LAB MANUAL
FOR
SIMULATION PRACTICE ON MATLAB

SEMESTER-4TH

DEPARTMENT OF ELECTRICAL ENGINEERING

GOVT. POLYTECHNIC
SONEPUR

LIST OF EXPERIMENT

Si. No.	**Name of Experiments**
1	Introduction to MATLAB Programming
	1.1 Functions and operation using variables and arrays. 1.1.1 To learn algebraic, trigonometric and exponential manipulation. 1.1.2 To learn Arithmetic, Relational and Logic operator .
	1.2 Matrix formation and its manipulation .
	1.3 Vector manipulation : 1.3.1 Use of line space to create vectors. 1.3.2 To create, add and multiply vectors. 1.3.3 Use of sin and sqrt functions with vector arguments .
	1.4 Plotting : 1.4.1Two dimensional plots and sub plots. 1.4.2Level the plot and printing.
	1.5 Write and execute a file to plot a circle, impulse, step, ramp, sine, and cosine functions.
2	Introduction to SIMULINK :
	2.1 Use of commonly used blocks, math operation blocks and Display block from SIMULINK library . 2.2 Use of logical and relational operator block. 2.3Use of Sim-power system block to use electrical sources, elements and power electronics devices .
	2.4 SIMULATION : 2.4.1 Verification of Network theorems. 2.4.2 Simulation of a half wave uncontrolled rectifier. 2.4.3 Simulation of 1 phase full bridge controlled rectifier. 2.4.4 Simulation of step-down chopper.

EXPERIMENT NO.1

AIM OF THE EXPERIMENT :-Introduction to MATLAB

THEORY : -

Introduction to MATLAB :-

1. MATLAB is a high level language & interactive environment for numerical computation, visualization& programming.
2. Using MATLAB we can analysis data, develop algorithms & create models & applications.
3. We can use MATLAB for the application including signal processing & communication, image & video processing, control systems, testing & measurement & technical computing.

Key features of MATLAB: -

1. High level language for numerical computation, visualization & application development.
2. Interactive environment for design and problem solving.
3. Mathematical function for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration & solving ordinary differential equation.
4. Built in graphics from for visualizing data & tools for creating custom plots.
5. Developments tools for improving code quality and maintainability & maximizing performance
6. Tools for building applications with custom graphical interfaces.
7. Functions for integrating MATLAB based algorithm with external applications & languages such as C, JAVA, .NET etc.

EXPERIMENT NO.2

AIM OF THE EXPERIMENT: - To study about arithmetic, algorithm, exponential & trigonometric function & operation using variables and arrays.

SOFTWARE REQUIRED: -

1. MATLAB
2. WINDOW 7

THEORY: -

Start MATLAB.

1. Current folder: - access your files.
2. Command window: - Enter commands at command line, indicated by the prompt (>>).
3. Work space: - Explore data that you create or import from files.
4. Command history: - view or re-run command that you enter at the command line.

PROCEDURE: -

1. Open MATLAB.
2. Open new m-file.
3. Type the program.
4. Save in the current directory.
5. Compile and run the program.
6. For the output see command window/figure window.

Arithmetic Operation

Example: -1

```
>> a = 5;

>> b = 10;

>> c = a + b   or   >> c = plus (a, b)

     c= 15                c = 15

>> d = a – b   or   >> d = mins (a, b)

     d = -5                 d = -5

>> e = a/b

    e = 0.5000

>> f = a * b   or  >>f = times (a, b)

    f = 50 f = 50

>> s = a^2    &    >> s = b^2

    s = 25  s = 100

>> k = log10(a)

    K = 0.6990
```

```
>> g = sqrt (36)

   g = 6
```

Example-2

Find value of π/4

Ans:

```
>> pi/4       or      >> a = pi/4

    0.7854               a = 0.7854
```

Algorithm and exponential Operation

Example-3

Find the value of $e^{\pi\sqrt{93}}$

```
>> a = sqrt (93)

    a = 9.6437

>> c = pi * 9.6437

    c = 30.2966

>> d = exp (30.2966)

     d = 1.4376e+13

>> double (ans)

     Ans = 9.64
```

Example-4

Find the value of $\log_{10}(e^5)$

```
>> a = 16 ^ 5

    a = 1048576

>> b = log10(a)

    B = 6.0206
```

Example-5

Find the value of $\log_{10}(e^5)$

```
>> a = exp (5);

>> b = log10 (a)

    b = 2.17
```

Trigonometric Operation: -

Example-6

Find the value of sin (0^0)

```
>> a = sin (0)

>> a = 0
```

Example-7

Find the value of sin (30^0)

```
>>b = sin (30)

>>b = 1.5708 – 4.09414i
```

Example-8

Find the value of sin (45^0)

```
>>c = sin (45)

>>c = 0.85091
```

Example-9

Find the value of sin 2($\frac{\pi}{4}$)

```
>>a = pi/4;

>>b = sin * 2* (a)

>> b = 1
```

Example-10

Find the value of 2sin ($\frac{\pi}{4}$). cos ($\frac{\pi}{4}$)

```
>> a = 2 * sin(pi/4)* cos(pi/4)

>>a = 1
```

Conclusion: -From the above experiment we knew about arithmetic, algorithm, exponential & trigonometric function & operation using variables and arrays.

EXPERIMENT NO.3

AIM OF THE EXPERIMENT: - To study about algebraic, relational, logical function & operation using variables and arrays.

SOFTWARE REQUIRED: -

1. MATLAB
2. Window 7

THEORY: -

Start matlab.

1. Current folder: - access your files.
2. Command window: - Enter commands at command line, indicated by the prompt (>>).
3. Work space: - Explore data that you create or import from files.
4. Command history: - view or re-run command that you enter at the command line.

PROCEDURE: -

1. Open MATLAB.
2. Open new m-file.
3. Type the program.
4. Save in the current directory.
5. Compile and run the program.
6. For the output see command window/figure window.

Algebraic operation: -

Example-1

Find x in x+3=2

```
>>Syms x

>> Solve (‘x+3=2’, x)

>> x = -1
```

Example-2

Find x in $x^2+2x+3 = 12$

```
>> Syms x

>> Solve (‘x^2+2*x+3=12’ x)

>> x= 2.54, -3.54
```

Example-3

Solve x+2y = -3z

```
>> Syms x, y, z

>> Syms x

>> solve (‘x+2*y = -3*z’, x)
>> ans= -2*y-3*z

>> syms y

>> solve (‘x+2*y = -3*z’, y)

>> ans = -3*z-x

>> syms z

>> solve (‘x+2*y = -3*z’, z)

>> ans = -x/3 + 2/3*y
```

Relational Operation

```
>> a = [0 1 0 0 1]

>> b = [0 0 1 0 1]

>> a = b

>> ans = [1 0 0 1 1]


>> a<b

>> ans = [0 0 1 0 0]

>> a<=b

>> ans = [1 0 1 1 1]

>> a>=b

>> ans = [1 1 0 1 1]
```

Logical Operation

1. OR – Gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 0]

>> c = or (a, b)

>> c = [1 1 0 1 1]
```

2. AND- Gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 1]
>> c = and (a, b)

>> c = [0 0 0 0 1]
```

3. NAND- Gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 1]

>> c = ~and (a, b)

>> c = [1 1 1 1 0]
```

4. NOR – Gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 1]

>> c = ~ or (a, b)

>> c = [0 0 1 0 0]
```

5. X-OR gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 1]

>> c = X or (a, b)

>> c = [1 1 0 1 0]
```

6. X-NOR Gate Operation

```
>> a = [0 1 0 0 1]

>> b = [1 0 0 1 1]

>> c = ~ X or (a, b)

>> c = [0 0 1 0 1]
```

CONCLUSION: -From the above experiment we knew about the algebraic, logical and relational function and operation using variables and arrays.

EXPERIMENT NO.4

AIM OF THE EXPERIMENT:- To study matrix formation and its manipulation.

SOFTWARE REQUIRED:-

1. Matlab software .
2. Personal computer.

THEORY:-

Start matlab

1. Current folder: - access your files.
2. Command window: - Enter commands at command line, indicated by the prompt (>>).
3. Work space: - Explore data that you create or import from files.
4. Command history: - view or re-run command that you enter at the command line.

PROCEDURE:-

1. Open matlab.
2. Open new m.file
3. Type the program
4 . Save the current directing.
5 . Compile and run the program.
6. For the output see the command window/Figure window.

1. Array creation

Examples

-To create an array with 'n' element in a single row, separate the element with either comma(,) or spsce ( ).

```
>> A= [  1   2   3 ]                        OR                    >>A=[     1,      2,     3 ]

     A= 1 2 3                                                          A= 1 2 3
```

This type of array is "ROW VECTOR"

-To create an array with 'n' element in a single column, separate the element with semicolon(;)

```
>> B = [ 4;   5;   6]

B  =    4

        5

        6
```

This type of array is "column vector"

- To create a matrix that has multiple rows, separate the rows with semicolon(;)

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


                        1      2      3

c =                     4      5      6

                        7      8      9
```

2.SPECIAL MATRIX

Another way to create a matrix is to use function such as ones, zeros.

Example:-   create 5/1 column vector of zeros.

>>D = Zeros (5,1)

```
            0

            0

 D=         0

            0

            0
```

>> E= ones (3,2)

```
           1      1

E=         1      1

           1      1
```

3.MATLAB AND ARRAY OPERATION.

matlab allows the user to process all the values in a matrix using a single arithmatic operator.

>> C+10

```
           11      12      13

Ans=       14      15      16

           17      18      19
```

-To transpose a matrix using a single quote (,)

```
>>C '

             1     4     7

 Ans=        2     5     8

             3     6     9
```

-Rise each element of c to 3rd power.

```
>>c.^3

         1       8        27

ans=    64      125      216

        343     512      729
```

-To obtain a value equal to zero.

```
>>C ( 2,3 ) = 0

              1      2    3

Ans=          4      5    0

              7     8     9
```

-To find the value

```
>> C ( 3,3)

Ans = 9
```

<u>4.METRIX OPERATON</u>

```
E=[ 1     2     3 ;   4     5     6;    7     8       9]

F=[5      0      2;   1     9     8;  3     4      7]
```

>>E*F

```
           16       30        39

Ans =     43        69        60

           70        108     141
```

>>E+F

```
           6         2        5

Ans=       5        14       14

           10       12       16
```

>>E-F

```
          -4      2      1

Ans=     3      -4     -2

          4      4       2
```

5.INVERSE OF MATRIX

```
T= [1    2    5;    0   1    5 ;   5    6     0]
```

>>inv(T)

```
            6.0000       -6.0000       -1.0000

ans=       -5.000         5.0000        10000

            1.0000        -0.8000       -0.2000
```

6.IDENTITY MATRIX

>>eye (3)

```
                1      0       0

ans=           0       1       0

                0       0      1
```

CONCLUSION:-From the above experiment we know about matrix formation and its manipulation.

EXPERIMENT NO.5

AIM OF THE EXPERIMENT:- To study about two dimensional Plots, multiple plots and subplots.

SYSTEM REQUIRED:-

(1)- Personal computer.

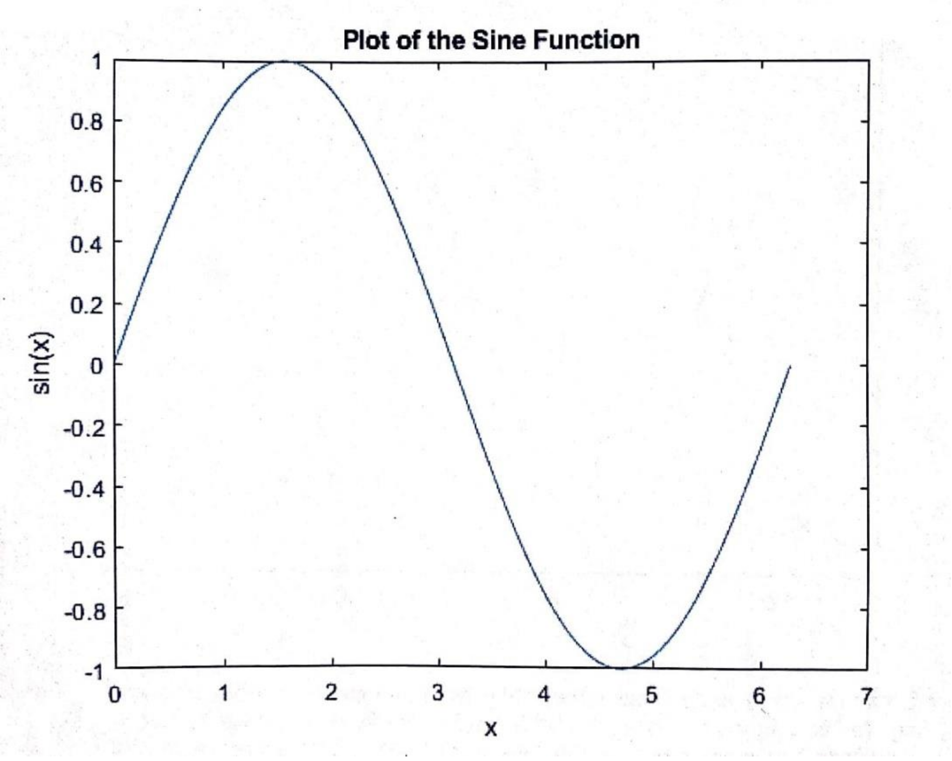
(2)- Matlab software.

PROGRAMME :-

(1) Plot For sine wave

Answer-

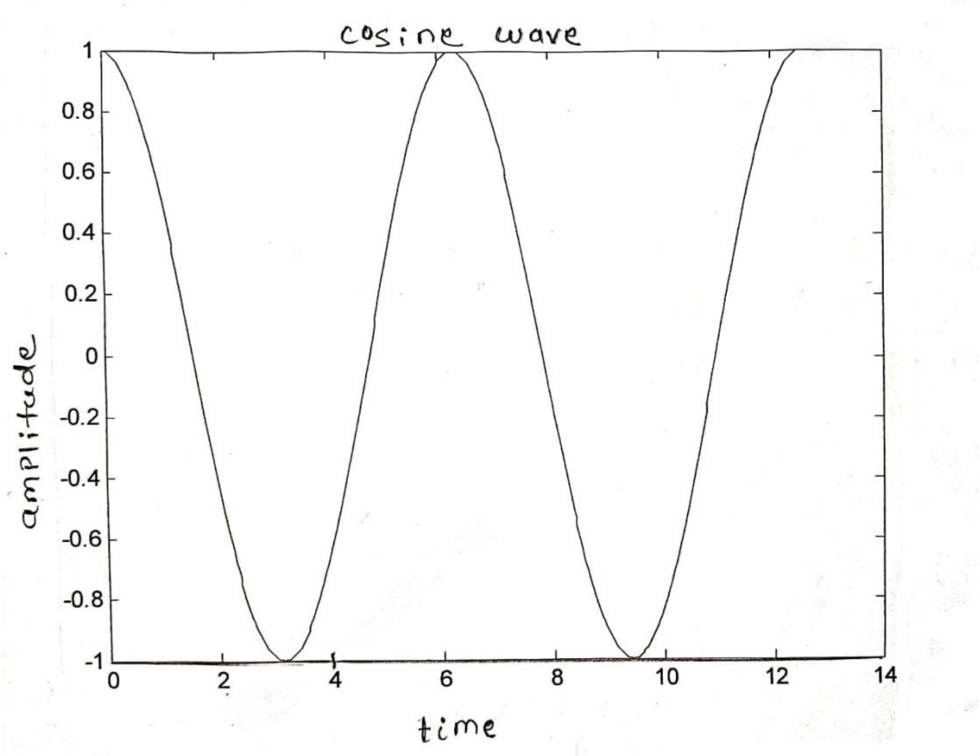
```
clc
Clear all
Close all
x= 0:pi/100:2*pi;
y= sin(x);
Plot (x,y)
xlabel ('x')
ylabel ('sin(x)')
title ('plot of the sine function')
```



(2) Plot for cosine wave

Answer-

```
Clc
Clear all
Close all
x= 0:pi/100:2*pi;
y= cos(x);
Plot (x,y)
xlabel (‘time’)
ylabel (‘amplitude’)
title(‘cosine wave’)
```

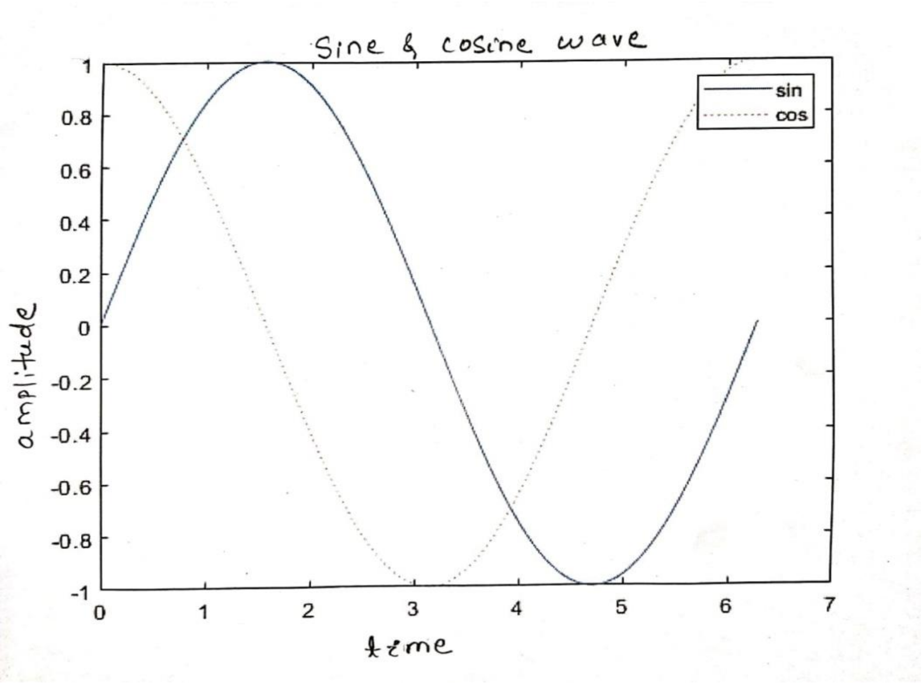


(3)Multiple Plot

(a) Multiple Plot for 2 phase signal

Answer-

```
Clc
  Clear all
  Close all
  x= 0:pi/100:2*pi;
  y= sin(x);
  z= cos(x);
  Plot (x,y;x,z)
 xlabel (‘time’)
 ylabel (‘amplitude’)
   title(‘sine & cosine wave’)
```



(b)Multiple Plot for 3phase signal

Answer-

```
Clc
Clear all
Close all
x=0:pi/100:4*pi;
R= sin(x);
Y= (x-(2*pi/3));
B= (x+(2*pi/3));
Plot (X,R,'r',X,Y,'y',X,B,'b')
axis ([0 10,-1 1])
xlable ('Time')
ylabel ('Magnitude')
title ('3 phase signal')
```

(4)Subplot

Answer-

```
Clc
Clear all
Close all
X=  0:pi/100:4*pi;
Y= sin(x);
Z= cos(x);
Subplot (3,1,1); plot (sin(x),'r')
Subplot (3,1,2); plot (cos(x),'b')
Subplot (3,1,3); plot (sin(x).*cos(x),'bla')
```

CONCLUSION:- From the above experiment we study about two decimal Plot, multiple plot and subplot.

EXPERIMENT NO.6

AIM OF THE EXPERIMENT:- To write and execute a file to plot a circle, impulse, unit step, ramp, functions.

SYSTEM REQUIRED:-

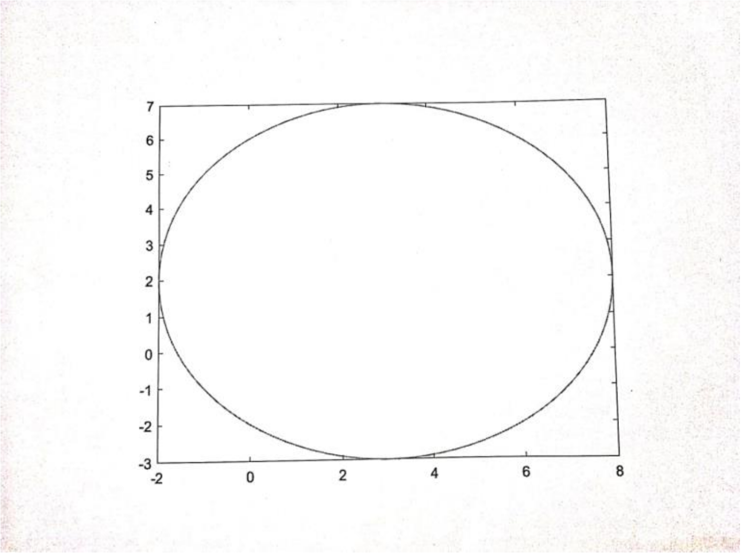
(1) Personal computer

(2) Matlab software

PROGRAMME

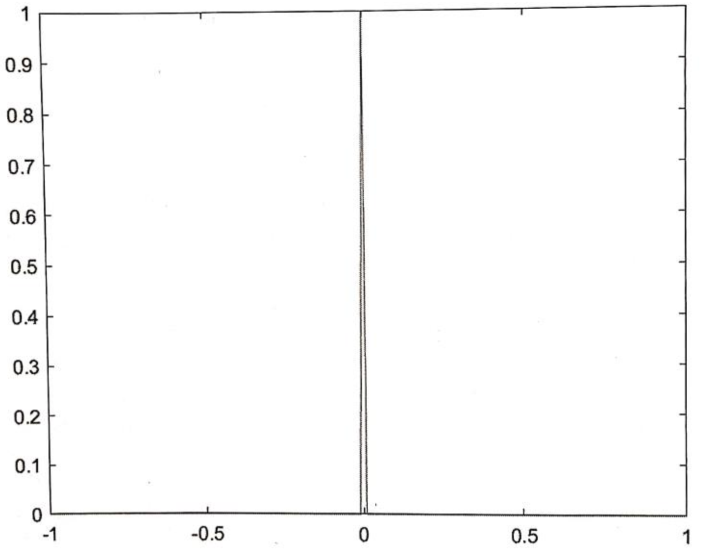
(a) For Circle

```
>> clc
>> clear all
>> close all
>> theta= linspace (-2*pi ,2* pi ,100);
>> r=5;
>> x1=3;
>> y1=2;
>> x= r* cos (theta) + x1;
>> y=r * sin (theta) +y1;
>> plot (x,y);
```



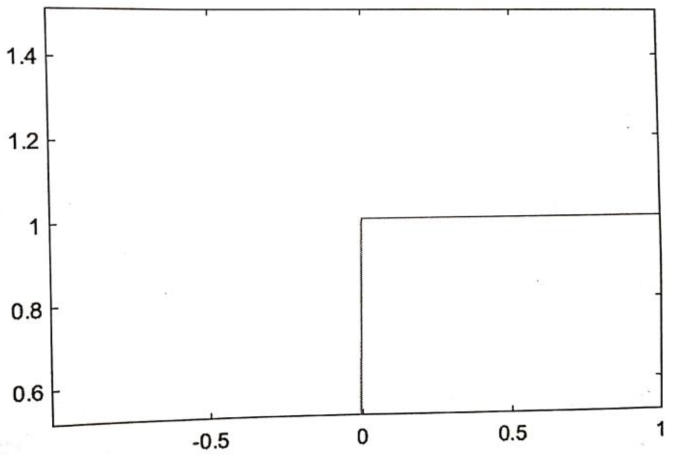
(b) For impulse function

```
>>  clc
>> clear all
>> close all
>> t= (-1 : 0.01: 1);
>> impulse = t==0
>> plot ( t, impulse);
```



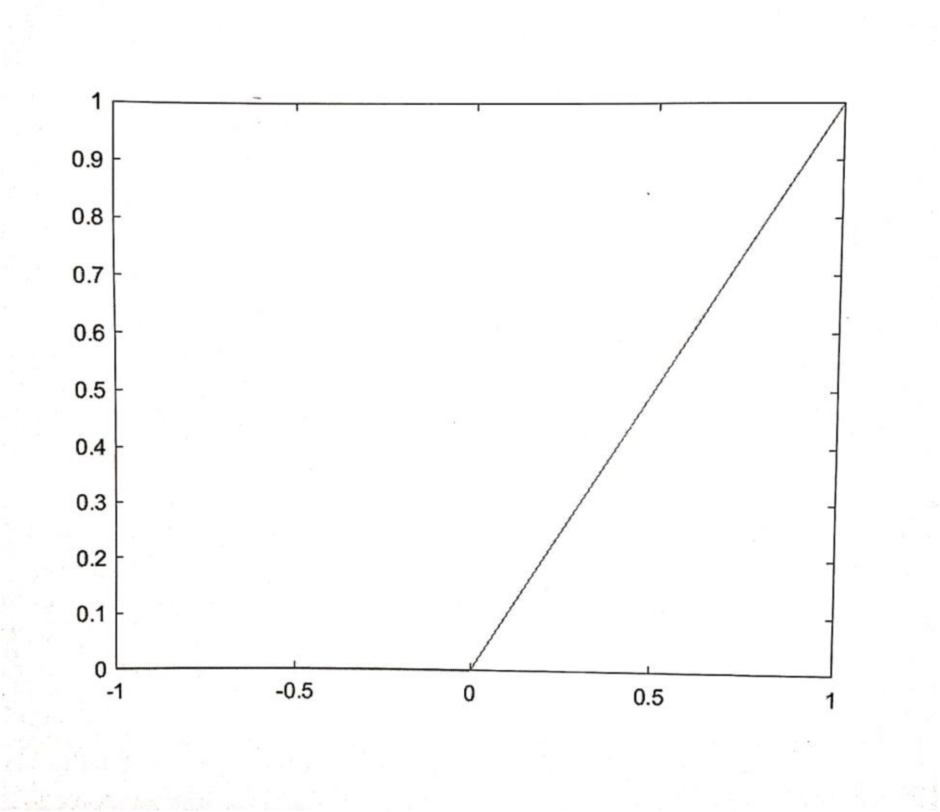
(c) For unit Step Function

```
>>  clc
>>  clear all
>>  close all
>>  t= (-1: 0.01:1);
>>  unit step = t > = 0;
>>  plot ( t, unit step);
```



(d) For ramp Function

```
>>  clc
>> clear all
>> close all
>> t= (-1 : 0.01: 1);
>> unit step = t > = 0;
>> ramp = t.* unit step;
>> plot (t, ramp);
```



CONCLUSION:- From the above experiment we are able to write and execute a file to plot a unit step function, impulse function, ramp function, and circle.

EXPERIMENT NO. 7 (a)

AIM OF THE EXPERIMENT:-To verify Superposition theorem by using simulink.

SOFTWARE USED:- Matlab & Simulink

SUPERPOSITION THEOREM:-

"In a linear bilateral network containing more than once source of energy, the resultant current in any branch is the algebraic sum of current that would be produced by each energy source acting alone, while other sources are non-operative. If the energy source is voltage source it is replaced by short circuit and the current source is replaced by open circuit across their terminal''.

PROCEDURE: -

Step 1:

1. Make the connections as shown in the circuit diagram by using MATLAB Simulink.

2. Measure the response 'I' in the load resistor by considering all the sources 5V and 12V in the network.

Step 2:

1. Replace the sources 12V with their internal impedances (short circuited).

2. Measure the response 'I_1' in the load resistor by considering 12V source in the network.

Step 3:

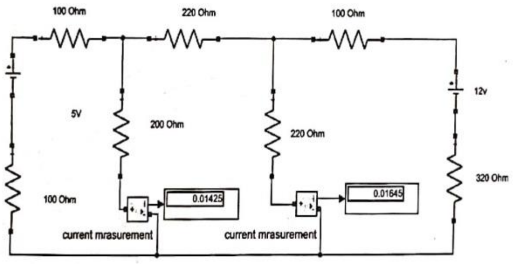
1. Replace the sources 5V with their internal impedances (short circuited).

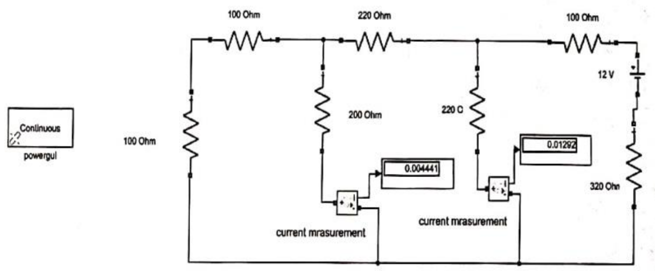
2. Measure the response 'I_2' in the load resistor by considering 5V source in the network.

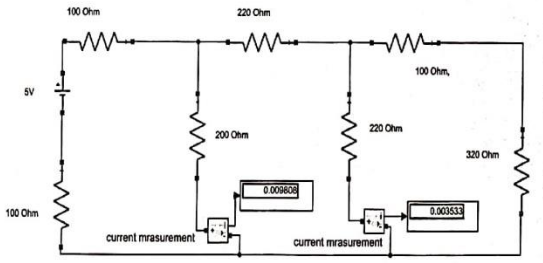
$$I=I_1+I_2$$

Hence Superposition Theorem is verified.

SUPERPOSITION THEOREM







Current through Load Resistor(R_L) 200 Ohms :

Considering 12V Source I_1: 0.00444 Amp

Considering 5V Source I_2: 0.00980 Amp

Total Current : $I_1+I_2=0.00444+0.0098= 0.01424$ A

With all the sources in the network $I_L = 0.01424$ A

$I=I_1+I_2$

CONCLUSION:-

From this experiment Super Position Theorem is Verified.

EXPERIMENT NO. 7 (b)

AIM OF THE EXPERIMENT:- To verify Thevenin’s theorem by using simulink.

SOFTWARE USED:- Matlab & Simulink

THEVENIN’S THEOREM:-

“Thevenin’s theorem state that any two terminal linear network having a no. of voltage and current source and resistance can be replaced by a simple equivalent circuit consisting of a single voltage source (Vth) in series with a equivalent resistance (Rth).

1. The thevenin’s equivalent voltage (Vth) is equal to the load

PROCEDURE: -

Step 1:

1. Make the connections as shown in the circuit diagram by using MULTISIM/MATLAB Simulink.

2. Measure the response ‘I_L’ in the load resistor(R_L=900 ohm) by considering all the sources in the network.

Step 2: Finding Thevenin’s Resistance(R_{TH})

1. Open the load terminals and replace all the sources with their internal impedances.

2. Measure the impedance across the open circuited terminal which is known as Thevenin’s Resistance.

Step 3: Finding Thevenin’s Voltage(V_{TH})

1. Open the load terminals and measure the voltage across the open circuited terminals.

2. Measured voltage will be known as Thevenin’s Voltage.

Step 4: Thevenin’s Equivalent Circuit

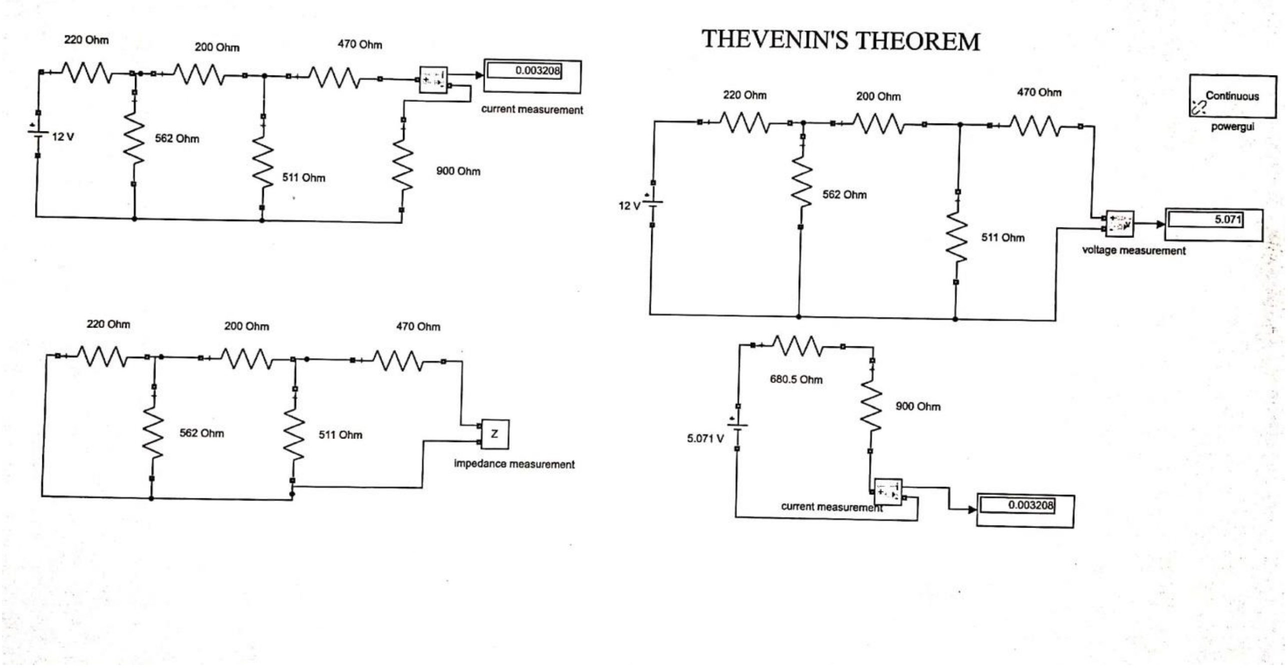
1. VTH and RTH are connected in series with the load.

2. Measure the current through the load resistor $I_L = \frac{\mathrm{VTH}}{\mathrm{RTH+RL}}$

Current measured from Thevenin’s Equivalent Circuit should be same as current obtained from the actual circuit.

$I = I_L$.

Hence Thevenin’s Theorem is Verified.



Open Circuit Voltage V_{TH} = 5.071 Volt

Thevenin's Resistance (R_{th})= 680.5 Ohms

Current through Load Resistor (R_L) 900 Ohms I_L = 0.00320A

With all the sources in the network Current through Load Resistor 900 Ohms : I_L=0.00320A

$I=I_L$

CONCLUSION:-

From this experiment Thevenin's Theorem is Verified.

EXPERIMENT NO. 7 (c)

AIM OF THE EXPERIMENT:- To verify Norton's theorem by using simulink.

SOFTWARE USED:- Matlab & Simulink

NORTON'S THEOREM:-

"Norton's theorem states that any linear active two terminal network containing resistance and voltage source or current source can be replaced by a single current source I_N in parallel with a single resistance R_N ".

PROCEDURE:-

Step 1:

1. Make the connections as shown in the circuit diagram by using MATLAB Simulink.

2. Measure the response 'I' in the load resistor by considering all the sources in the network.

Step 2: Finding Norton's Resistance(R_N)

1. Open the load terminals and replace all the sources with their internal impedances.

2. Measure the impedance across the open circuited terminal which is known as Norton's Resistance.

Step 3: Finding Norton's Current(I_N)

1. Short the load terminals and measure the current through the short circuited terminals.

2. Measured current is known as Norton's Current.

Step 4: Norton's Equivalent Circuit

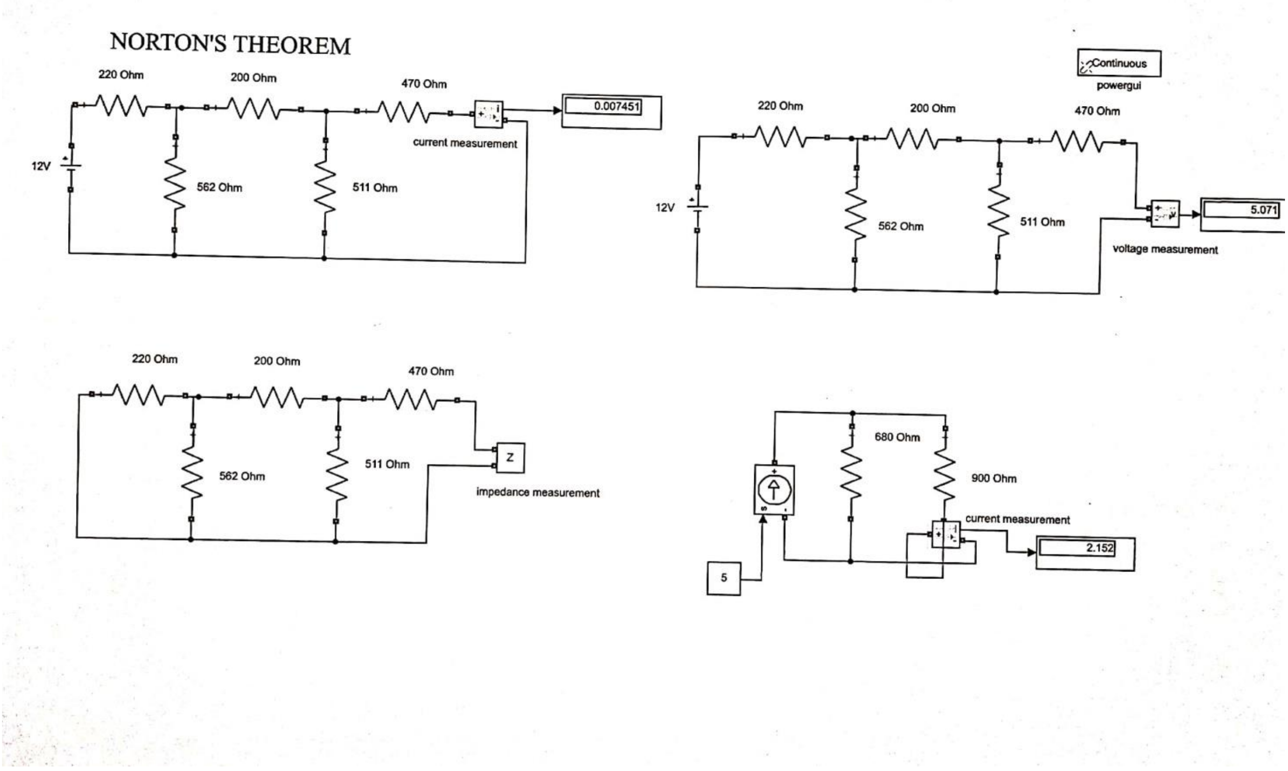
1. R_N and I_N are connected in parallel to the load.

2. Measure the current through the load resistor $I_L=\frac{IN\times RN}{RN+RL}$

Current measured from Norton's Equivalent Circuit should be same as current obtained from the actual circuit.

I = IL.

Hence Norton's Theorem is Verified.



.

Norton's Current = 0.00745A

Norton's Resistance = 680 Ohms

Current through Load Resistor (R_L) 900 Ohms = 2.152A

With all the sources in the network Current through Load Resistor 900 Ohms =2.152A

CONCLUSION:-

From this experiments Norton's Theorem is Verified.

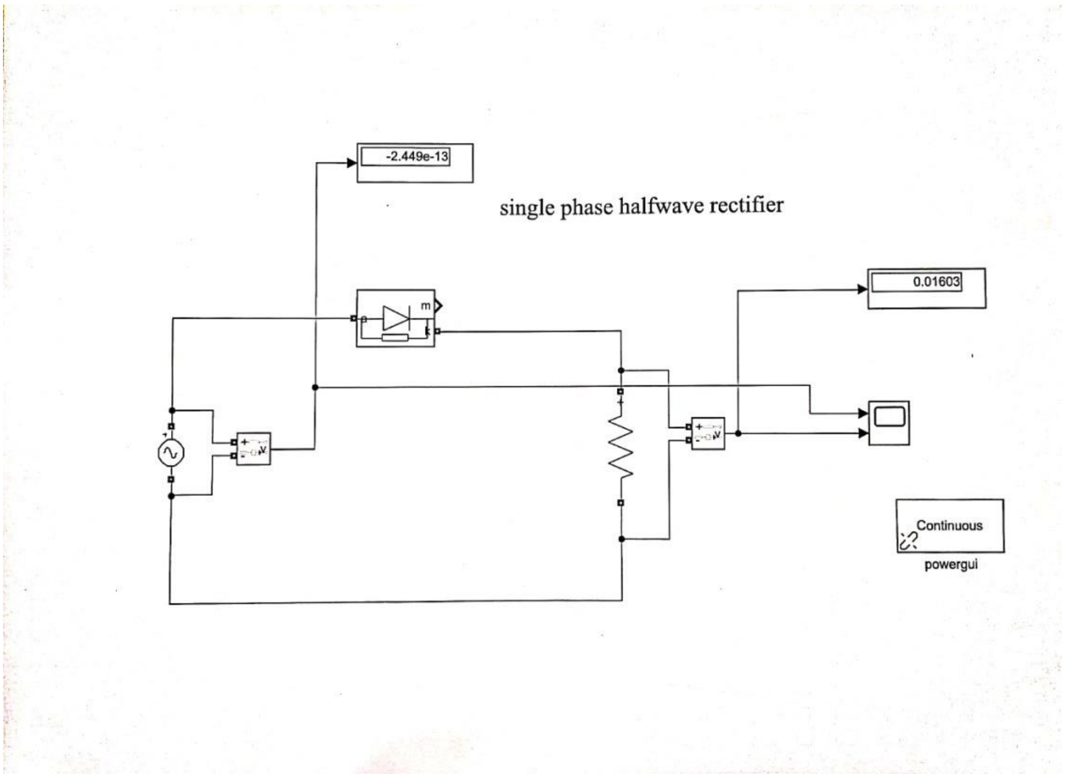
EXPERIMENT NO. 8

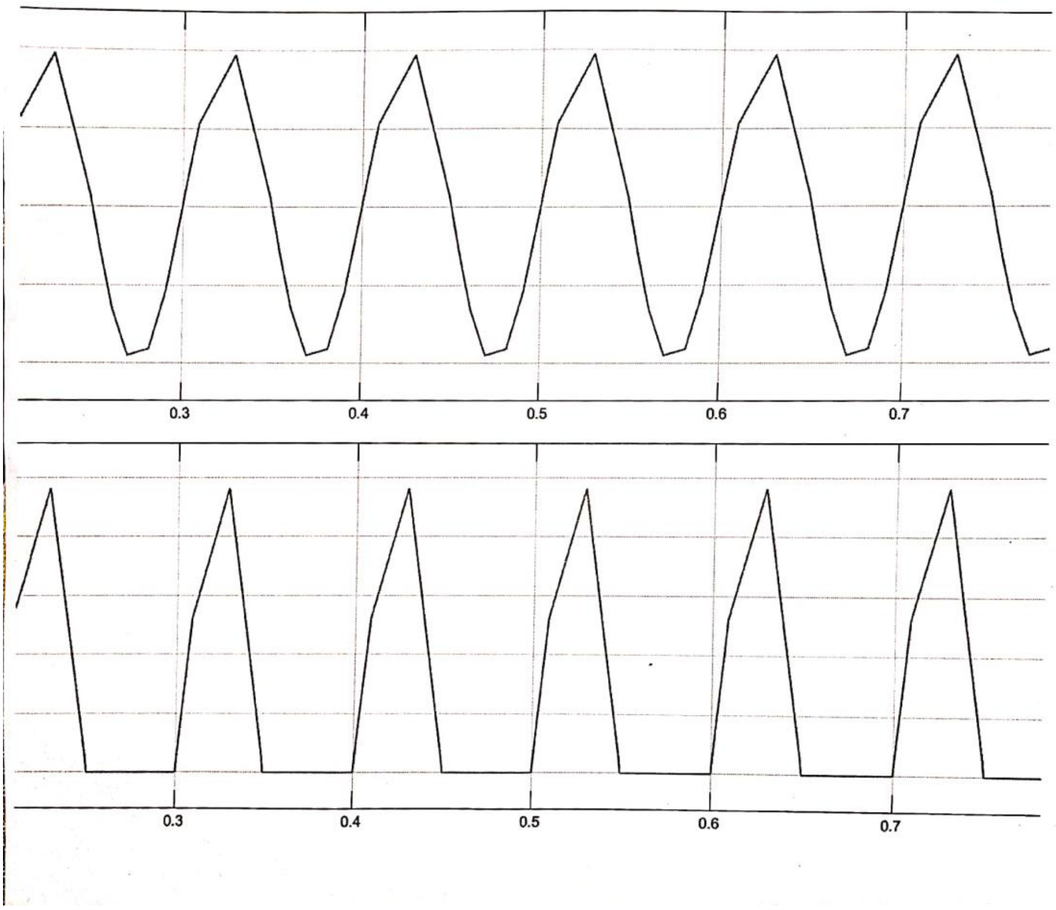
AIM OF THE EXPERIMENT:- To simulate Single phase half wave uncontrolled rectifier with resistive load in simulink.

SOFTWARE USED:- : Matlab & Simulink

THEORY: - Rectification is a process of conversion of alternating input voltage to direct output voltage. A rectifier converts ac power to dc power. In a single phase half wave rectifier, for one cycle of supply voltage, there is one half cycle of output or load voltage. The circuit diagram is shown in the figure. During the positive half cycle, diode is forward biased, therefore it conducts from wt=0^0 to wt= π. During positive half cycle, output voltage V_o=source voltage Vs and load current i_o=V_o/R. At wt=π , V_o=0 and for R load, i_o is also zero. As soon as Vs tends to become negative after wt=π , diode D is reverse biased, it is therefore turned off and goes into blocking state. Output voltage as well as output current, are zero from wt=π to wt=2π . After wt=2π , diode is again forward biased and conduction begins.

CIRCUIT DIAGRAM:-





CONCLUSION:- From the above experiments we able to draw the single phase half wave uncontrolled rectifier by using simulink.

EXPERIMENT NO. 9

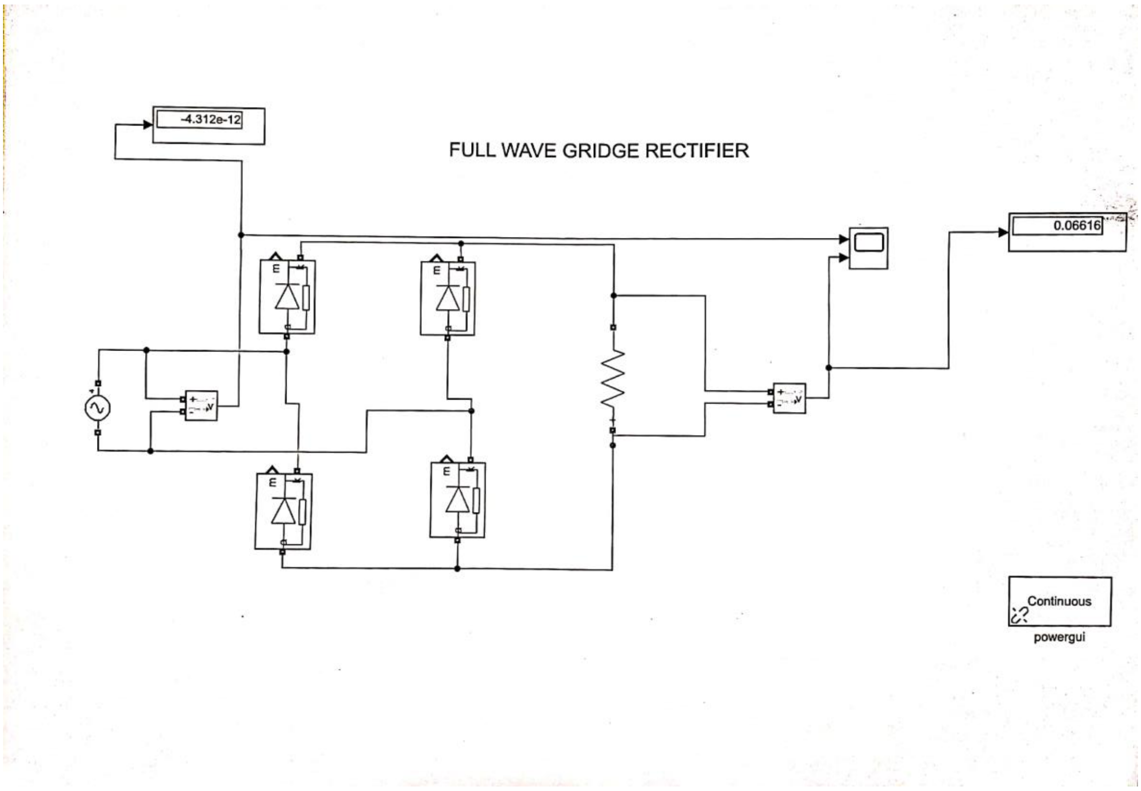
AIM OF THE EXPERIMENT:- To simulate Single phase Full bridge uncontrolled rectifier with resistive load in simulink.

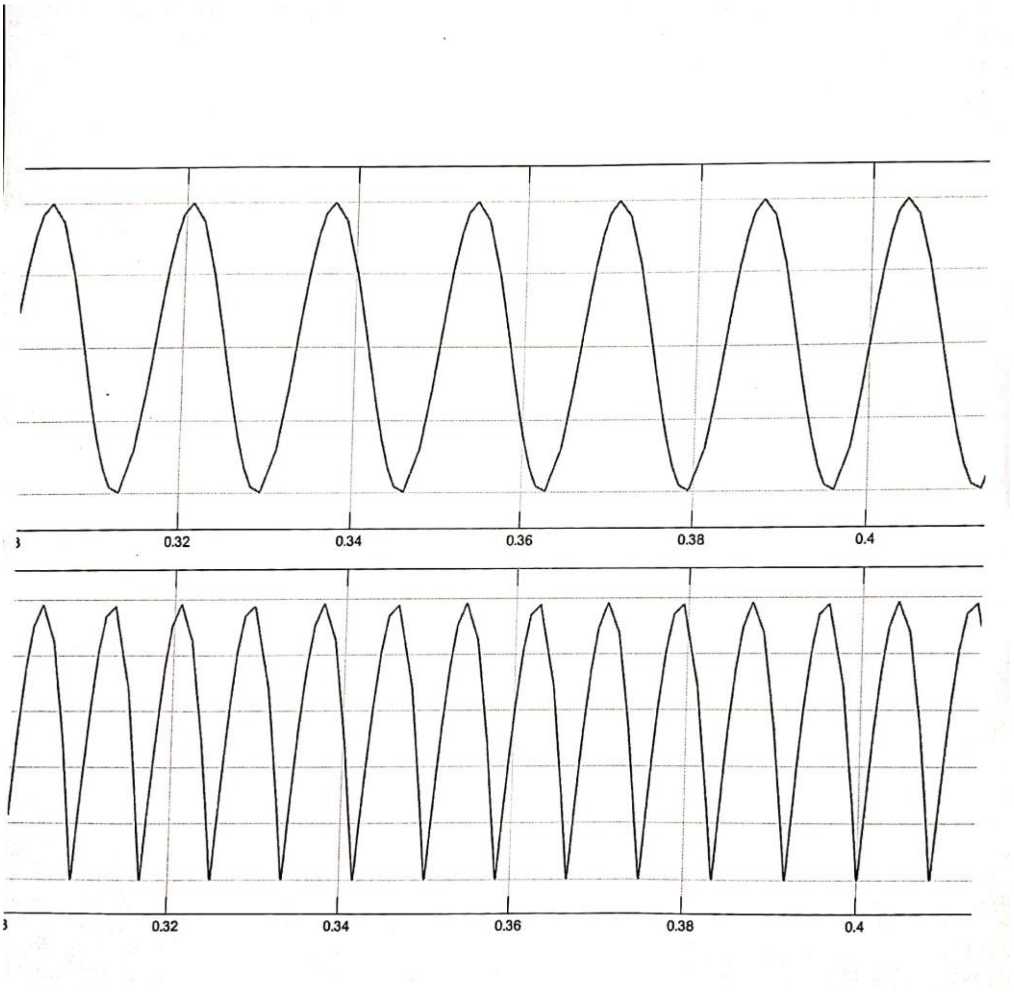
SOFTWARE USED:- : Matlab & simulink

THEORY:-

The circuit consist of four diodes D_1,D_2,D_3,D_4 and a voltage source (V) and a load R. During positive half cycle of the input voltage ,the diodes D_1 & D_3 are forward biased and current flow through V^+-D_1-R-D_3-V^-. During negative half cycle D_2 & D_4 are forward biased and current flow through V^+-D_2-R- D_4-V^- ,the diodes D_1 & D_3 are reversed biased. The wave form show the output voltage ,output current & voltage across diodes.

CIRCUIT DIAGRAM:-





CONCLUSION:- From the above experiments we able to draw the single phase full bridge controlled rectifier by using simulink.

EXPERIMENT NO. 10

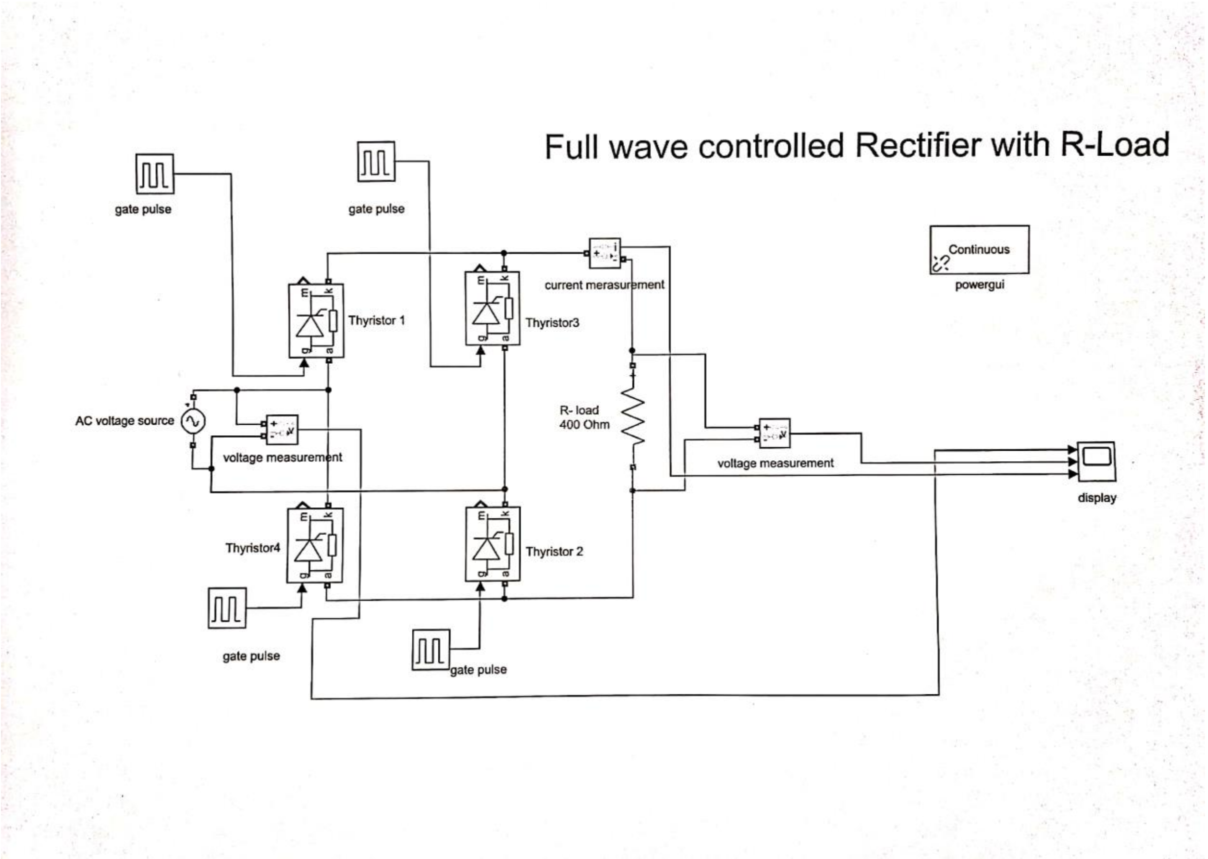
AIM OF THE EXPERIMENT:-To simulate Single phase Full bridge controlled rectifier with resistive load in simulink.

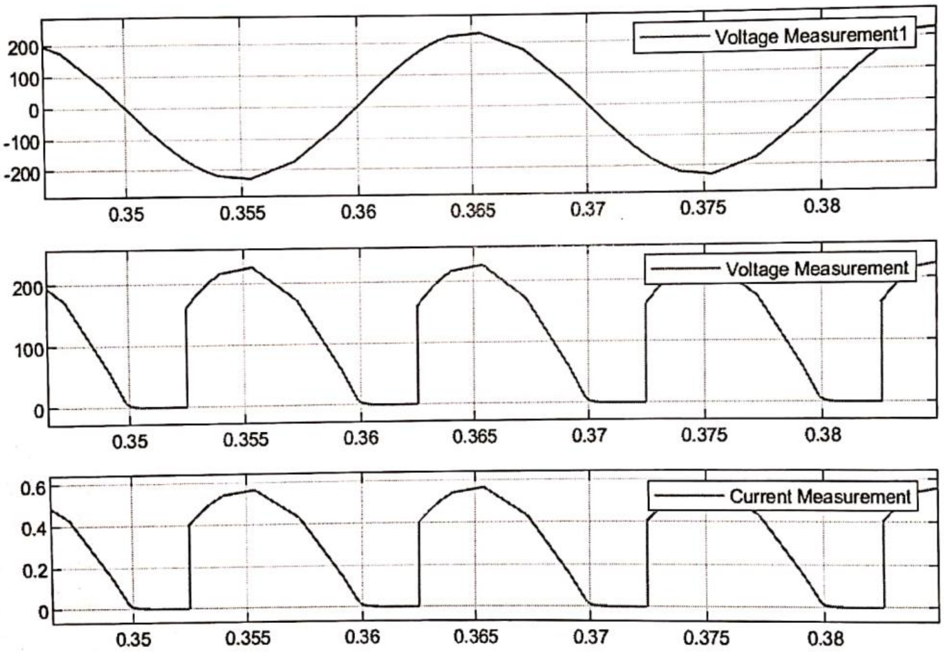
SOFTWARE USED:- : Matlab & simulink

THEORY:-

The circuit consist of four thyristor T1,T2,T3,T4 and a voltage source and a load R. During positive half cycle of the input voltage ,the thyristor T1 &T2 are forward biased and T3 & T4 are reverse biased . It does not conduct until a gate signal is applied to it and current flow through the path v$^+$-T1-R-T2-V$^-$. During negative half cycle T3 & T4 is forward biased and the thyristor T1 &T2 are reversed biased. The current flow through the path v$^+$-T3-R-T4-V$^-$. The wave form show the output voltage ,output current & voltage across thyristor.

CIRCUIT DIAGRAM:-





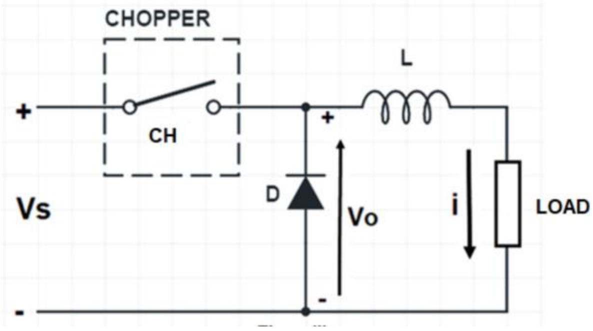
CONCLUSION:- From the above experiments we able to draw the single phase full bridge controlled rectifier by using simulink.

EXPERIMENT NO. 11

AIM OF THE EXPERIMENT:- To study the simulink model of step down chopper.

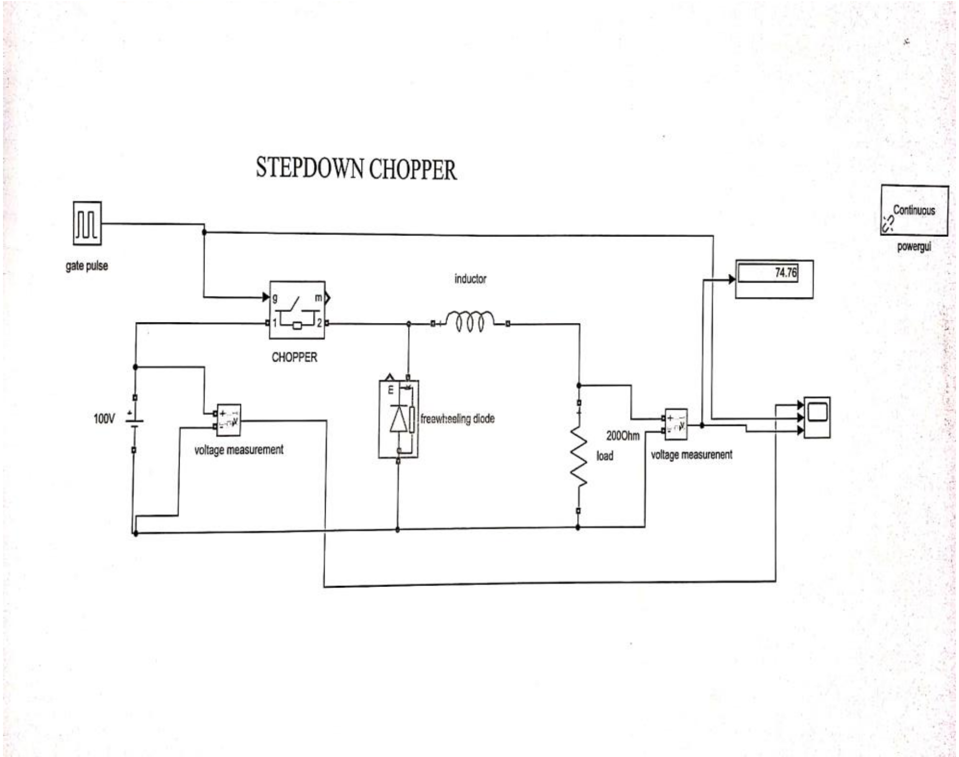
SOFTWARE USED:- : Matlab & simulink

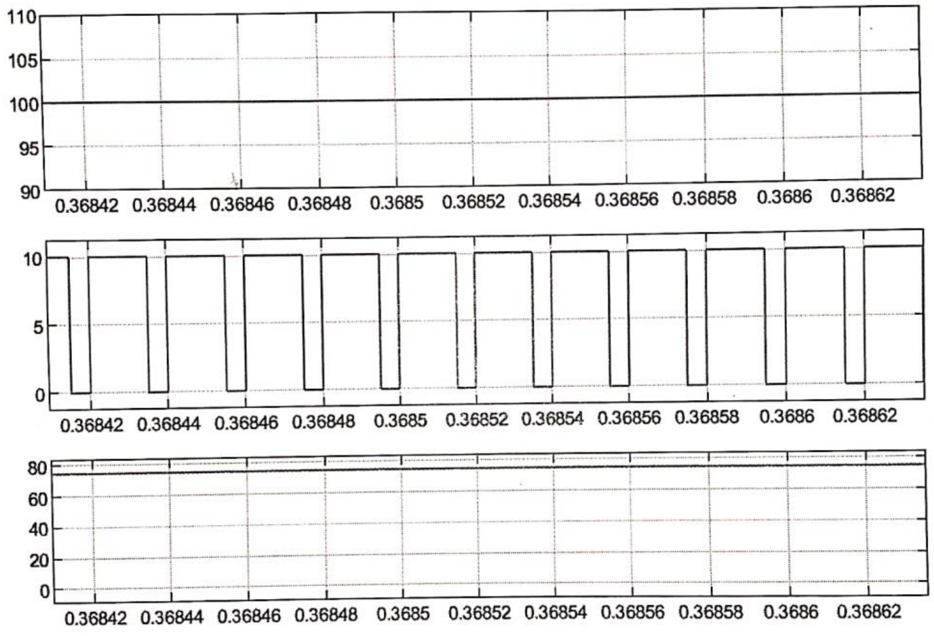
THEORY:-



- A chopper that produces an output voltage lesser than source voltage is called step-down chopper.
- In general, DC chopper consists of power semiconductor devices like SCR, BJT,G.T.O , Power MOSFET etc. which work as a switch.
- The average output voltage across the load is control by varying the ON & OFF period of switch.
- During the period of T_{ON} chopper is ON & supply terminal are connected to the load . During the interval when chopper is OFF the load current flow through the free wheeling diode.

CIRCUIT DIAGRAM:-





CONCLUSION:- From the above experiments we able to draw bridge step down chopper by using simulink