create X and Y* matrices.
- The general syntax to use this function is

  [X, Y]=meshgrid(x, y)

- **[X, Y]=meshgrid (xstart: xinc: xend, ystart: yinc: yend)**

3-D plots: Mesh and surface plot

- Step I: create a grid in the x-y plane

```
>> x=-1:2;
>> y=-1:3;
>> [X,Y]=meshgrid(x,y)

X =

    -1     0     1     2
    -1     0     1     2
    -1     0     1     2
    -1     0     1     2
    -1     0     1     2


Y =

    -1    -1    -1    -1
     0     0     0     0
     1     1     1     1
     2     2     2     2
     3     3     3     3
```

3-D plots: Mesh and surface plot

Step II: Calculate the value of Z

- The mesh grid so obtained can be further used to calculate the dependent variable Z.
- For Example, if Z is given by $Z = \frac{X^2 Y}{X^2+Y^2} + X$ then the value of Z at each point of the grid can be calculated as below

```
>> Z=((X.^2.*Y)./(X.^2+Y.^2))+X

Z =

   -1.5000         0    0.5000    1.2000
   -1.0000       NaN    1.0000    2.0000
   -0.5000         0    1.5000    2.8000
   -0.6000         0    1.4000    3.0000
   -0.7000         0    1.3000    2.9231
```

3-D plots: Mesh and surface plot

- **Step III: Creating Mesh and Surface Plot**
- Once the three matrices are available, they can be used to plot mesh and surface plots as follows:
- mesh (X, Y, Z)
- surf(X, Y, Z)

3-D plots: Mesh and surface plot

❖ Example: Plot the function $Z = \frac{X^2Y}{X^2+Y^2} + X$, over the domain $-1 \le x \le 2$ and $-1 \le y \le 3$ using mesh and surface plot.

```
% Plotting a Function using Mesh and Surface Plot
% File nome Example_4_10.m

%clear; clc; close all;
x=-1:2;
y=-1:3;
[X,Y] = meshgrid(x,y);
Z = ((X.^2.*Y)./(X.^2+Y.^2))+ X;

figure(1);
mesh(X,Y,Z);
xlabel('x'); ylabel('y'); zlabel('z');

figure(2);
surf(X,Y,Z);
xlabel('x'); ylabel('y'); zlabel('z');
```

3-D plots: Mesh and surface plot

Mesh Plot

❖peaks : A sample function of two variables

```
Z = peaks;
Z = peaks(N);
Z = peaks(V);
Z = peaks(X,Y);

peaks;
peaks(N);
peaks(V);
peaks(X,Y);

[X,Y,Z] = peaks;
[X,Y,Z] = peaks(N);
[X,Y,Z] = peaks(V);
```

```
The first variant produces a 49-by-49 matrix.
The second variant produces an N-by-N matrix.
The third variant produces an N-by-N matrix where N = length(V).
The fourth variant evaluates the function at the given X and Y,
which must be the same size.  The resulting Z is also that size.
```

3-D plots: Mesh and surface plot

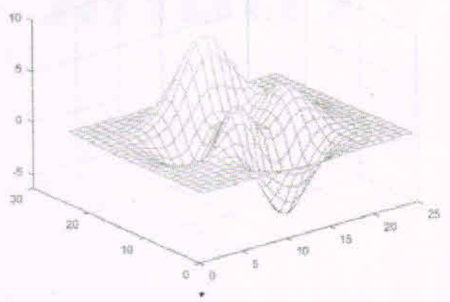
Mesh Plot

- The mesh function creates a wireframe mesh.
- By default, the color of the mesh is proportional to the surface height.
- peaks : A sample function of two variables

```
>>z = peaks(25);          % Now z=25x25 matrix data will generate
>>figure
>>mesh(z)
```

3-D plots: Mesh and surface plot

Mesh Plot



3-D plots: Mesh and surface plot

Surface Plot

The surf function is used to create a 3-D surface plot.

```
>>surf(z)
>>colormap(jet)    % change color map
```

Thank You

Unit-2

MATRICES

Contents:

- ❖ Creating and Manipulating matrices
- ❖ Matrix mathematics
- ❖ Matrix functions
- ❖ Colon operator
- ❖ Line space, Cross product
- ❖ Dot product
- ❖ Logical functions
- ❖ Logical indexing
- ❖ 3 – dimensional arrays
- ❖ Cell arrays, Structures
- ❖ Plotting: 2-D and 3-D plots
- ❖ Basic plots, subplots, Histograms, Bar graphs, Pie charts

Introduction to Matrices in MATLAB

➢A basic introduction to defining and manipulating matrices is given here.

➢Defining a matrix is similar to defining a vector

➢To define a matrix, you can treat it like a column of row vectors (note that the spaces are required)

Initialising Matrices Within MATLAB

The simplest
method involves simply typing the elements:

```
>> A = [2 3 4; 5 4 3]
A =
2 3 4
5 4 3
```

❑Here the elements in the first row are separated by a space and the end of the first row is denoted by a semicolon.

❑The second row is then typed, again with a space between successive elements.

❑The whole matrix is contained within square brackets.

The variable A is now initialised to be a two-by-three matrix;

we can see this by using the command size(A).

```
>> size(A)
ans =
2 3
```

To enter a column vector we could use any of:

```
>> column_vector = [4
5
6];
>> column_vector = [4;5;6];
>> column_vector = [4 5 6]';
```

MATRIX Functions

Function	Description	Example
size(A)	Returns a row vector [m,n], where m and n are the size $m \times n$ of the array A.	>> A = [6 1 4 0 12; 5 19 6 8 2] A = 6 1 4 0 12 5 19 6 8 2 >> size(A) ans = 2 5
reshape(A, m,n)	Rearrange a matrix A that has r rows and s columns to have m rows and n columns. r times s must be equal to m times n.	>> A = [5 1 6; 8 0 2] A = 5 1 6 8 0 2 >> B = reshape(A,3,2) B = 5 0 8 6 1 2
diag(v)	When v is a vector, creates a square matrix with the elements of v in the diagonal.	>> v = [7 4 2]; >> A = diag(v) A = 7 0 0 0 4 0 0 0 2

MATRIX Functions

diag(A)	When A is a matrix, creates a vector from the diagonal elements of A.	>> A = [1 2 3; 4 5 6; 7 8 9] A = 1 2 3 4 5 6 7 8 9 >> vec = diag(A) vec = 1 5 9

Sample Problem : Create a matrix

Create a 6×6 matrix in which the middle two rows, and the middle two columns are 1's, and the rest are 0's.

Built in array functions

Function	Description	Example
mean(A)	If A is a vector, returns the mean value of the elements of the vector.	>> A = [5 9 2 4]; >> mean(A) ans = 5
C=max(A)	If A is a vector, C is the largest element in A. If A is a matrix, C is a row vector containing the largest element of each column of A.	>> A = [5 9 2 4 11 6 7 11 0 1]; >> C = max(A) C = 11
[d,n]=max(A)	If A is a vector, d is the largest element in A, n is the position of the element (the first if several have the max value).	>> [d,n] = max(A) d = 11 n = 5

Built in array functions

min(A) [d,n]=min(A)	The same as max(A), but for the smallest element. The same as [d,n]= max(A), but for the smallest element.	>> A=[5 9 2 4]; >> min(A) ans = 2
sum(A)	If A is a vector, returns the sum of the elements of the vector.	>> A=[5 9 2 4]; >> sum(A) ans = 20
sort(A)	If A is a vector, arranges the elements of the vector in ascending order.	>> A=[5 9 2 4]; >> sort(A) ans = 2 4 5 9
median(A)	If A is a vector, returns the median value of the elements of the vector.	>> A=[5 9 2 4]; >> median(A) ans = 4.5000

We now turn our attention to how we access elements (or parts of a matrix).

Let us start with the matrix

>> A = [11 12 13 14; 21 22 23 24; 31 32 33 34];

so that

$$A = \begin{pmatrix} 11 & 12 & 13 & 14 \\ 21 & 22 & 23 & 24 \\ 31 & 32 & 33 & 34 \end{pmatrix}$$

It is also possible to refer to a whole row (or column) of a matrix.

For example

>> A(2,:)

ans =

21 22 23 24

Alternatively to refer to a particular column we could use to return the fourth column of matrix A.

```
>> A(:,4)
ans =
14
24
34
```

Note that in both cases the answers are the same "shape" as they would appear in the matrix, that is the second row has been returned as a row vector and the fourth column has been returned as a column vector.

With the colon operator we can create row vectors which can then be used as arguments in other commands. For instance

```
>> r = 1:3;
>> A(r,1)
ans =
11
21
31
```

$$A = \begin{pmatrix} 11 & 12 & 13 & 14 \\ 21 & 22 & 23 & 24 \\ 31 & 32 & 33 & 34 \end{pmatrix}$$

This yields the same result as A(1:3,1) or A(:,1).

We could also use r = 1:2 to get the first two elements of the first column.

The possibilities are extensive; for example if we want to obtain the top left hand two-by-two corner of A, we could employ the following:

```
>> r = 1:2;
>> B = A(r,r)
B =
11 12
21 22
```

$$A = \begin{pmatrix} 11 & 12 & 13 & 14 \\ 21 & 22 & 23 & 24 \\ 31 & 32 & 33 & 34 \end{pmatrix}$$

Enter the matrix in MATLAB

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 0 & 0 & 0 \\ 3 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 \end{pmatrix}$$

In order to achieve this we use the commands

In order to achieve this we use the commands

```
>> A = zeros(4);
>> r = 1:4;
>> A(:,1) = r'; % First column
>> A(1,:) = r % First row
A =
1 2 3 4
2 0 0 0
3 0 0 0
4 0 0 0
```

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 0 & 0 & 0 \\ 3 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 \end{pmatrix}$$

Note: This is fine for small matrices but not practical for when we need to set up larger matrices.

Another variant which can be used to set up the matrix is

>> A = [1 2 3 4; 2 zeros(1,3); 3 zeros(1,3); 4 zeros(1,3)];

Here the command zeros(1,3) sets up a row vector (one-by-three) full of zeros.

This example serves to emphasise there is no unique way to go about setting up a particular matrix;

some ways are more elegant (and sometimes less readable) than others.

Matrix Operations

Consider the addition (**C = A + B**) and subtraction (**D = A − B**) of the matrices

$$A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} \ and\ B = \begin{pmatrix} 4 & 3 \\ 2 & 1 \end{pmatrix}.$$

We shall start by working through these by hand and then proceed to give the MATLAB code.

Addition

$$C = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} + \begin{pmatrix} 4 & 3 \\ 2 & 1 \end{pmatrix},$$
$$= \begin{pmatrix} 1+4 & 2+3 \\ 3+2 & 4+1 \end{pmatrix} = \begin{pmatrix} 5 & 5 \\ 5 & 5 \end{pmatrix};$$

Subtraction

$$D = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} - \begin{pmatrix} 4 & 3 \\ 2 & 1 \end{pmatrix},$$
$$= \begin{pmatrix} 1-4 & 2-3 \\ 3-2 & 4-1 \end{pmatrix} = \begin{pmatrix} -3 & -1 \\ 1 & 3 \end{pmatrix}.$$

The MATLAB code to achieve these operations is

```
>>A = [1 2; 3 4]; B = [4 3; 2 1];
>>C = A+B
     C =
     5 5
     5 5
>>D = A-B
     D =
     -3 -1
     1 3
```

Consider the expression $\mathbf{A} - 3\mathbf{B}^T$

$$\mathbf{A} = \begin{pmatrix} 3 & 8 & -1 \\ 5 & 2 & 0 \end{pmatrix} \; and \; \mathbf{B} = \begin{pmatrix} -3 & 2 \\ 2 & 2 \\ -1 & 3 \end{pmatrix}$$

The MATLAB code is:

```
A = [3 8 -1; 5 2 0];
B = [-3 2; 2 2; -1 3];
C = A-3*transpose(B);
```

```
>>A = ones(3); B = ones(2);
>>C = A+B
??? Error using ==> +
Matrix dimensions must agree.
```

```
>>A = ones(1); B = ones(2);
>>C = A+B
C =
2 2
2 2
```

In this case although the variable A is a one-by-one matrix it is treated as a scalar.

In this case the command is interpreted by MATLAB as

$$c_{i,j} = \lambda + b_{i,j}, \qquad i = 1, \cdots, m \text{ and } j = 1, \cdots, n;$$

```
>> A = [pi/4  pi/2 ;  pi  pi/3]
        A =
        0.7854  1.5708
        3.1416  1.0472
        >> B = sin(A)
        B =
        0.7071  1.0000
        0.0000  0.8660
```

Here we have set up the matrix3

$$A = \begin{pmatrix} \frac{\pi}{4} & \frac{\pi}{2} \\ \pi & \frac{\pi}{3} \end{pmatrix}$$

and it returns the matrix **B as**

$$B = \begin{pmatrix} \sin\frac{\pi}{4} & \sin\frac{\pi}{2} \\ \sin\pi & \sin\frac{\pi}{3} \end{pmatrix} = \begin{pmatrix} \frac{1}{\sqrt{2}} & 1 \\ 0 & \frac{\sqrt{3}}{2} \end{pmatrix}$$

```
>> A = [1 2 3];
>> B = [4; 5; 6];
>> A*B
ans =
     32
>> B*A
ans =
     4 8 12
     5 10 15
     6 12 18
```

Dot arithmetic can be readily extended to work with matrices. With matrices A and B the matrix C = A.*B is given by

$$c_{i,j} = a_{i,j} b_{i,j}, \qquad i = 1, \cdots, m \text{ and } j = 1, \cdots, n$$

and similarly those of D = A./B by

$$d_{i,j} = \frac{a_{i,j}}{b_{i,j}}, \qquad i = 1, \cdots, m \text{ and } j = 1, \cdots, n.$$

In addition to multiplication .* and division ./ we can also use dot arithmetic for exponentiation using .^as in

```
>> A = [1 2; 3 4];
>> B = [1 2; 3 4];
>> A.^B
   ans =
   1    4
   27   256
```

By using dot arithmetic in MATLAB we must ensure the matrices are of the same size for the operation to be defined. We note either of the arguments can be scalars:

```
>> A = [1 2; 3 4];
>> B = A.^2;       % square all entries
>> C = 2.^A;       % [2 4; 8 16]
```

```
>>A = eye(2); B = [1 2; 3 4];
>>C = A*B
C =
1 2
3 4
>> C = A.*B
C =
1 0
0 4
>> C = A/B
C =
-2.0000 1.0000
1.5000 -0.5000
>> C = A./B
C =
1.0000 0
0 0.2500
```

Given the matrices $\mathbf{A} = \mathbf{I}$ *and* $\mathbf{B} = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$

*compare the results of the MATLAB calculations A*B, A.*B, A/B and A./B.*
For the multiplications we have the code:

The zeros, ones and eye commands

•The eye(n) command creates a square matrix with n rows and n columns in which the diagonal elements are equal to 1, and rest of the elements are 0.

•This matrix is called the identity matrix.

```
>> x=eye(3)
x=
1 0 0
0 1 0
0 0 1
```

The zeros, ones and eye commands

- The zeros(m,n), the ones(m,n) and eye(n) commands can be used to create matrices that have elements with special values.

- The zeros(m,n) and ones(m,n) commands create a matrix with m rows and n columns, in which all the elements are the numbers 0 and 1 respectively.

For a matrix

- A(:,n) refers to the elements in all the rows of column n of the matrix A
- A(n,:) refers to the elements in all columns of row n of the matrix A
- A(:,m:n) refers to the elements in all the rows between columns m and n of the matrix A
- A(m:n,:) refers to the elements in all the columns between rows m and n of the matrix A
- A(m:n, p:q) refers to the elements in rows m through n and columns p through q of the matrix A

Using indexing to edit 2D arrays

•What happens when sizes of matrices don't match?

y = zeros(3,3);

x = ones(3,3);

y(1, 2 : 3) = x(1 : 2, 2 : 3)

```
y =              x =

0   0   0        1   1   1
0   0   0        1   1   1
0   0   0        1   1   1

??? Subscripted assignment dimension mismatch.
```

Sub-array searching

▪Find the **indexes of values in x that are larger than 3**

x = [2 8 7 0 6 2 3];

>> **find(x > 3)**

2 3 5

▪Find the **actual values in x that are larger than 3**

>> x = [2 8 7 0 6 2 3];

>> x(**find(x > 3)**)

8 7 6

We can also get the same result by breaking this into 2 steps:

>> inds = find(x > 3);

>> x(inds)

8 7 6

Finding the **size of a matrix**

x =[2 4 6

3 6 9];

size(x)

2 3

Rows columns

• Finding the length of a matrix: LENGTH(X) returns the length of vector X. It is equivalent to MAX(SIZE(X))

length(x)

>>ans=

3

Finding the **maximal numbers in each matrix column**

>> x = [1 8 3; 7 2 6; 4 5 9]

>> max(x)

ans=

7 8 9

x =

1 8 3

7 2 6

4 5 9

How do we get the maximal element in the entire matrix?

>> max(max(x))

Ans=9

Operators (arithmetic)

+ addition
- subtraction
* multiplication
/ division
^ power
' complex conjugate
transpose

.* element-by-element mult
./ element-by-element div
.^ element-by-element power
.' transpose

Operators (relational, logical)

== equal
~= not equal
< less than
<= less than or equal
> greater than
>= greater than or equal
& AND
| OR
~ NOT

pi 3.14159265...
j imaginary unit,
i same as j

Question: write a command that subtracts 1 from all the values in y that are larger than 4 and stores it back into y.
y = [1 3 5; 2 5 8];

```
>> y = [1 3 5; 2 5 8]
y =
    1   3   5
    2   5   8

>> y(find(y > 4))
ans =
    5
    5
    8
```

```
>> y(find(y > 4))-1
ans =
    4
    4
    7

>> y([4 5 6])= [4 4 7]

y =

    1   3   4
    2   4   7
```

Matrix Built in functions:

A=[1 4 6; 2 5 7;3 0 6]

inv(a)

det(A)

sort(A,'descend')

sort(A,'ascend')

rank(A)

max(A): returns the row vector containing the largest element of each column of A

Eigenvalue: returns the eigenvectors and eigenvalues given on the main diagonal of matrix A

[v,x]=eig(A)

Command	Description	Example
rand	Generates a random number between 0 and 1	>> rand ans = 0.1270
rand (1,n)	Generates a row vector with n random numbers between 0 and 1	>> rand(1,5) ans = 0.9134 0.6324 0.0975 0.2785 0.5469
rand (n)	Generates an $n \times n$ matrix with random numbers between 0 and 1	>> rand(3) ans = 0.9575 0.9706 0.8003 0.9649 0.9572 0.1419 0.1576 0.4854 0.4218
rand (n, m)	Generates an $n \times m$ matrix with random numbers between 0 and 1	>> rand(2,3) ans = 0.9157 0.9595 0.0357 0.7922 0.6557 0.8491

```
>> x = ones(4,1)
x =
   1
   1
   1
   1
>> diag(x,0)
ans =
   1  0  0  0
   0  1  0  0
   0  0  1  0
   0  0  0  1
>> diag(x,1)
ans =
   0  1  0  0  0
   0  0  1  0  0
   0  0  0  1  0
   0  0  0  0  1
   0  0  0  0  0
```

```
>> diag(x(1:3),1)
ans =
   0  1  0  0
   0  0  1  0
   0  0  0  1
   0  0  0  0

>> diag(x(1:3),-1)

ans =

   0  0  0  0
   1  0  0  0
   0  1  0  0
   0  0  1  0
```

We can use this command to produce combinations such as
diag(x,0)+diag(x(1:3)*2,1)+diag(x(1:3)*(-2),-1)

```
>> diag(x,0)+diag(x(1:3)*2,1)+diag(x(1:3)*(-2),-1)

ans =

 1   2   0   0
-2   1   2   0
 0  -2   1   2
 0   0  -2   1
```

Solving Equations with MATLAB:

- In this we discuss how to solve algebraic equations using MATLAB
- We will discuss both linear and non-linear algebraic equations .
- First let us solve the following for the variable x:simple linear equation

2x-3=0;

p(x)=2x-3=0

```
>>p=[2 -3]
>> roots(p)
>>ans=1.5000
```

$$5x^5 - 3x^4 - 5x^3 + x^2 - 1 = 0$$

```
>> p=[5 -3 -5 1 0 -1]
p =
   5   -3   -5   1   0   -1
>> roots(p)
ans =
  1.3129 + 0.0000i
  0.3192 + 0.4612i
  0.3192 - 0.4612i
 -0.6757 + 0.1663i
 -0.6757 - 0.1663i
```

- Consider the following simple system of two linear algebraic equations in the variables x and y:

$$x - 3y = 5$$
$$4x + 6y = 3$$

The resulting equivalent matrix equation is written as follows:

$$\begin{bmatrix} 1 & -3 \\ 4 & 6 \end{bmatrix} \begin{Bmatrix} x \\ y \end{Bmatrix} = \begin{Bmatrix} 5 \\ 3 \end{Bmatrix}$$

$$[A]\{x\} = \{b\}$$

$$\{x\} = [A]^{-1}\{b\}$$

```
>> a=[1 -3;4 6]

a =
    1   -3
    4    6

>> b=[5;3]

b =
    5
    3

>> x=inv(a)*b

x =
   2.1667
  -0.9444
```

Solving equations with MATLAB:

- In this case, it was quick to find this inverse because the coefficient matrix was small.
- But for larger matrices, finding the inverse using MATLAB may take more time.
- Therefore, it is advised to use another method to solve the above system.
- One such method that is rather fast in execution is called Gaussian elimination.
- This method is already implemented in MAT- LAB as matrix division using the backslash operator "\".

Here is the solution of the above system again using Gaussian

elimination and the backslash operator:

```
>>A = [1 -3 ; 4 6]
>>b=[5; 3]
>>x = A\b
x = 2.1667
-0.9444
```

It is clear that we obtain exactly the same solution as before but with more speed on the part of MATLAB.

Solving equations with MATLAB

- let us solve the following sys- tem of five algebraic linear simultaneous equations

$$2x_1 - 4x_2 - x_3 + 3x_4 - x_5 = 3$$
$$x_1 + x_2 - 2x_3 + x_5 = 6$$
$$-x_1 - 3x_2 + x_4 + 3x_5 = -4$$
$$3x_1 - x_2 - x_3 + 4x_4 - x_5 = 1$$
$$x_1 + x_2 - x_3 + 2x_4 = 5$$

Solving equations with MATLAB

```
>>A=[2 -4 -1 3 -1; 1 1 -2 0 1; -1 -3 0 1 3; 3 -1 -1 4 -1; 1 1 -1 2 0]
>>b=[3; 6; -4; 1; 5]
>>x=A\b
x =
-4.3571
0.3571
-6.4286
1.2857
-2.8571
```

$$2x_1 - 4x_2 - x_3 + 3x_4 - x_5 = 3$$
$$x_1 + x_2 - 2x_3 + x_5 = 6$$
$$-x_1 - 3x_2 + x_4 + 3x_5 = -4$$
$$3x_1 - x_2 - x_3 + 4x_4 - x_5 = 1$$
$$x_1 + x_2 - x_3 + 2x_4 = 5$$

Example:

For x in the range `x=[0:0.1:1]`, calculate $f(x) = xe^{-2x}$. Report the value of x at which $f(x)$ is maximum.

1. DEMO PROBLEM

Code of `demoProblem.m` (Method-1: using loops):

```
% Program to obtain the maximum value and the corresponding index
x = 0:0.1:1;
y = 1:length(x);
f(y) = x.*exp(-2*x);
index = 1;
while (f(index)<max(f))
    index = index + 1;
end
display(['result = ' num2str(x(index)) ]);
```

<u>Final Result:</u> 0.5

For x in the range `x=[0:0.1:1]`, calculate $f(x) = xe^{-2x}$. Report the value of x at which $f(x)$ is maximum.

Code of demoProblem.m (Method-2: without using loops):

```
% Program to obtain the maximum value and the corresponding index

x = 0:0.1:1;
f = x.*exp(-2*x);
[maxVal,index] = max(f);
display(['result = ' num2str(x(index)) ]);
```

Final Result: 0.5

SALARY PROBLEM

Two friends A and B start with initial salaries of 1 unit and 1.25 unit, respectively. At the end of each year, they get a raise of 6% and 2% respectively. Write a MATLAB code that uses either a `for` or `while` loop to calculate annual salaries of the two until the year when A's salary exceeds that of B's. Report the value of the earliest year n when A's salary exceeds B's.

When the program ends, A and B should be a n-dimensional vectors, containing their salaries in the respective years.

3. SALARY PROBLEM

Code of `salary.m` (Method 1: Using while loop)

```
% Program using while loop
salA(1) = 1;
salB(1) = 1.25;
n = 1;
while(salA<salB)
    salA(n+1) = (1.06) * salA(n);
    salB(n+1) = (1.02) * salB(n);
    n = n + 1;
end
```

Final Result: Number of years = 7 (6 years later, i.e., in the 7^{th} year)

Code of `salary.m` (Method 2: Using for loop)

```
% Program using for loop
salA(1) = 1;
salB(1) = 1.25;
maxYears = 20;
for n=2:maxYears
    salA(n) = (1.06) * salA(n-1);
    salB(n) = (1.02) * salB(n-1);
    if (salA(n+1)>salB(n+1))
        break
    end
end
```

Final Result: Number of years = 7 (6 years later, i.e., in the 7^{th} year)

1. A NON-CONVERGENT INFINITE SERIES

All the examples in the course videos have been about convergent series. In this example, you will code a series that does not converge:

$$S = 1 + \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} + \cdots + \frac{1}{\sqrt{n}}$$

Write a MATLAB code that takes in the value n and computes the above series sum S. Please report the value S for various cases, n = 500, 1000, 5000 and 10000.

1. A NON-CONVERGENT INFINITE SERIES

```
n=500;
vec=1./sqrt(1:n);
S=sum(vec);
disp(S)
```

The above code may be repeated for each value of n. The results for the four values are:

	n	S
1	500	43.28
2	1000	61.80
3	5000	139.97
4	10000	198.54

Dot product

dot Vector dot product.

C = dot(A,B) returns the scalar product of the vectors A and B.

▪A and B must be vectors of the same length. When A and B are both column vectors, dot(A,B) is the same as A'*B.

▪dot(A,B), for N-D arrays A and B, returns the scalar product along the first non-singleton dimension of A and B. A and B must have the same size.

▪dot(A,B,DIM) returns the scalar product of A and B in the dimension DIM.

Cross product

cross Vector cross product. C = cross(A,B)

▪ returns the cross product of the vectors A and B. That is, C = A x B. A and B must be 3 element vectors.

C = cross(A,B)

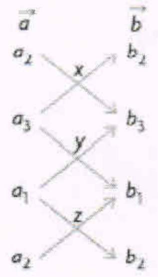
▪returns the cross product of A and B along the first dimension of length 3.

C = cross(A,B,DIM),

where A and B are N-D arrays, returns the cross product of vectors in the dimension DIM of A and B.

A and B must have the same size, and both SIZE(A,DIM) and SIZE(B,DIM) must be 3.

Calculating the Cross Product



$x = a_2b_3 - a_3b_2$

$y = a_3b_1 - a_1b_3$

$z = a_1b_2 - a_2b_1$

$\vec{a} \times \vec{b} = (a_2b_3 - a_3b_2, a_3b_1 - a_1b_3, a_1b_2 - a_2b_1)$

- For vector a = (1, 2, 1) and b = (4, 1, 2), calculate:

a) a x b

Cell Arrays

- Cell arrays are arrays of indexed cells where each cell can store an array of a different dimensions and data types.
- The **cell function is used for creating a cell array. Syntax for the cell** function is

C = cell(dim); C = cell(dim1,...,dimN); D = cell(obj)

Where, C is the cell array,

- **dim is a scalar integer or vector of integers that specifies the** dimensions of cell array C;
- **dim1, ... , dimN** are **scalar integers** that specify the dimensions of C;
- ***obj*** *is One of the following: (1) Java array or object, (2) .NET array of type* System.String or System.Object

Cell Arrays

Example:

- c = cell(2, 5)
- c = {'Red', 'Blue', 'Green', 'Yellow', 'White'; 1 2 3 4 5}

- OUTPUT:

```
c =
  []  []  []  []  []
  []  []  []  []  []
c =
  'Red'  'Blue'  'Green'  'Yellow'  'White'
  [ 1]   [ 2]    [ 3]     [ 4]      [ 5]
```

Cell Arrays

- Accessing Data in Cell Arrays
- There are **two ways to refer to the elements of a cell array**
- Enclosing the indices in first **bracket ()**, to refer to sets of cells
- Enclosing the indices in **braces {}**, to refer to the data within individual cells
- When you enclose the indices in first bracket, it refers to the set of cells.

Cell Arrays

```
>> c = {'Red', 'Blue', 'Green', 'Yellow', 'White'; 1 2 3 4 5}
c =
   'Red'   'Blue'   'Green'   'Yellow'   'White'
   [ 1]    [ 2]     [ 3]      [ 4]       [ 5]
>> c(1:2,1:2)
ans =
   'Red'   'Blue'
   [ 1]    [ 2]
```

Accessing Data in Cell Arrays

>>c{1, 2:4}

```
>> c{1, 2:4}
ans =
Blue

ans =
Green

ans =
Yellow
```

Cell Arrays

- Using Element wise Assignment.
- We can also create a cell array by assigning element wise through context indexing or through cell indexing.
- In former case, we enclose the cell subscripts in curly braces as well as the contents of the cell array on the right side of the assignment statement.

Example:

```
A(1,1) = { [1 2 3;4 5 6;7 8 9]}
A(1,2) = {1+2i}
A(2,1) = {'A Character String'}
A(2,2) = { 12:-2:0 }
```

OUT PUT:

```
A =
 [3x3 double]
A =
 [3x3 double]   [1.0000e+00 + 2.0000e+00i]
A =
 [3x3 double]   [1.0000e+00 + 2.0000e+00i]
 'A Character String'        []
A =
 [3x3 double]   [1.0000e+00 + 2.0000e+00i]
 'A Character String'        [1x7 double]
```

Cell Arrays

- **Example:**
- B{1,1} = [10 11 12;13 14 15;16 17 18];
- B{1,2} = 5+2i;
- B{2,1} = 'We are happy to learn MATLAB';
- B{2,2} = 0:0.1:1

OUTPUT:

```
B =
  [3x3  double]  [5.0000e+00 + 2.0000e+00i]
  [1x28 char ]            [1x11 double]
```

Cell Arrays

- Friens_data = {'Name','Age','Phone Number','Qualification','Address'; 'Hari','30','9876543210','M.Com','Hyderabad';'Ramu','32','9876321054' ,'BE','Delhi';}
- OUTPUT:

```
Friens_data =

  Columns 1      through 3
 'Name'   'Age'   'Phone Number'
 'Hari'   '30'    '9876543210'
 'Ramu'   '32'    '9876321054'

  Columns 4     through 5
 'Qualification'  'Address'
 'M.Com'          'Hyderabad'
 'BE'             'Delhi'
```

Cell Arrays

Filling of Pre allocated cell arrays

```
>> A{4,3}=[]

A =

    []    []    []
    []    []    []
    []    []    []
    []    []    []
```

❖ Then, we can assign the individual elements of the cell array

```
>> A(1,2)={[3, 4]}
A =
    [ ] [1 × 2 double] [ ]
    [ ]      [ ]       [ ]
    [ ]      [ ]       [ ]
    [ ]      [ ]       [ ]

>> A(3,2)={[1 2; 3 2]}
A =
    [ ] [1 × 2 double]  [ ]
    [ ]      [ ]        [ ]
    [ ] [2 × 2 double]  [ ]
    [ ]      [ ]        [ ]
```

Cell Arrays

- Filling of Pre allocated cell arrays
- If we want to create empty cell arrays using **cell function,** we have to specify **the size as inputs of the cell function** and then assign the output to a variable.

```
>> B=cell(4,3) % creates an empty cell array of size 4-by-3
B =
    [ ]    [ ]    [ ]
    [ ]    [ ]    [ ]
    [ ]    [ ]    [ ]
    [ ]    [ ]    [ ]
```

```
>> A=cell(3,3)

A =
    [ ]  [ ]  [ ]
    [ ]  [ ]  [ ]
    [ ]  [ ]  [ ]
```

We can assign them with values using cell indexing as

```
>> A(1,1)={'Sun flower'};
>> A(2,1)={'Cauli flower'};
>> A(3,1)={'Asiatic dayflower'};
>>A

A =
    'Sunflower'           [ ]  [ ]
    'Cauliflower'         [ ]  [ ]
    'Asiaticdayflower'    [ ]  [ ]
```

Cell Arrays

- Accessing the contents of cell arrays
- **Using context Indexing**

```
>> Friends={'Karambi', 'Yumnambi', 'Urmila',{'Sangeeta',35}};
>>Friends{3} % gives the third element of the cell array.
ans =
  Urmila
>>Friends{1} % gives the content of the first cell.
ans =
  Karambi
>>Friends{4} % gives the content of the fourth cell.
ans =
  'Sangeeta' [35]
```

Thus, Friends{4}{1} denotes the first element of the fourth cell of the cell array Friends. And Friends{4}{2} denotes the second element of the fourth cell of the cell array Friends.

```
>> Friends{4}{1}
ans =
   'Sangeeta'
>>Friends{4}{2}
ans =
  35
```

Cell Arrays

- Accessing the contents of cell arrays
- **Using Cell Indexing**

```
>> Bio_data={ 'Name', 'Age', 'phone number', 'Qualification', 'Address';
'Ram', 32, 9876543210, 'Ph.D','Hyderabad';'Hari',35, 9123456780,'M.Tech','Delhi';
'Suresh',30, 8976543210,'B.E','Bengalore';'Ramesh',21,7896543210,'B.Tech','Chennai'}

Bio_data =

    'Name'      'Age'    'phone number'     'Qualification'    'Address'
    'Ram'       [ 32]    [  9.8765e+09]     'Ph.D'             'Hyderabad'
    'Hari'      [ 35]    [  9.1235e+09]     'M.Tech'           'Delhi'
    'Suresh'    [ 30]    [  8.9765e+09]     'B.E'              'Bengalore'
    'Ramesh'    [ 21]    [  7.8965e+09]     'B.Tech'           'Chennai'

>> Bio_data{4,1}

ans =

Suresh
```

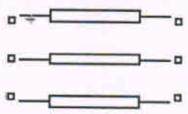
```
>> Bio_data{:,1}
```

```
ans =
Name
ans =
Ram
ans =
Hari
ans =
Suresh
ans =
Ramesh
```

	Full Name In CAPITALS	Roll Number	08-06-2020		`09/06/2020		10-06-2020		11-06-2020		#########		13-06-2020		15-06-2020		16-06-2020		17-06-2020		18-06-2020		19-06-2020		20-06-2020	
			FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN	FN	AN
1	RAGHAVESHWAR GUGGILLA	160118734039	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2	SINGAJOGI BHARGAVI	160118734061	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
3	NISHITHA SURUKANTI	160118734066	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	ARIKOTLA RISHITHA	160118734069	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5	SNEHA BHANDHAVI THUMU	160118734072	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6	SADINENI SRAVANTHI	160118734075	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7	SANKARNENI SRAVYA	160118734076	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
8	UMMAY SALMA	160118734079	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
9	M ABHISHEK	160118734080	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
10	AJAY GUNNALA	160118734082	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11	GANAMONI JEEVAN KUMAR	160118734090	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
12	PANDULA MANIDEEP	160118734092	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
13	ANNAM RAKESH	160118734097	A	A	A	A	P	A	A	A	A	A	A	A	P	A	A	A	A	A	P	A	A	A	A	A
14	SAITEJA KOTHAKONDA	160118734100	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
15	SAIKIRAN KOLLOJU	160118734101	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
16	GANASALA HEPSIBA RANI	160118734312	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
17	ANGEL SHEEBA KAPARTHI	160119734001	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
18	DEVIKARANI SANABOYINA	160119734002	A	P	P	P	P	A	A	P	A	P	A	A	A	A	A	A	A	A	A	A	A	A	P	P
19	SEGGAM GNANA PRASANNA	160119734003	P	P	P	P	A	A	P	P	P	P	P	P	P	P	P	A	P	P	P	A	P	P	P	P
20	JAYASREE MOCHI	160119734004	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
21	S KARUNYA RAM	160119734005	P	P	A	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P
22	P.Lakshmi Sahitya	160119734006	P	P	P	P	P	P	P	P	P	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P
23	LIKHITHA GADE	160119734007	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
24	YENUGULA MANASA	160119734008	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	A	P	P
25	VUGGAM MANEESHA	160119734009	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
26	GUNDU NIHARIKA	160119734010	P	P	P	A	P	P	P	P	P	P	P	P	P	A	P	P	P	P	P	A	P	P	P	P
27	PATIL SAI VAISHNAVI	160119734011	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
28	MANNE. SHINY ROSELEEN	160119734012	A	P	A	P	P	P	P	P	P	P	P	P	P	P	P	A	P	A	P	A	P	P	P	P
29	SMRIDHI UPPALA	160119734013	A	P	A	P	A	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
30	SNEHA NALLURI	160119734014	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	P	P
31	M.SNEHA SUNDARI	160119734015	A	P	P	P	P	P	A	P	A	P	P	A	A	A	A	A	A	A	A	A	A	A	P	P
32	VELPULA SNEHA	160119734016	P	P	A	P	P	P	P	P	P	P	A	P	P	A	P	P	P	P	P	P	P	A	P	P
33	MEDAM SOUMYA	160119734017	P	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
34	VAMSHIKA KATIKAM	160119734018	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P	P	P
35	V.VIJAYA CHANDANA	160119734019	P	P	P	P	P	P	P	P	P	P	A	P	A	P	A	P	P	P	P	P	P	P	P	P
36	YAMINI KUSA	160119734020	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	P	P
37	ANANTHULA ADARSH	160119734022	P	P	A	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
38	RAMAVATH ARAVIND	160119734025	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
39	ADUVALA ARUN	160119734026	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
40	DOSAPATI CHRISTOPHER STE	160119734027	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
41	DHANUSH CHANDRA	160119734028	A	A	A	A	P	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	P	P
42	GUNDEBOINA GANESH	160119734029	A	A	P	A	A	A	A	A	A	A	P	P	A	A	P	A	A	A	A	A	A	A	P	P
43	ERABELLY GYAN VIKAS	160119734030	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
44	MUCHERLA HARI PRAVEEN	160119734031	P	P	P	P	P	P	P	P	P	A	P	A	A	A	A	A	A	A	A	A	A	A	P	P
45	NALLA JAYANTH	160119734032	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P	P
46	NAGA VENKATASAI VISHWANA	160119734033	P	P	A	P	P	P	A	P	P	P	A	A	P	P	P	A	P	A	A	A	A	A	P	P
47	NISHANTH AYYALASOMAYAJUI	160119734034	P	P	P	P	A	A	A	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
48	A.NITHIN	160119734035	A	P	A	A	A	A	A	P	A	A	A	A	A	P	A	A	A	P	A	P	A	P	P	P
49	KANIKARAPU PAVAN KUMAR	160119734037	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
50	RAJESH CHINTA	160119734039	A	A	P	P	P	A	A	A	P	A	P	A	P	A	P	A	A	A	A	A	A	A	P	P
A	CHEVULA SAIANIVESH	160119734043	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
52	GANDU SAI LIKHITH	160119734045	P	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P

53	SANJAY KUMAR POGULA	160119734047	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	P	A	A	A	A	A	P	P
54	FARDEEN AHMED SHAIK	160119734048	A	A	P	P	A	P	P	P	P	P	P	A	P	P	A	P	A	P	P	P	P	P	P	P
55	POLYSETTY SHIVA SAI	160119734050	A	P	A	P	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	P	P
56	USHAKOYLA SHIVA SAI	160119734051	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
57	KALKURI SHIVA SHANTH	160119734052	P	P	P	P	P	A	A	A	P	P	P	A	P	P	P	P	A	A	P	A	P	P	P	P
58	GODAVARI SRI SAI AKHIL	160119734054	P	P	P	A	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P
59	LANKALA SRISANTH	160119734055	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
60	SUHASH GAMPA	160119734057	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
61	KETHANAPALLY SUSENAREDD	160119734058	P	P	P	A	P	P	A	P	P	A	P	A	A	A	A	A	A	A	A	A	A	A	P	P
62	DAREDDY THULASI HUSEN RE	160119734060	A	A	P	A	P	A	P	P	A	A	A	A	P	A	A	A	A	A	A	A	A	A	P	P
63	KURRI ANITHA	160119734061	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
64	Firdous Anjum	160119734062	P	P	P	P	P	P	P	P	P	P	P	P	A	A	A	A	P	A	A	A	A	A	P	P
65	BURRI GOWTHAMI	160119734063	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
66	V. KRISHNA SREE	160119734064	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
67	CHAKKA LAHARI	160119734065	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
68	ESLAVATH.MANASA	160119734066	A	A	A	A	A	A	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P
69	POOJA MUNNOLA	160119734067	A	A	P	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
70	NAGAVELLI PRATHYUSHA	160119734068	A	A	A	P	P	P	P	P	P	P	A	P	P	P	P	A	P	A	A	P	A	P	P	P
71	CHELLE SABHYATA	160119734069	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
72	SINGIREDDY SAI NAGA KEERT	160119734070	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
73	BHEEMANADHUNI SAIMEGHAN	160119734071	A	A	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P	P	P	P	P	P	P
74	B. SANDHYA	160119734072	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
75	CHERUKU SANDHYA	160119734073						P	P	P	A		P	P	A	P	P	P	A	A	P	A	A	P	P	P
76	PASHAM SHARATHDEEPIKA	160119734074	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
77	REGU SHRUTHI	160119734075	P	A	P	P	P	P	P	P	P	P	P	P	P	A	P	A	P	P	P	A	A	P	P	P
78	VINUKULA SUSHMA	160119734076	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
79	DINTAKURTHI ABHINAY	160119734079	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
80	POLU ABISHEK REDDY	160119734080	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
81	AKHIL	160119734082	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
82	G BHARGAV	160119734087							P	P	P	P	P	P	P	A	P	P	P	P	P	A	A	P	P	P
83	DUSHYANTH YADAV	160119734088	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
84	HADEEL SHAIK	160119734089	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	A	P	P
85	THALARI HAREESH	160119734090	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
86	HARISH PAIDI	160119734091	A	A	P	P	P	P	A	P	P	A	P	A	A	A	P	A	P	A	A	P	A	A	P	P
87	JASHWANTH SAMBARAJU	160119734092	P	P	P	P	P	P	P	A	P	A	P	A	A	A	P	A	A	A	A	A	A	A	P	P
88	KOUSTHUBH VANGAPALLY	160119734094	P	P	P	P	P	A	P	A	P	A	P	A	P	A	A	A	A	A	P	A	A	A	P	P
89	N.LALU PRASAD	160119734095	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
90	CHAPALAMADUGU MAHENDER	160119734097	A	A	P	P	P	A	A	P	P	A	P	P	P	P	P	A	P	P	P	A	P	P	P	P
91	MOHAMMAD AMAAN	160119734099	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
92	GEDDAM NEENA NIKHIL	160119734100	P	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
93	NIKHIL	160119734101	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
94	Y PRANEETH	160119734103	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
95	MANNEM RAVI TEJA	160119734106	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
96	T ROHITH	160119734107	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
97	PATLOLLA SANDEEP KUMAR	160119734109	P	A	A	P	P	A	A	P	A	A	P	A	A	A	P	A	P	A	A	A	P	A	P	P
98	CHETKURI SHIVA	160119734110	A	A	A	A	P	A	P	P	P	A	A	P	P	P	A	A	A	A	A	A	A	A	P	P
99	Pogula Shivamani	160119734111	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	A	P	P
##	SHIVATEJA PUNNA	160119734112	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P	P
##	SUPREETH AUTI	160119734113	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P
##	CH.THARUN TEJA	160119734115	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	P
##	TOKALA VISHNUVARDHAN	160119734117							P	P	P	P	P	P	A	P	A	A	P	P	P	P	P	P	P	P
##	VIVEK CHANDRA ATIKETI	160119734118	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	A	P	P	P	P

1. Which of the following block is essential for analysis of circuits?
   a) Ground
   b) Scope
   c) Powergui
   d) Measurement block
2. Which of the following waveform cannot be produced by Signal generator block
   a) sinewave
   b) square wave
   c) sawtooth
   d) trapezoidal wave
3. Sim power system is found in which of the following library?
   a) Simulink Coder
   b) Simscape
   c) SimRF
   d) SimEvents
4. Diode block is found under which library?
   a) Sources
   b) Elements
   c) Measurements
   d) Power electronics
5. Using universal bridge single phase and three phase converter topologies can be obtained. State true or false.
6. To observe many waveforms at once ______ block is used.
   a) Demux
   b) Mux
   c) Add
   d) Display
7. Choose the right statement
   a) In order to obtain quick response we require more samples
   b) More samples will cause process delay
   c) More samples will reduce the accuracy
   d) More samples will not cause any process delay.
8. What is the name of the following block?



   a) Series RLC branch
   b) Series RLC Load
   c) Distributed Parameters of line
   d) Parallel RLC Branch
9. Scope is analogous to _________ in laboratory.
   a) Potentiometer
   b) CRO
   c) Signal generator
   d) Multiplexer
10. Frequency spectrum can be viewed by ______ analysis
   a) fft
   b) loadflow
   c) Fault analysis
   d) Symmetric component

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This is to Certify that Mr. /Ms. / Mrs. **VELPULA SNEHA** bearing Roll No. **160119734016** of **II-SEMESTER, EEE** has Attended in the Two Week Online Training / Internship Course, VIDYUT PRASIKSHANA (VIPRA) on "SIMULATION TOOLS FOR ELECTRICAL & ELECTRONICS ENGINEERING", conducted by the Department of Electrical and Electronics Engineering during 8th June to 20th June, 2020.

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This is to Certify that Mr. /Ms. / Mrs. **GADDAM BHARGAV** bearing Roll No. **160119734087** of **II-SEMESTER, EEE** has Attended in the Two Week Online Training / Internship Course, VIDYUT PRASIKSHANA (VIPRA) on "SIMULATION TOOLS FOR ELECTRICAL & ELECTRONICS ENGINEERING", conducted by the Department of Electrical and Electronics Engineering during 8th June to 20th June, 2020.

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This is to Certify that Mr. /Ms. / Mrs. **HADEEL SHAIK** bearing Roll No. **160119734089** of **II-SEMESTER, EEE** has Attended in the Two Week Online Training / Internship Course, VIDYUT PRASIKSHANA (VIPRA) on "SIMULATION TOOLS FOR ELECTRICAL & ELECTRONICS ENGINEERING", conducted by the Department of Electrical and Electronics Engineering during 8th June to 20th June, 2020.

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