BASIC SIMULATION

LABORATORY MANUAL

II – I SEMESTER

Prepared By
Mr.GS Naveen Kumar, Associate Professor
Ms.N.Saritha, Assistant Professor

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS ENGG

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
(Sponsored by CMR Educational Society)
(Affiliated to JNTU, Hyderabad)
Secunderabad-100.

CONTENTS

VISION

To evolve into a center of excellence in Engineering Technology through creative and innovative practices in teaching-learning, promoting academic achievement & research excellence to produce internationally accepted competitive and world class professionals.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry institute interaction aimed at employability, entrepreneurship, leadership and research aptitude among students.

QUALITY POLICY

- Impart up-to-date knowledge to the students in Electronics & Communication area to make them quality engineers.
- Make the students experience the applications on quality equipment and tools.
- Provide systems, resources and training opportunities to achieve continuous improvement.
- Maintain global standards in education, training and services.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: PROFESSIONALISM & CITIZENSHIP To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
PEO2: TECHNICAL ACCOMPLISHMENTS To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
PEO3: INVENTION, INNOVATION AND CREATIVITY To make the students to design, experiment, analyze, interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
PEO4: PROFESSIONAL DEVELOPMENT To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
PEO5: HUMAN RESOURCE DEVELOPMENT To graduate the students in building national capabilities in technology, education and research.

CODE OF CONDUCT FOR THE LABORATORIES

- All students must observe the Dress Code while in the laboratory.
- Sandals or open-toed shoes are NOT allowed.
- Foods, drinks and smoking are NOT allowed.
- All bags must be left at the indicated place.
- The lab timetable must be strictly followed.
- Be PUNCTUAL for your laboratory session.
- Program must be executed within the given time.
- Noise must be kept to a minimum.
- Workspace must be kept clean and tidy at all time.
- Handle the systems and interfacing kits with care.
- All students are liable for any damage to the accessories due to their own negligence.
- All interfacing kits connecting cables must be RETURNED if you taken from the lab supervisor.
- Students are strictly PROHIBITED from taking out any items from the laboratory.
- Students are NOT allowed to work alone in the laboratory without the Lab Supervisor
- USB Ports have been disabled if you want to use USB drive consult lab supervisor.
- Report immediately to the Lab Supervisor if any malfunction of the accessories, is there.

Before leaving the lab

- Place the chairs properly.
- Turn off the system properly
- Turn off the monitor.
- Please check the laboratory notice board regularly for updates.

Experiment No-1

BASIC OPERATIONS ON MATRICES

AIM: Generate a matrix and perform basic operation on matrices using MATLAB software.

Software Required: MATLAB software

Theory:

MATLAB treats all variables as matrices. Vectors are special forms of matrices and contain only one row or one column. Whereas scalars are special forms of matrices and contain only one row and one column. A matrix with one row is called row vector and a matrix with single column is called column vector.

The first one consists of convenient matrix building functions, some of which are given below.

1. eye - identity matrix
2. zeros - matrix of zeros
3. ones - matrix of ones
4. diag - extract diagonal of a matrix or create diagonal matrices
5. triu - upper triangular part of a matrix
6. tril - lower triangular part of a matrix
7. rand - ran

commands in the second sub-category of matrix functions are

1. size- size of a matrix
2. det -determinant of a square matrix
3. inv- inverse of a matrix
4. rank- rank of a matrix
5. rref- reduced row echelon form
6. eig- eigenvalues and eigenvectors
7. poly- characteristic polynomialdomly generated matrix

Program:

% Creating a column vector

```
>> a=[1;2;3]

a =

1

2

3
```

% Creating a row vector

```
>> b=[1 2 3]

b=

1 2 3
```

% Creating a matrix

>> m=[1 2 3;4 6 9;2 6 9]

m =

1 2 3

4 6 9

2 6 9

% Extracting sub matrix from matrix

>> sub_m=m(2:3,2:3)

sub_m =

6 9

6 9

% extracting column vector from matrix

>> c=m (:,2)

c =

2
6
6
% extracting row vector from matrix

>> d=m (3,:)

d =

2 6 9

% creation of two matrices a and b

>> a=[2 4 -1;-2 1 9;-1 -1 0]

a =

2 4 -1

-2 1 9

-1 -1 0

>> b=[0 2 3;1 0 2;1 4 6]

b =

0 2 3

1 0 2

1 4 6

% matrix multiplication

>> x1=a*b

x1 =

3 0 8

10 32 50

-1 -2 -5

% element to element multiplication

>> x2=a.*b

x2 =

0 8 -3

-2 0 18

-1 -4 0

% matrix addition

>> x3=a+b

x3 =

2 6 2

-1 1 11

0 3 6

% matrix subtraction

>> x4=a-b

x4 =

2 2 -4

-3 1 7

-2 -5 -6

% matrix division

>> x5=a/b

x5 =

-9.0000 -3.5000 5.5000

12.0000 3.7500 -5.7500

3.0000 0.7500 -1.7500

% element to element division

>> x6=a./b

Warning: Divide by zero.

x6 =

Inf 2.0000 -0.3333

-2.0000 Inf 4.5000

-1.0000 -0.2500 0

% inverse of matrix a

>> x7=inv(a)

x7 =

-0.4286 -0.0476 -1.7619

0.4286 0.0476 0.7619

-0.1429 0.0952 -0.4762

% transpose of matrix a

>> x8=a'

x8 =

2 -2 -1

4 1 -1

-1 9 0

RESULT: Matrix operations are performed using Matlab software.

VIVA QUESTIONS:-

1. Expand MATLAB? And importance of MATLAB?
2. What is clear all and close all will do?
3. What is disp() and input()?
4. What is the syntax to find the eigen values and eigenvectors of the matrix?
5. What is the syntax to find rank of the matrix?

Experiment No-2
Generation of signals and sequences

AIM: Generate various signals and sequences (Periodic and aperiodic), such as Unit Impulse, Unit Step, Square, Saw tooth, Triangular, Sinusoidal, Ramp, Sinc.

Software Required: Matlab software

Theory: If the amplitude of the signal is defined at every instant of time then it is called continuous time signal. If the amplitude of the signal is defined at only at some instants of time then it is called discrete time signal. If the signal repeats itself at regular intervals then it is called periodic signal. Otherwise they are called aperiodic signals.

EX: ramp,Impulse,unit step, sinc- Aperiodic signals

square,sawtooth,triangular sinusoidal – periodic signals.

Ramp sinal: The **ramp function** is a unitary real function, easily computable as the mean of the independent variable and its absolute value.This function is applied in engineering. The name *ramp function* is derived from the appearance of its graph.

$$\mathbf{r(t)} = \begin{cases} \mathbf{t} & \textbf{when } t \geq 0 \\ \mathbf{0} & \textbf{else} \end{cases}$$

Unit impulse signal: One of the more useful functions in the study of linear systems is the "unit impulse function."An ideal impulse function is a function that is zero everywhere but at the origin, where it isinfinitely high. However, the *area* of the impulse is finite

Y(t)= 1 when t=0

=0 other wise

Unit step signal: The unit step function and the impulse function are considered to be fundamental functions in engineering, and it is strongly recommended that the reader becomes very familiar with both of these functions.

$$\mathbf{u(t)} = \begin{cases} \mathbf{0} \textbf{ if } \mathbf{t < 0} \\ \mathbf{1} \textbf{ if } \mathbf{t > 0} \\ \frac{1}{2} \textbf{ If } \mathbf{t=0} \end{cases}$$

Sinc signal: There is a particular form that appears so frequently in communications engineering, that we give it its own name. This function is called the "Sinc function”.

The Sinc function is defined in the following manner:

$$sinc(x) = \frac{\sin \pi x}{\pi x} \quad \textbf{if } x \neq 0 \textbf{ and } \textbf{sinc(0) =1}$$

The value of sinc(x) is defined as 1 at x = 0, since

$$\lim_{x \to 0} sinc(x) = 1$$

PROCEDURE:-

- Open MATLAB
- Open new M-file
- Type the program
- Save in current directory
- Compile and Run the program
- For the output see command window\ Figure window

PROGRAM:

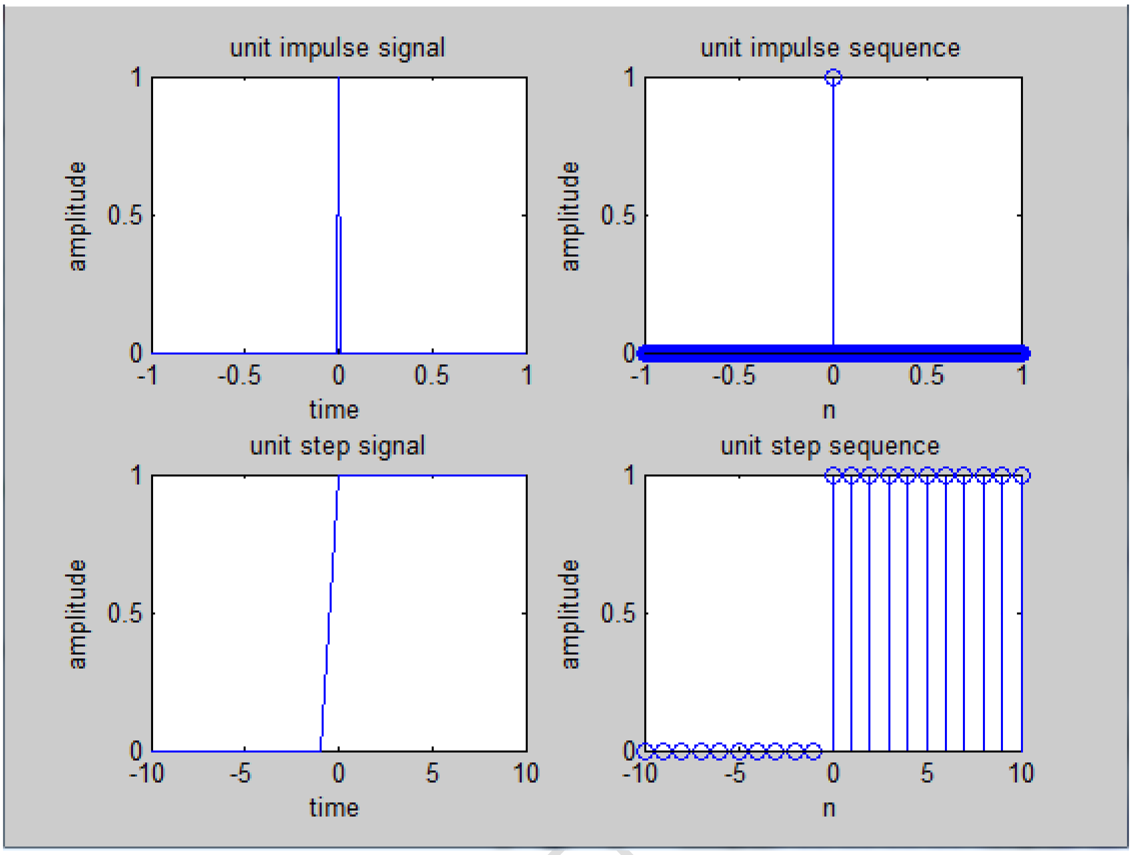
```
% Generation of signals and sequences
clc;
clear all;
close all;
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
%generation of unit impulse signal
t1=-1:0.01:1
y1=(t1==0);
subplot(2,2,1);
plot(t1,y1);
xlabel('time');
ylabel('amplitude');
title('unit impulse signal');
%generation of impulse sequence
subplot(2,2,2);
stem(t1,y1);
xlabel('n');
ylabel('amplitude');
title('unit impulse sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of unit step signal
t2=-10:1:10;
y2=(t2>=0);
subplot(2,2,3);
plot(t2,y2);
xlabel('time');
ylabel('amplitude');
title('unit step signal');
%generation of unit step sequence
subplot(2,2,4);
stem(t2,y2);
xlabel('n');
ylabel('amplitude');
title('unit step sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of square wave signal
t=0:0.002:0.1;
y3=square(2*pi*50*t);
```

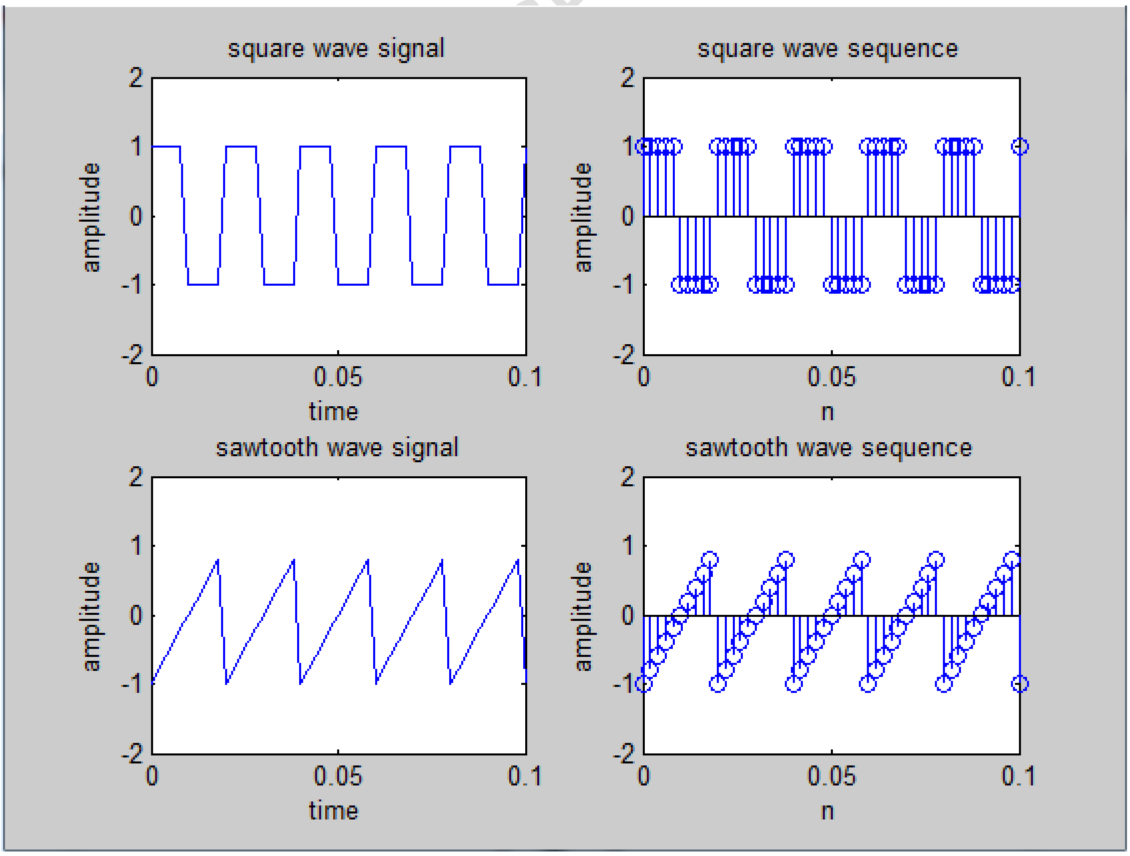
```
figure;
subplot(2,2,1);
plot(t,y3);
axis([0 0.1 -2 2]);
xlabel('time');
ylabel('amplitude');
title('square wave signal');
%generation of square wave sequence
subplot(2,2,2);
stem(t,y3);
axis([0 0.1 -2 2]);
xlabel('n');
ylabel('amplitude');
title('square wave sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of sawtooth signal
y4=sawtooth(2*pi*50*t);
subplot(2,2,3);
plot(t,y4);
axis([0 0.1 -2 2]);
xlabel('time');
ylabel('amplitude');
title('sawtooth wave signal');
%generation of sawtooth sequence
subplot(2,2,4);
stem(t,y4);
axis([0 0.1 -2 2]);
xlabel('n');
ylabel('amplitude');
title('sawtooth wave sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of triangular wave signal
y5=sawtooth(2*pi*50*t,.5);
figure;
subplot(2,2,1);
plot(t,y5);
axis([0 0.1 -2 2]);
xlabel('time');
ylabel('amplitude');
title(' triangular wave signal');
%generation of triangular wave sequence
subplot(2,2,2);
stem(t,y5);
axis([0 0.1 -2 2]);
xlabel('n');
ylabel('amplitude');
title('triangular wave sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

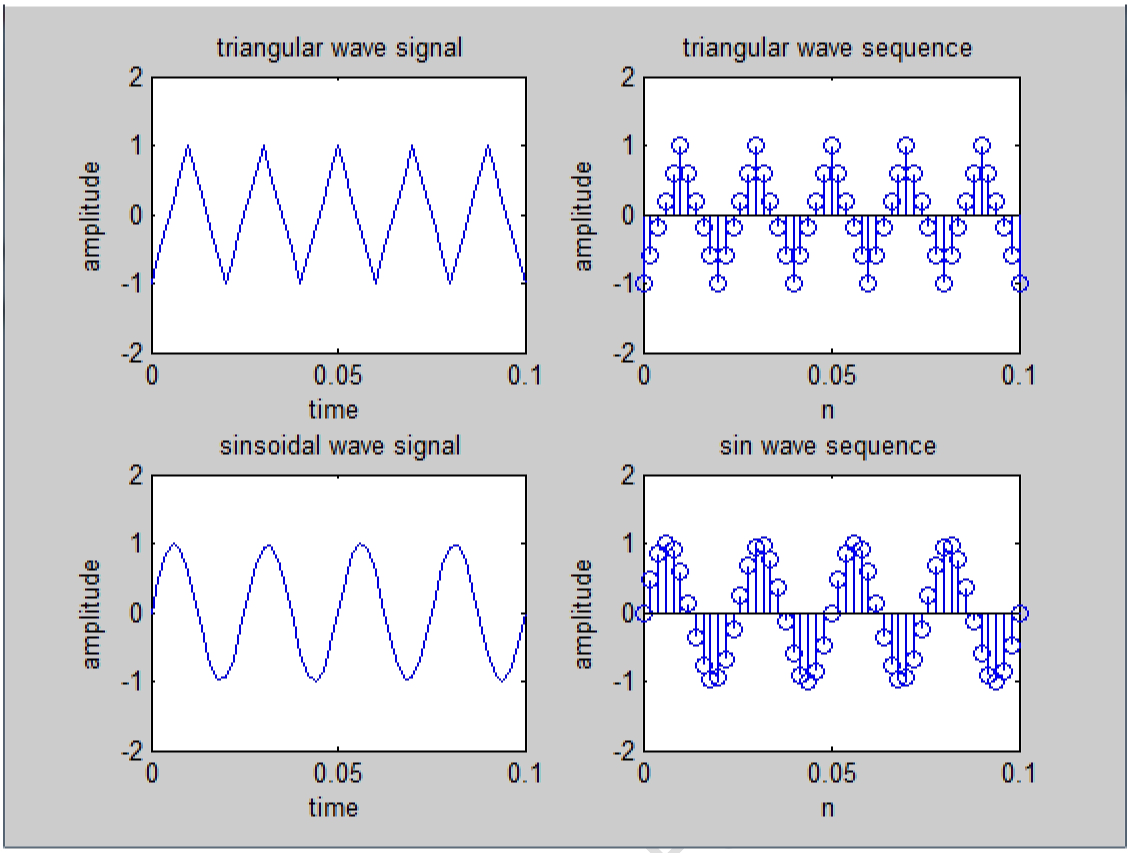
```
%generation of sinsoidal wave signal
y6=sin(2*pi*40*t);
subplot(2,2,3);
plot(t,y6);
axis([0 0.1 -2 2]);
xlabel('time');
ylabel('amplitude');
title(' sinsoidal wave signal');
%generation of sin wave sequence
subplot(2,2,4);
stem(t,y6);
axis([0 0.1 -2 2]);
xlabel('n');
ylabel('amplitude');
title('sin wave sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of ramp signal
y7=t;
figure;
subplot(2,2,1);
plot(t,y7);
xlabel('time');
ylabel('amplitude');
title('ramp signal');
%generation of ramp sequence
subplot(2,2,2);
stem(t,y7);
xlabel('n');
ylabel('amplitude');
title('ramp sequence');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

%generation of sinc signal
t3=linspace(-5,5);
y8=sinc(t3);
subplot(2,2,3);
plot(t3,y8);
xlabel('time');
ylabel('amplitude');
title(' sinc signal');
%generation of sinc  sequence
subplot(2,2,4);
stem(y8);
xlabel('n');
ylabel('amplitude');
title('sinc sequence');
```

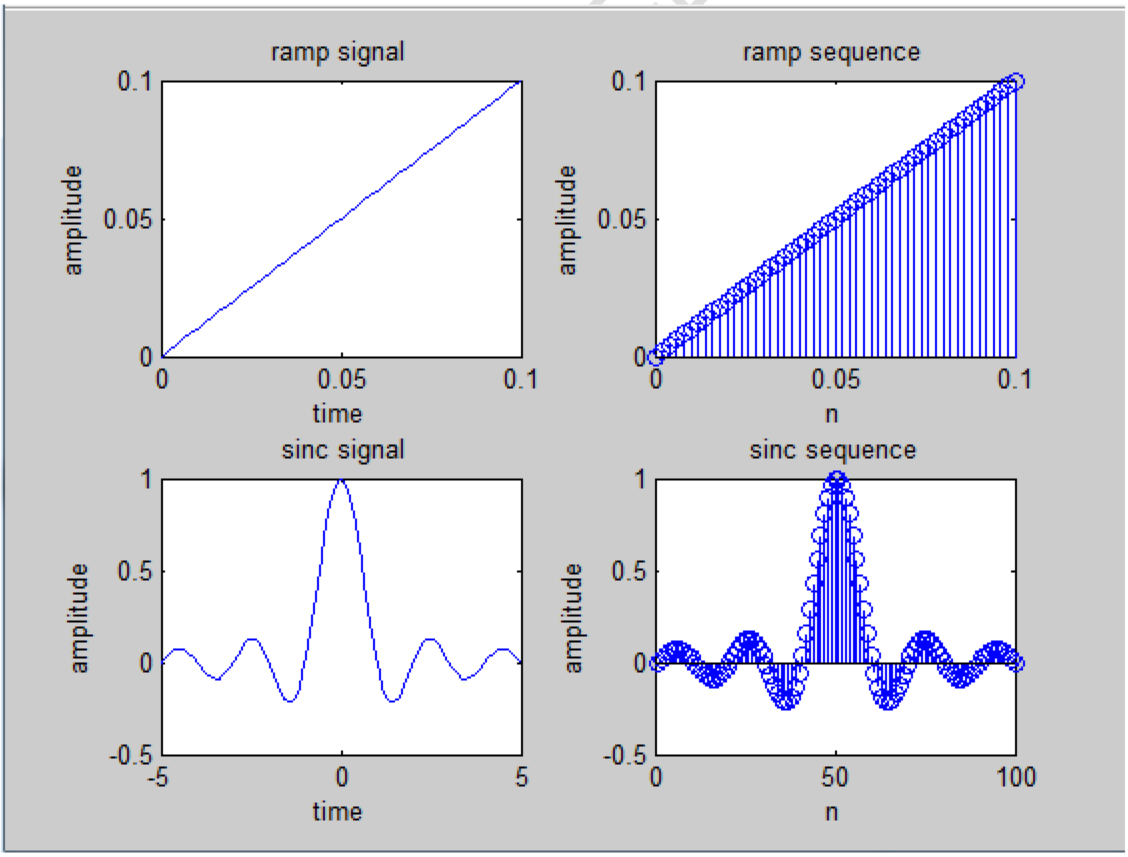

Result: Various signals & sequences generated using Matlab software.

output:


unit impulse signal
amplitude
time
unit impulse sequence
amplitude
n
unit step signal
amplitude
time
unit step sequence
amplitude
n


square wave signal
amplitude
time
square wave sequence
amplitude
n
sawtooth wave signal
amplitude
time
sawtooth wave sequence
amplitude
n


triangular wave signal
amplitude
time
triangular wave sequence
amplitude
n
sinsoidal wave signal
amplitude
time
sin wave sequence
amplitude
n


ramp signal
amplitude
time
ramp sequence
amplitude
n
sinc signal
amplitude
time
sinc sequence
amplitude
n

VIVA QUESTIONS:-

1. Define Signal?
2. Define continuous and discrete Signals?
3. State the relation between step, ramp and Delta Functions?
4. Differentiate saw tooth and triangular signals?
5. Define Periodic and aperiodic Signal?

Experiment No-3
Basic Operations on Signals and sequences

AIM: perform the operations on signals and sequences such as addition, multiplication, scaling, shifting, folding and also compute energy and power.

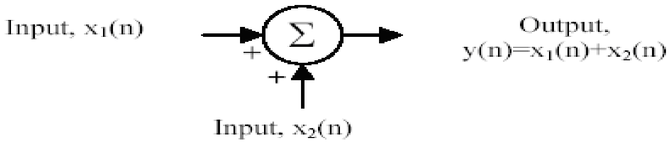
Software Required: Matlab software.

Theory:

Signal Addition

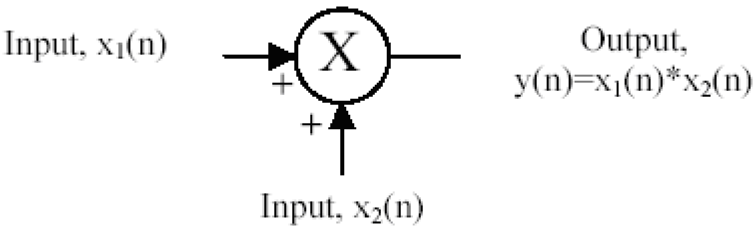
Addition: any two signals can be added to form a third signal,

$$z(t) = x(t) + y(t)$$



Multiplication :

Multiplication of two signals can be obtained by multiplying their values at every instants . z
$z(t) = x(t)\, y(t)$

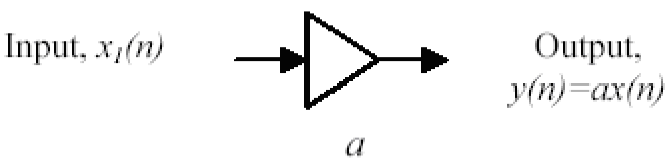


Time reversal/Folding:

Time reversal of a signal x(t) can be obtained by folding the signal about t=0.
$Y(t)=y(-t)$

Signal Amplification/Scaling : $Y(n)=ax(n)$ if $a < 1$ attnuation

$a > 1$ amplification



Time shifting: The time shifting of x(n) obtained by delay or advance the signal in time by using $y(n)=x(n+k)$

If k is a positive number, y(n) shifted to the right i e the shifting delays the signal

If k is a negative number, y(n) it gets shifted left. Signal Shifting advances the signal

Energy:

$$E[n] = \lim_{N\to\infty} \sum_{n=-N}^{N} |x[n]|^2 = \sum_{n=-\infty}^{\infty} |x[n]|^2$$

Average power:

$$P[n] = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$$

Program:

```
clc;
clear all;
close all;
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

% generating two input signals
t=0:.01:1;
x1=sin(2*pi*4*t);
x2=sin(2*pi*8*t);
subplot(2,2,1);
plot(t,x1);
xlabel('time');
ylabel('amplitude');
title('input signal 1');
subplot(2,2,2);
plot(t,x2);
xlabel('time');
ylabel('amplitude');
title('input signal 2');

% addition of signals
y1=x1+x2;
subplot(2,2,3);
plot(t,y1);
xlabel('time');
ylabel('amplitude');
title('addition of two signals');

% multiplication of signals
y2=x1.*x2;
subplot(2,2,4);
plot(t,y2);
xlabel('time');
ylabel('amplitude');
title('multiplication of two signals');
```

```
% scaling of a signal1
A=2;
y3=A*x1;
figure;
subplot(2,2,1);
plot(t,x1);
xlabel('time');
ylabel('amplitude');
title('input signal')
subplot(2,2,2);
plot(t,y3);
xlabel('time');
ylabel('amplitude');
title('amplified input signal');

% folding of a signal1
h=length(x1);
nx=0:h-1;
subplot(2,2,3);
plot(nx,x1);
xlabel('nx');
ylabel('amplitude');
title('input signal')
y4=fliplr(x1);
nf=-fliplr(nx);
subplot(2,2,4);
plot(nf,y4);
xlabel('nf');
ylabel('amplitude');
title('folded signal');

%shifting of a signal 1
figure;
subplot(3,1,1);
plot(t,x1);
xlabel('time t');
ylabel('amplitude');
title('input signal');
subplot(3,1,2);
plot(t+2,x1);
xlabel('t+2');
ylabel('amplitude');
title('right shifted signal');
subplot(3,1,3);
plot(t-2,x1);
xlabel('t-2');
ylabel('amplitude');
title('left shifted signal');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

```
%operations on sequences
n1=1:1:9;
s1=[1 2 3 0 5 8 0 2 4];
figure;
subplot(2,2,1);
stem(n1,s1);
xlabel('n1');
ylabel('amplitude');
title('input sequence1');
s2=[1 1 2 4 6 0 5 3 6];
subplot(2,2,2);
stem(n1,s2);
xlabel('n2');
ylabel('amplitude');
title('input sequence2');

% addition of sequences
s3=s1+s2;
subplot(2,2,3);
stem(n1,s3);
xlabel('n1');
ylabel('amplitude');
title('sum of two sequences');

% multiplication  of sequences
s4=s1.*s2;
subplot(2,2,4);
stem(n1,s4);
xlabel('n1');
ylabel('amplitude');
title('product of two sequences');
%~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

% program for energy of a sequence
z1=input('enter the input sequence');
e1=sum(abs(z1).^2);
disp('energy of given sequence is');e1

% program for energy of a signal
t=0:pi:10*pi;
z2=cos(2*pi*50*t).^2;
e2=sum(abs(z2).^2);
disp('energy of given signal is');e2

% program for power of a sequence
p1= (sum(abs(z1).^2))/length(z1);
disp('power of given sequence is');p1

% program for power of a signal
p2=(sum(abs(z2).^2))/length(z2);
disp('power of given signal is');p2
```

OUTPUT:

enter the input sequence[1 3 2 4 1]

energy of given sequence is

e1 = 31

energy of given signal is

e2 = 4.0388

power of given sequence is

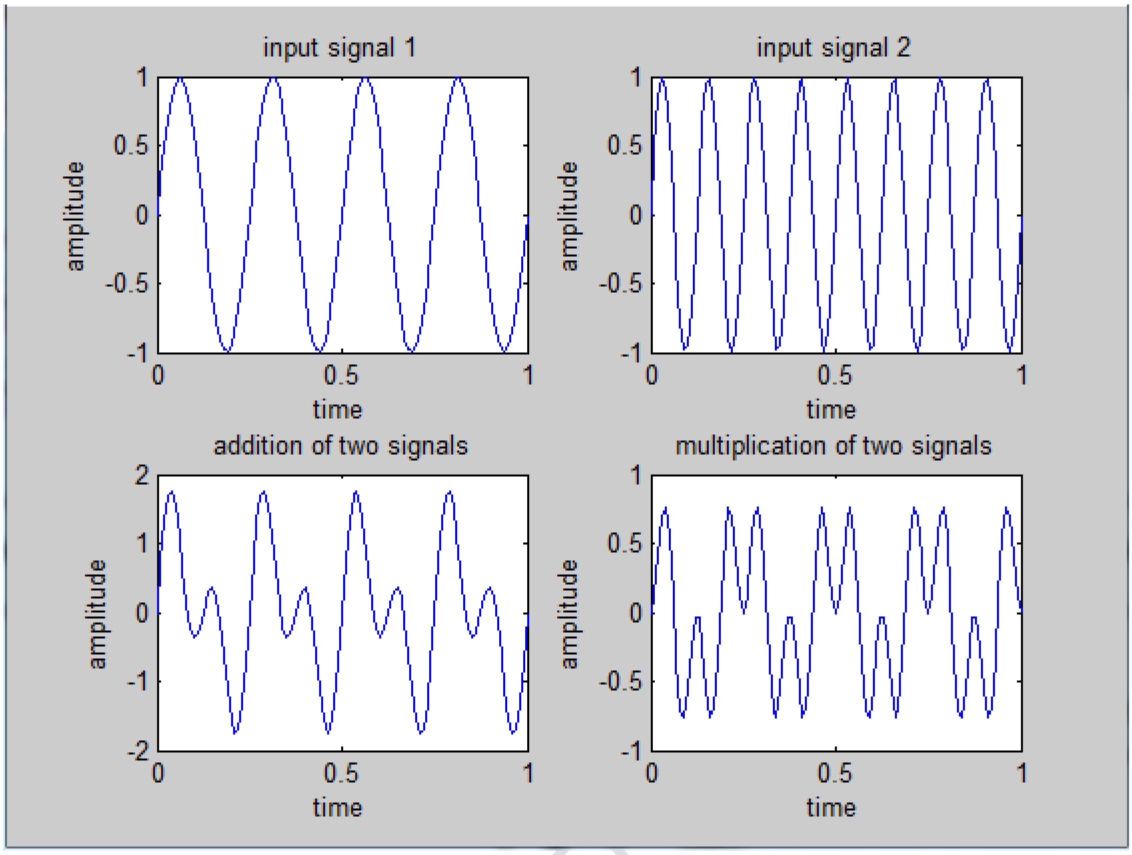
p1 = 6.2000

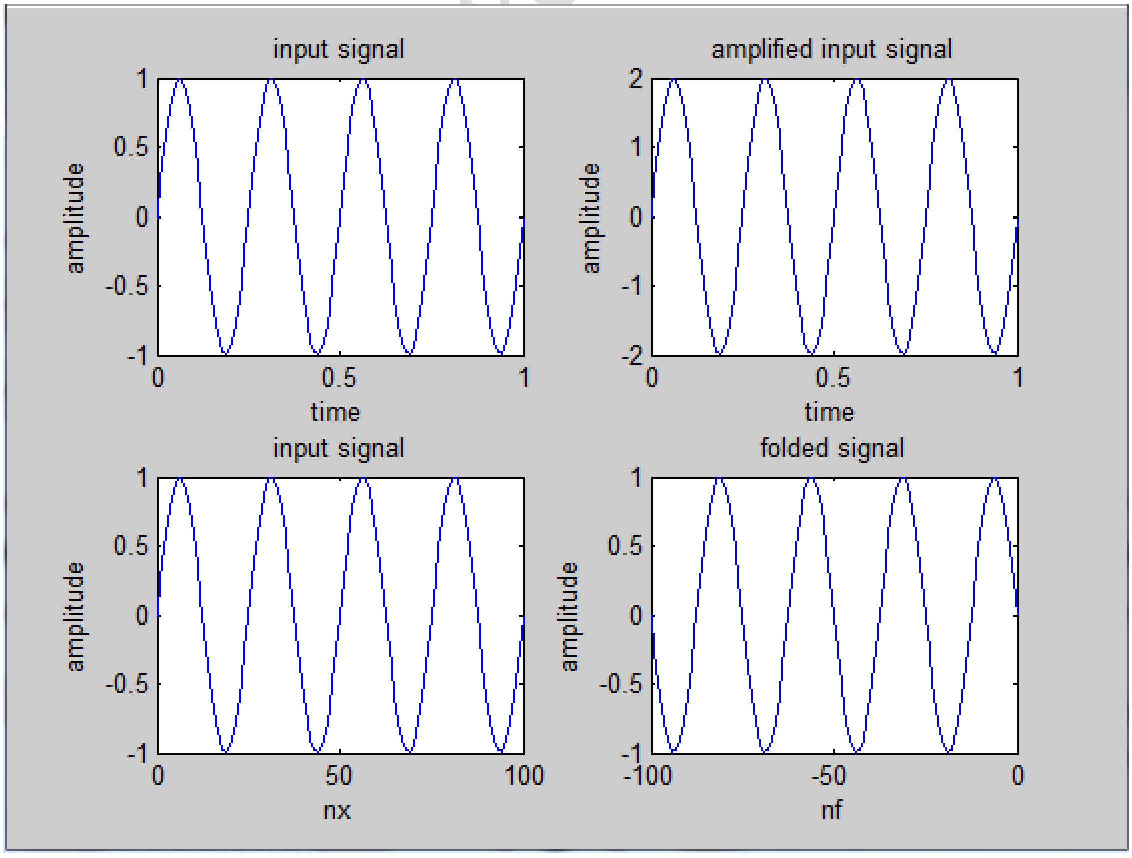
power of given signal is

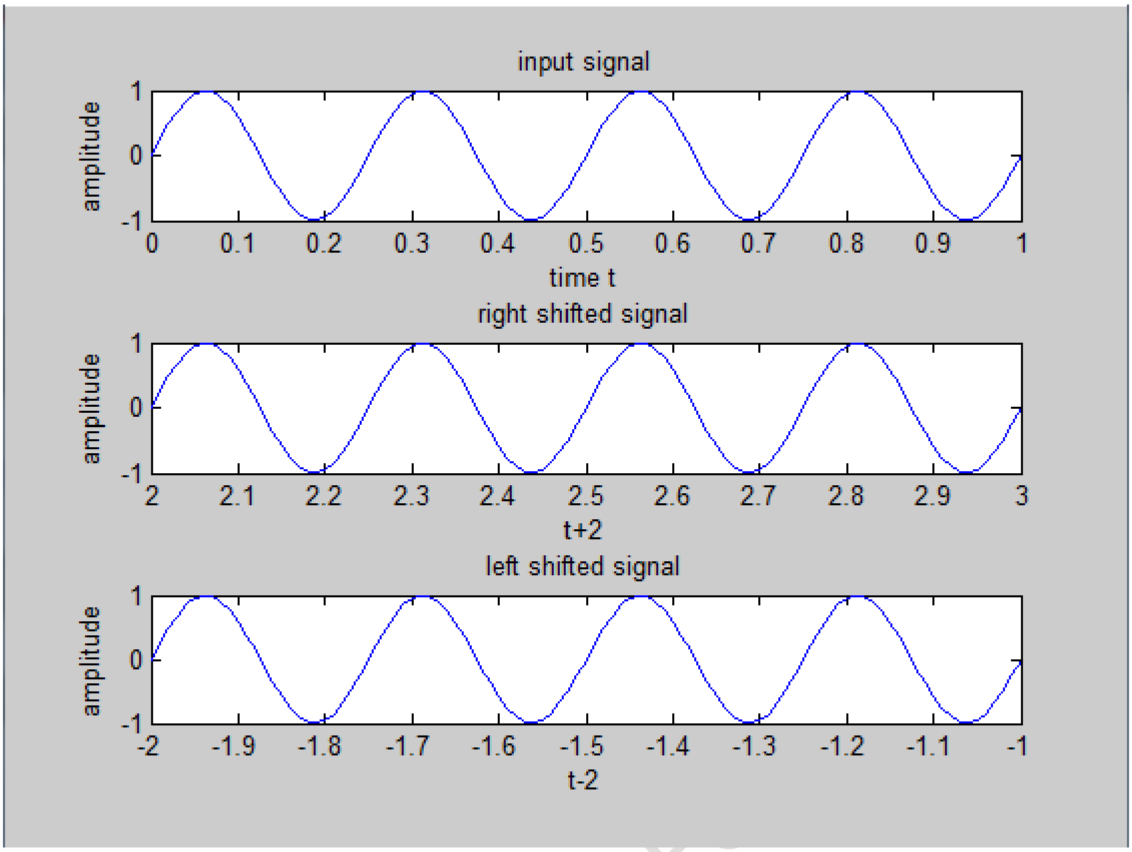
p2 = 0.3672

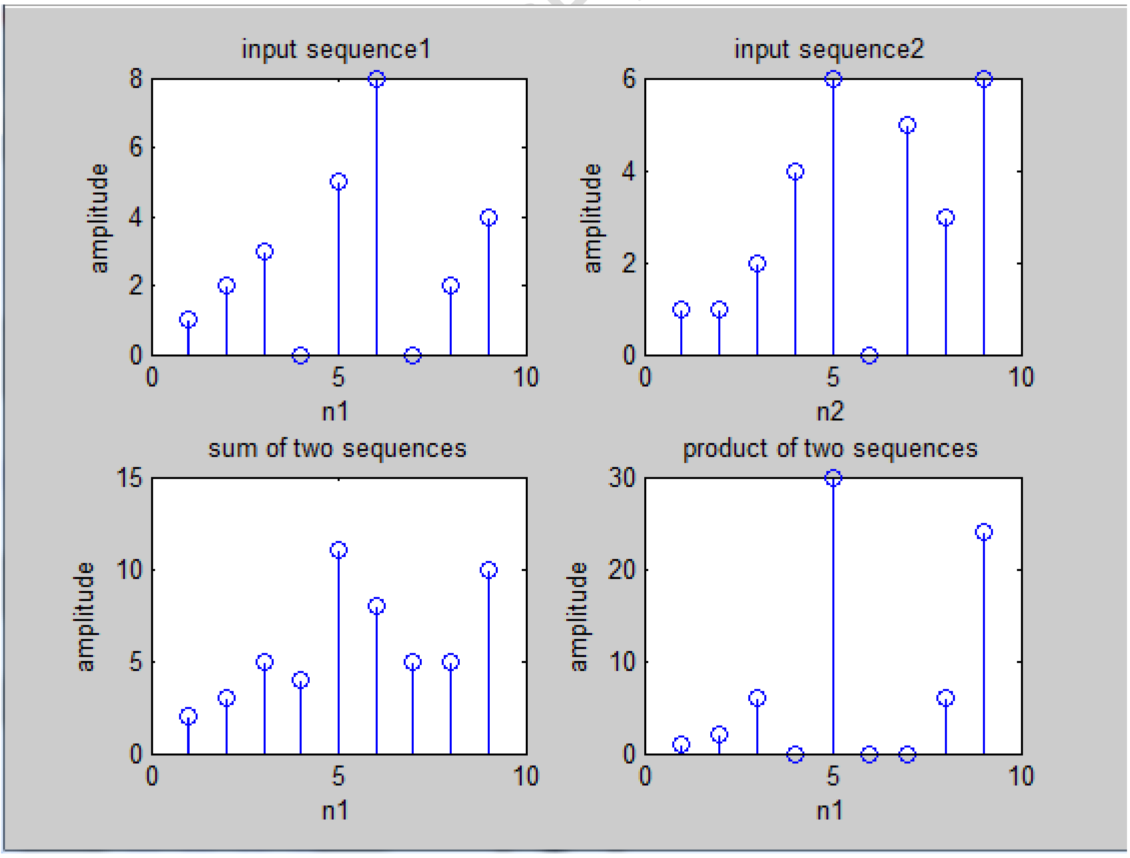
Result: Various operations on signals and sequences are performed.

Output:


input signal 1
amplitude
time
input signal 2
amplitude
time
addition of two signals
amplitude
time
multiplication of two signals
amplitude
time


input signal
amplitude
time
amplified input signal
amplitude
time
input signal
amplitude
nx
folded signal
amplitude
nf


input signal
amplitude
time t
right shifted signal
t+2
left shifted signal
t-2


input sequence1
input sequence2
amplitude
n1
n2
sum of two sequences
product of two sequences

VIVA QUESTIONS:-

1. Define Symmetric and Anti-Symmetric Signals?
2. Define Continuous and Discrete Time Signals?
3. What are the Different types of representation of discrete time signals?
4. What are the Different types of Operation performed on signals?
5. What is System?

Experiment No-4
Even and odd parts of signal and sequence & Real and imaginary parts of Signal

AIM: Finding even and odd part of the signal and sequence and also find real and imaginary parts of signal.

Software Required: Matlab software

Theory: One of characteristics of signal is symmetry that may be useful for signal analysis. Even signals are symmetric around vertical axis, and Odd signals are symmetric about origin.

Even Signal: A signal is referred to as an even if it is identical to its time-reversed counterparts; x(t) = x(-t).

Odd Signal: A signal is odd if x(t) = -x(-t).

An odd signal must be 0 at t=0, in other words, odd signal passes the origin.

Using the definition of even and odd signal, any signal may be decomposed into a sum of its even part, xe(t), and its odd part, xo(t), as follows

Even and odd part of a signal: Any signal x(t) can be expressed as sum of even and odd components i.e .,

$$x(t)=x_e(t)+x_o(t)$$

$$x_e(t) = \frac{1}{2}\{x(t) + x(-t)\}$$

$$x_o(t) = \frac{1}{2}\{x(t) - x(-t)\}$$

$$\begin{aligned} x(t) &= x_e(t) + x_o(t) \\ &= \frac{1}{2}\{x(t) + x(-t)\} + \frac{1}{2}\{x(t) - x(-t)\} \end{aligned}$$

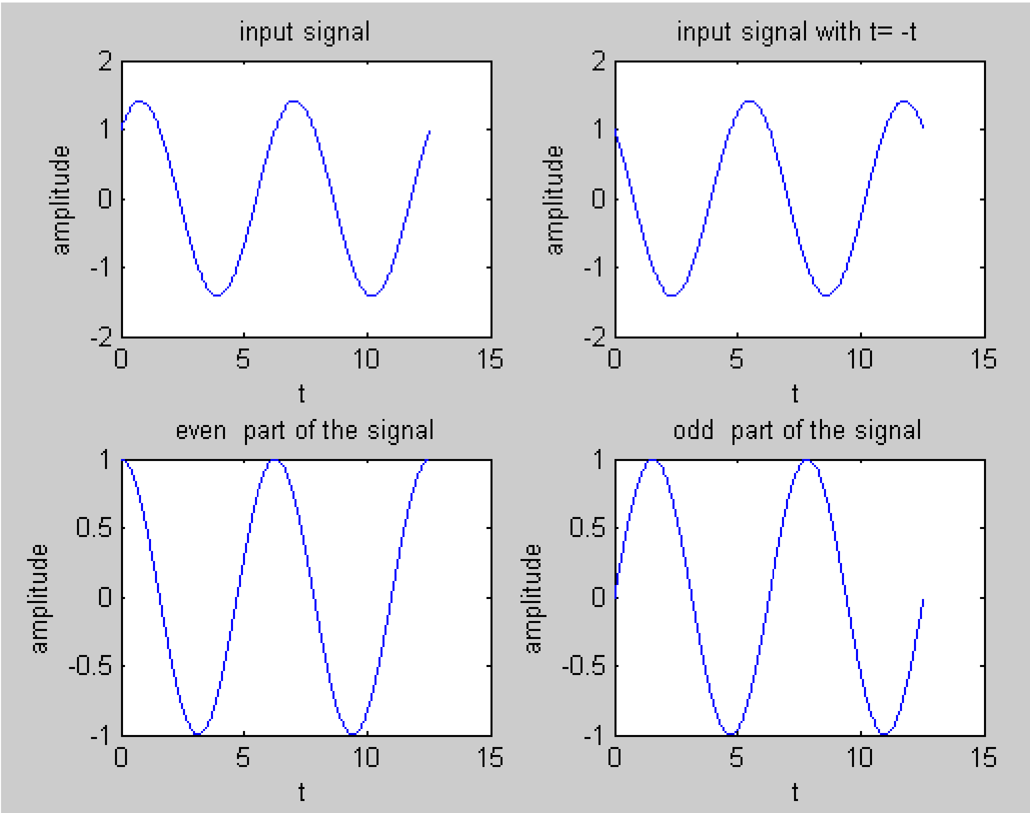
Program:

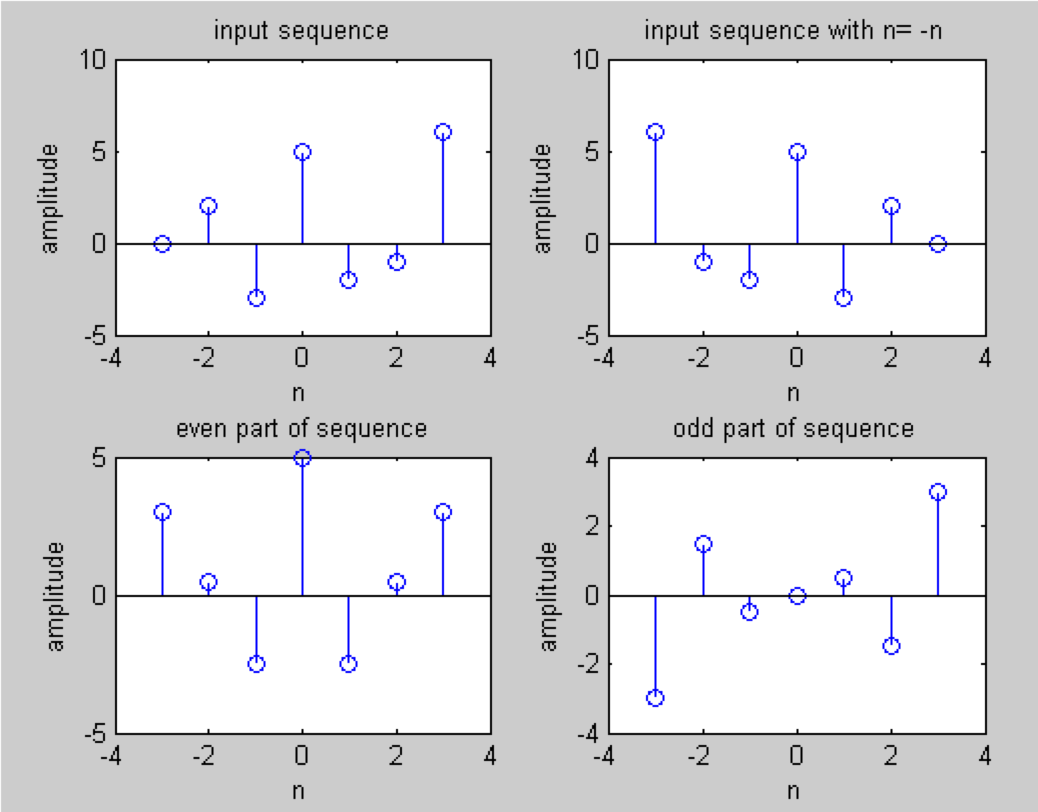
```
clc
close all;
clear all;

%Even and odd parts of a signal
t=0:.001:4*pi;
x=sin(t)+cos(t);      % x(t)=sint(t)+cos(t)
subplot(2,2,1)
plot(t,x)
xlabel('t');
ylabel('amplitude')
title('input signal')

y=sin(-t)+cos(-t);  % y(t)=x(-t)
subplot(2,2,2)
plot(t,y)
xlabel('t');
ylabel('amplitude')
title('input signal with t= -t')
even=(x+y)/2;
subplot(2,2,3)
plot(t,even)
xlabel('t');
```

```
ylabel('amplitude')
title('even  part of the signal')
odd=(x-y)/2;
subplot(2,2,4)
plot(t,odd)
xlabel('t');
ylabel('amplitude');
title('odd  part of the signal');

% Even and odd parts of a sequence
x1=[0,2,-3,5,-2,-1,6];
n=-3:3;
y1= fliplr(x1);%y1(n)=x1(-n)
figure;
subplot(2,2,1);
stem(n,x1);
xlabel('n');
ylabel('amplitude');
title('input sequence');
subplot(2,2,2);
stem(n,y1);
xlabel('n');
ylabel('amplitude');
title('input sequence with n= -n');
even1=.5*(x1+y1);
odd1=.5*(x1-y1);

% plotting even and odd parts of the sequence
subplot(2,2,3);
stem(n,even1);
xlabel('n');
ylabel('amplitude');
title('even part of sequence');
subplot(2,2,4);
stem(n,odd1);
xlabel('n');
ylabel('amplitude');
title('odd part of sequence');

% plotting real and imginary parts of the signal
x2=sin(t)+j*cos(t);
figure;
subplot(3,1,1);
plot(t,x2);
xlabel('t');
ylabel('amplitude');
title('input signal');
subplot(3,1,2)
plot(t,real(x2));
xlabel('time');
ylabel('amplitude');
title('real part of signal');
subplot(3,1,3)
plot(t,imag(x2));
xlabel('time');
ylabel('amplitude');
title('imaginary part of siganl');
```

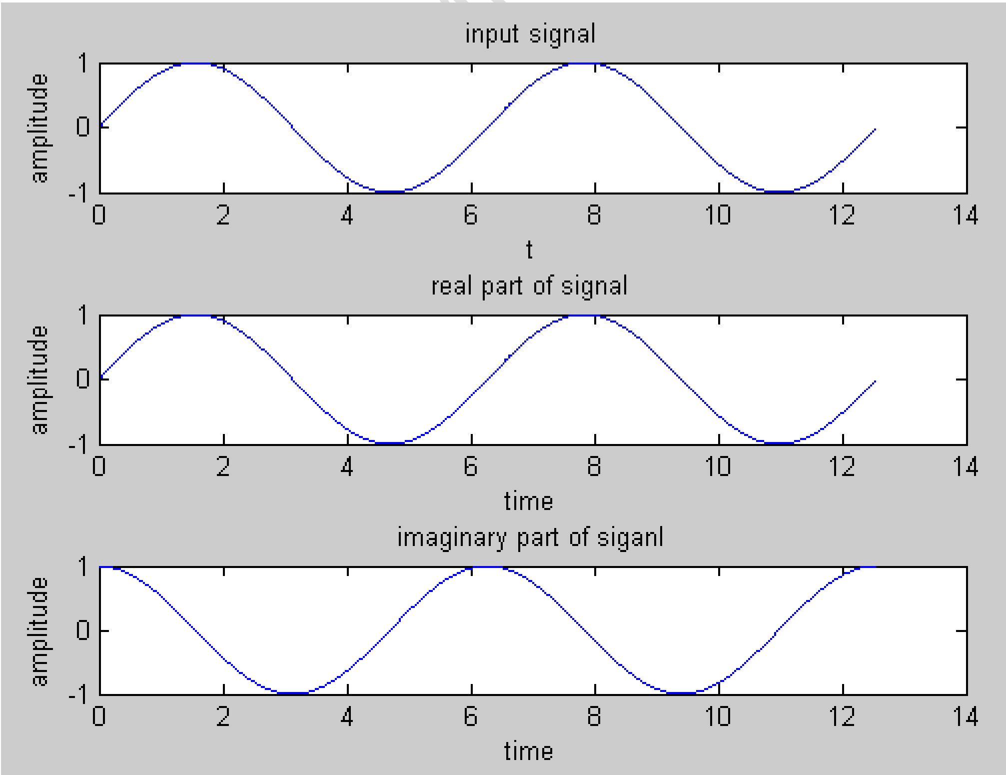
RESULT: Even and odd part of the signal and sequence, real and imaginary parts of signal are computed.

Output:





input sequence
input sequence with n= -n
even part of sequence
odd part of sequence
amplitude
n



input signal
real part of signal
imaginary part of siganl
amplitude
t
time

VIVA QUESTIONS:-

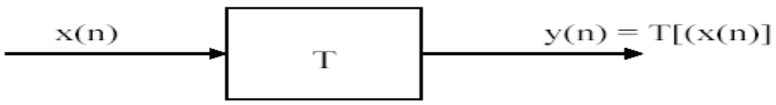
1. What is the formula to find odd part of signal?
2. What is Even Signal?
3. What is Odd Signal?
4. What is the formula to find even part of signal?
5. What is the difference b/w stem & plot?

Experiment No-5
Convolution between signals& sequences

Aim: Write the program for convolution between two signals and also between two sequences.

Software Required: Matlab software

Theory:



Convolution involves the following operations.

1. Folding
2. Multiplication
3. Addition
4. Shifting

$$y[n] = T \sum_{k=-\infty} x[k]. \delta(n-k)$$

These operations can be represented by a Mathematical Expression as follows:

x[n]= Input signal Samples

h[n-k]= Impulse response co-efficient.

y[n]= Convolution output.

n = No. of Input samples

h = No. of Impulse response co-efficient.

Example : X(n)={1 2 -1 0 1}, h(n)={ 1,2,3,-1}

Program:

```
clc;
close all;
clear all;
%program for convolution of two sequences
x=input('enter input sequence: ');
h=input('enter impulse response: ');
y=conv(x,h);
subplot(3,1,1);
stem(x);
xlabel('n');
ylabel('x(n)');
title('input sequence')
subplot(3,1,2);
stem(h);
xlabel('n');
ylabel('h(n)');
title('impulse response sequence')
subplot(3,1,3);
stem(y);
xlabel('n');
ylabel('y(n)');
title('linear convolution')
disp('linear convolution y=');
```

```
disp(y)
%program for signal convolution
t=0:0.1:10;
x1=sin(2*pi*t);
h1=cos(2*pi*t);
y1=conv(x1,h1);
figure;
subplot(3,1,1);
plot(x1);
xlabel('t');
ylabel('x(t)');
title('input signal')
subplot(3,1,2);
plot(h1);
xlabel('t');
ylabel('h(t)');
title('impulse response')
subplot(3,1,3);
plot(y1);
xlabel('n');
ylabel('y(n)');
title('linear convolution');
```

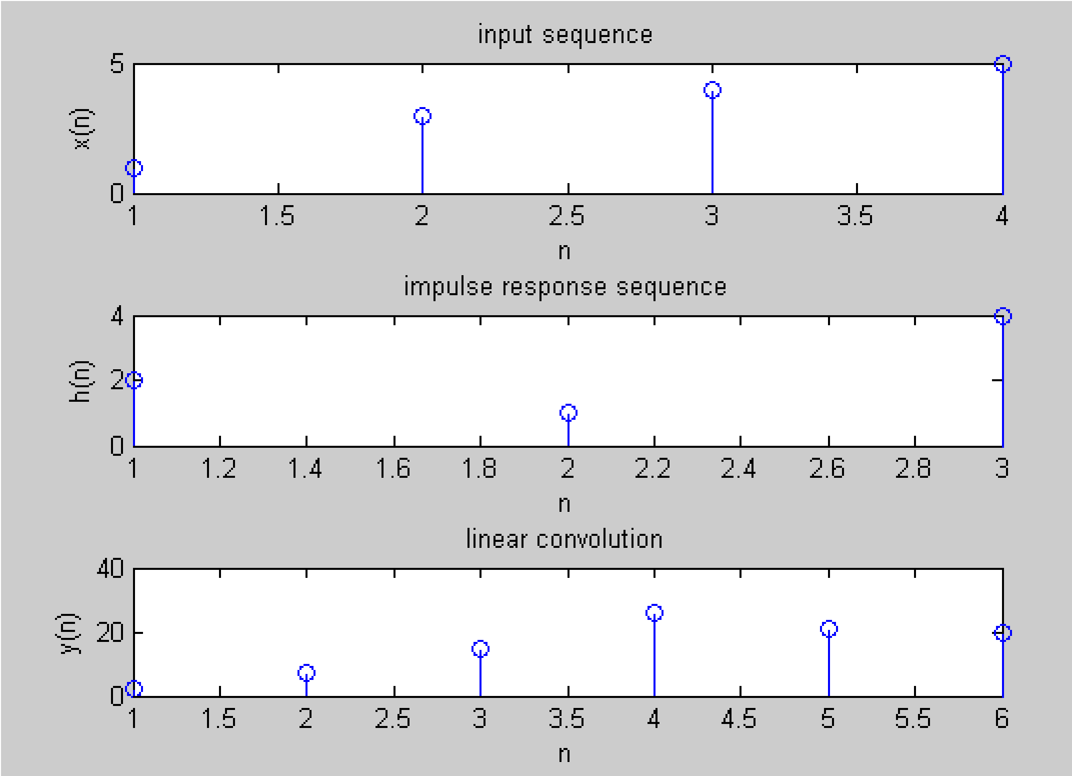
RESULT: convolution between signals and sequences is computed.

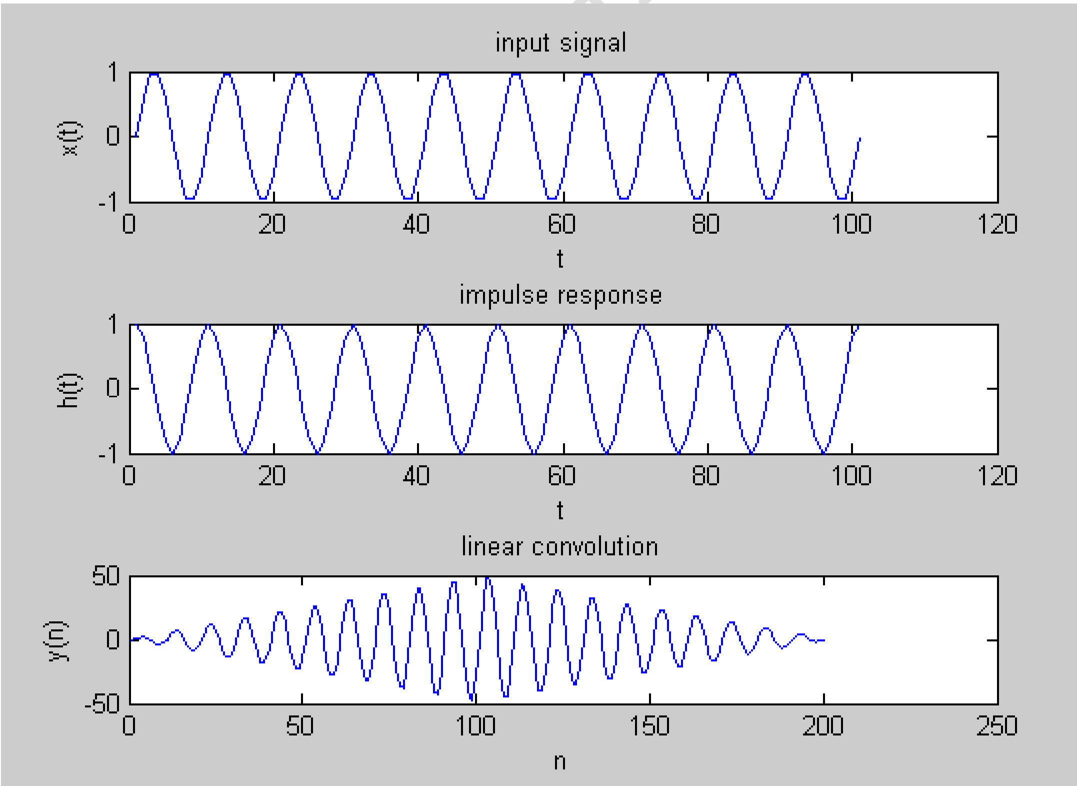
Output:
enter input sequence: [1 3 4 5]

enter impulse response: [2 1 4]

linear convolution y=

2 7 15 26 21 20


input sequence
x(n)
5
0
1
1.5
2
2.5
3
3.5
4
n
impulse response sequence
h(n)
4
2
0
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
n
linear convolution
y(n)
40
20
0
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
n


input signal
x(t)
1
0
-1
0
20
40
60
80
100
120
t
impulse response
h(t)
1
0
-1
0
20
40
60
80
100
120
t
linear convolution
y(n)
50
0
-50
0
50
100
150
200
250
n

VIVA QUESTIONS:-

1. Define Convolution?
2. Define Properties of Convolution?
3. What is the Difference between Convolution& Correlation?
4. Define impulse response?
5. What is Half Wave Symmetry?

Experiment No-6
Auto correlation and Cross correlation

Aim: To compute Auto correlation and Cross correlation between signals and sequences.

Software Required: Mat lab software

Theory:

Correlations of sequences:

It is a measure of the degree to which two sequences are similar. Given two real-valued sequences $x(n)$ and $y(n)$ of finite energy,

Convolution involves the following operations.

1. Shifting
2. Multiplication
3. Addition

These operations can be represented by a Mathematical Expression as follows:

Cross correlation

$$r_{x,y}(l) = \sum_{n=-\infty}^{+\infty} x(n)y(n-l)$$

The index l is called the shift or lag parameter

Autocorrelation

$$r_{x,x}(l) = \sum_{n=-\infty}^{+\infty} x(n)x(n-l)$$

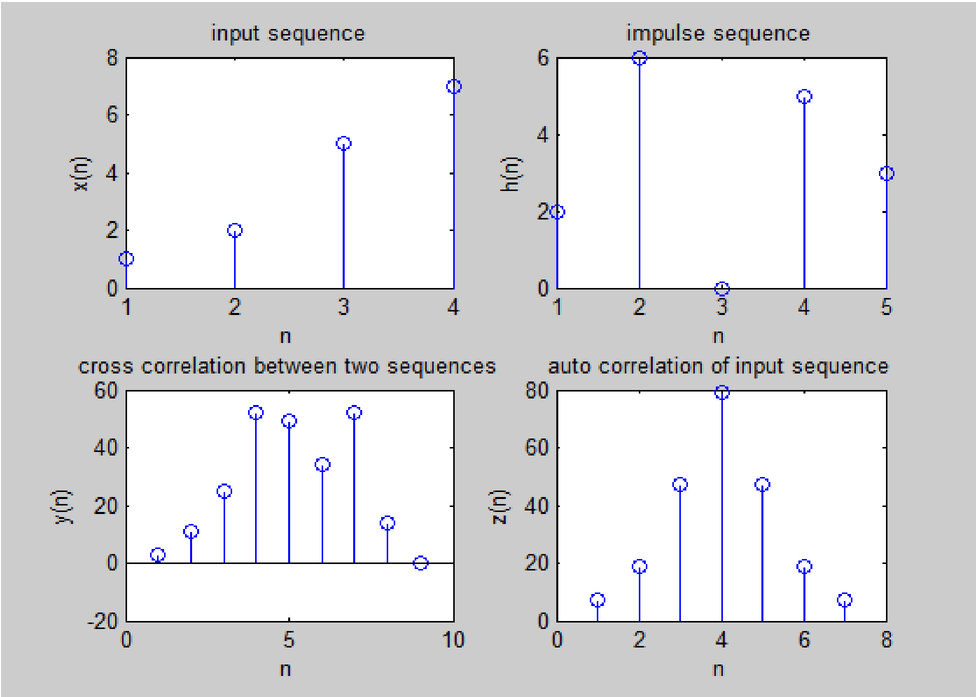
Program:

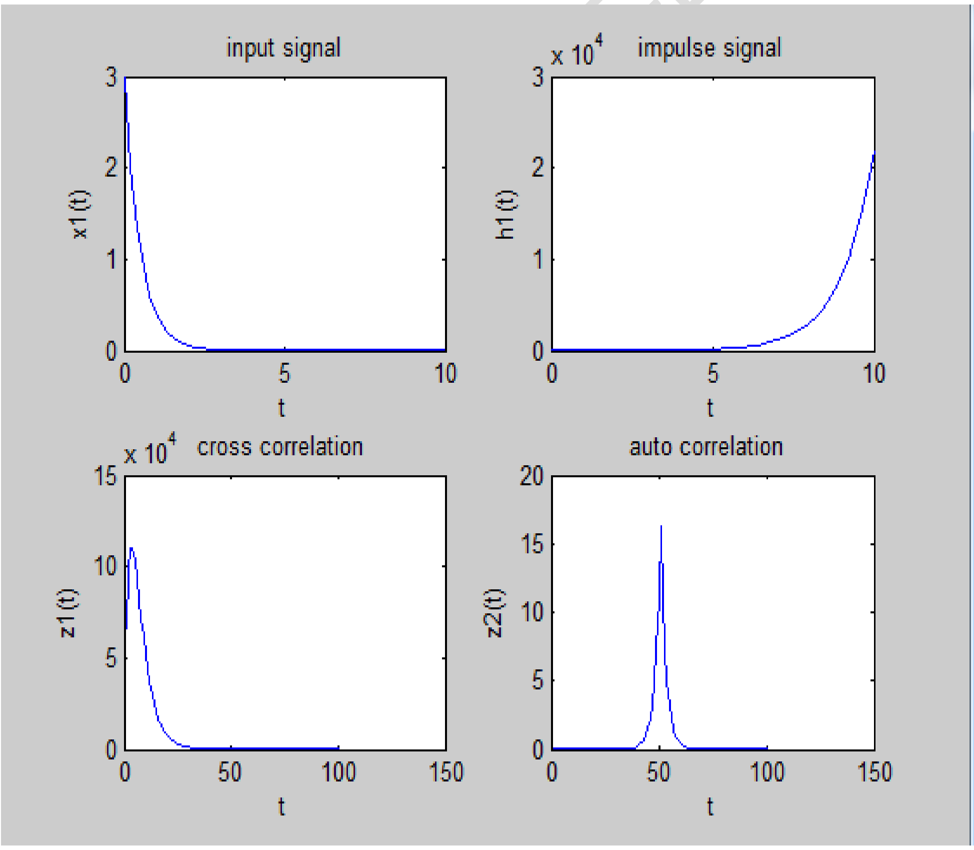
```
clc;
close all;
clear all;

% two input sequences
x=input('enter input sequence');
h=input('enter the impulse suquence');
subplot(2,2,1);
stem(x);
xlabel('n');
ylabel('x(n)');
title('input sequence');
subplot(2,2,2);
stem(h);
xlabel('n');
ylabel('h(n)');
title('impulse sequence');

% cross correlation between two sequences
```

```
y=xcorr(x,h);
subplot(2,2,3);
stem(y);
xlabel('n');
ylabel('y(n)');
title(' cross correlation between two sequences ');
% auto correlation of input sequence
z=xcorr(x,x);
subplot(2,2,4);
stem(z);
xlabel('n');
ylabel('z(n)');
title('auto correlation of input sequence');

%  cross correlation between two signals
% generating two input signals
t=0:0.2:10;
x1=3*exp(-2*t);
h1=exp(t);
figure;
subplot(2,2,1);
plot(t,x1);
xlabel('t');
ylabel('x1(t)');
title('input signal');
subplot(2,2,2);
plot(t,h1);
xlabel('t');
ylabel('h1(t)');
title('impulse signal');

%  cross correlation
subplot(2,2,3);
z1=xcorr(x1,h1);
plot(z1);
xlabel('t');
ylabel('z1(t)');
title('cross correlation ');
% auto correlation
subplot(2,2,4);
z2=xcorr(x1,x1);
plot(z2);
xlabel('t');
ylabel('z2(t)');
title('auto correlation ');
```

Result: Auto correlation and Cross correlation between signals and sequences is computed.

Output: enter input sequence [1 2 5 7]
enter the impulse sequence [2 6 0 5 3]


input sequence
x(n)
n
impulse sequence
h(n)
n
cross correlation between two sequences
y(n)
n
auto correlation of input sequence
z(n)
n


input signal
x1(t)
t
x 10^4 impulse signal
h1(t)
t
x 10^4 cross correlation
z1(t)
t
auto correlation
z2(t)
t

VIVA QUESTIONS:-

1. Define Correlation? And its properties?
2. Define Auto-Correlation?
3. Define Cross-Correlation?
4. What is the importance of correlation?
5. What is the difference b/w correlation and convolution?

Experiment No-7(a)
Verification of Linearity of a Discrete System

AIM: Verify the Linearity of a given Discrete System.

Software Required:
Mat lab software 7.0 and above

Theory:

LINEARITY PROPERTY:
Any system is said to be linear if it satisfies the superposition principal. superposition principal state that Response to a weighted sum of input signal equal to the corresponding weighted sum of the outputs of the system to each of the individual input signals.

If x(n) is a input signal and y(n) is a output signal then

y(n)=T[x(n)]

y1(n)=T[x1(n)] and y2(n)=T[x2(n)]

x3=[a*x1(n) +b *x2(n)]

Y3(n)= T [x3(n)]

T [a*x1(n)+b*x2(n)] = a y1(n)+ b y2(n)

Program:
```
% Verification of Linearity of a given System.
% a) y(n)=nx(n)   b) y=x^2(n)
clc;
clear all;
close all;

n=0:40;
a1=input('enter the scaling factor a1=');
a2=input('enter the scaling factor a2=');
x1=cos(2*pi*0.1*n);
x2=cos(2*pi*0.4*n);
x3=a1*x1+a2*x2;
%y(n)=n.x(n);
y1=n.*x1;
y2=n.*x2;
y3=n.*x3;
yt=a1*y1+a2*y2;
yt=round(yt);
y3=round(y3);
if y3==yt
    disp('given system [y(n)=n.x(n)]is Linear');
else
    disp('given system [y(n)=n.x(n)]is non Linear');
end
%y(n)=x(n).^2
x1=[1 2 3 4 5];
x2=[1 4 7 6 4];
```

```
x3=a1*x1+a2*x2;
y1=x1.^2;
y2=x2.^2;
y3=x3.^2;
yt=a1*y1+a2*y2;
if y3==yt
    disp('given system [y(n)=x(n).^2 ]is Linear');
else
    disp('given system is [y(n)=x(n).^2 ]non Linear');
end
```

Result: The Linearity of a given Discrete System is verified.

Output:
enter the scaling factor a1=3
enter the scaling factor a2=5
given system [y(n)=n.x(n)]is Linear
given system is [y(n)=x(n).^2]non Linear

VIVA QUESTIONS:-
1. Define linear system with example?
2. Define non- linear system with example?
3. Define super position principle?
4. Give mathematical expression for Linearity.
5. Identity the system $y(n)=[x(n)]^3$ is linear or non-linear system.

Experiment No -7(b)
Verification of Time Invariance of a Discrete System

AIM: Verify the Time Invariance of a given Discrete System.

Software Required: Mat lab software
Theory:

TIME INVARIENT SYSTEMS(TI):

A system is called time invariant if its input – output characteristics do not change with time

X(t)---- input : Y(t) ---output
X(t-k) -----delay input by k seconds : Y(t-k) ------ Delayed output by k seconds

If Y(t)=T[X(t)] then Y(t-k)=T[X(t-k)] then system is time invariant system.

Program:

```
% Verification of Time Invariance of a Discrete System
% a)y=x^2(n)   b) y(n)=nx(n)
clc;
clear all;
close all;
n=1:9;
x(n)=[1 2 3 4 5 6 7 8 9];
d=3; % time delay
xd=[zeros(1,d),x(n)];%x(n-k)
y(n)=x(n).^2;
yd=[zeros(1,d),y];%y(n-k)
disp('transformation of delay signal yd:');disp(yd)
dy=xd.^2; % T[x(n-k)]
disp('delay of transformation signal dy:');disp(dy)
if dy==yd
    disp('given system [y(n)=x(n).^2 ]is time invariant');
else
    disp('given system is [y(n)=x(n).^2 ]not time invariant');
end
y=n.*x;
yd=[zeros(1,d),y(n)];
disp('transformation of delay signal yd:');disp(yd);
n1=1:length(xd);
dy=n1.*xd;
disp('delay of transformation signal dy:');disp(dy);
if yd==dy
    disp('given system [y(n)=nx(n)]is a time invariant');
else
    disp('given system [y(n)=nx(n)]not a time invariant');
end
```

Result: The Time Invariance of a given Discrete System is verified.

Output:

```
transformation of delay signal yd:
     0     0     0     1     4     9    16    25    36    49    64    81

delay of transformation signal dy:
     0     0     0     1     4     9    16    25    36    49    64    81

given system [y(n)=x(n).^2 ]is time invariant
transformation of delay signal yd:
     0     0     0     1     4     9    16    25    36    49    64    81

delay of transformation signal dy:
     0     0     0     4    10    18    28    40    54    70    88   108

given system [y(n)=nx(n)]not a time invariant
```

VIVA QUESTIONS:-

1. Define time invariant system with example?
2. Define time variant system with example?
3. Define LTI system?
4. Give mathematical expression for time invariant system?
5. Give another name for time invariant system and time variant system ?

Experiment No-8
Unit sample, unit step and sinusoidal response of the given LTI system and verifying its stability

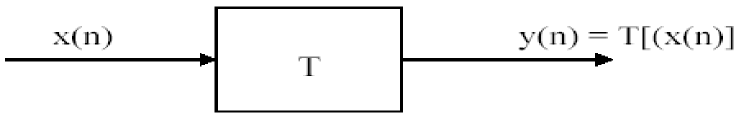
AIM: Compute the Unit sample, unit step and sinusoidal response of the given LTI system and verifying its stability

Software Required:

Mat lab software 7.0 and above

Theory:

A discrete time system performs an operation on an input signal based on predefined criteria to produce a modified output signal. The input signal x(n) is the system excitation, and y(n) is the system response. The transform operation is shown as,



If the input to the system is unit impulse i.e. x(n) = δ(n) then the output of the system is known as impulse response denoted by h(n) where,

$$h(n) = T[\delta(n)]$$

we know that any arbitrary sequence x(n) can be represented as a weighted sum of discrete impulses. Now the system response is given by,

$$y(n) = T[x(n)] = T\Big[\sum_{k=-\infty}^{\infty} x(k)\ \delta(n-k)\Big]$$

For linear system (1) reduces to

$$y(n) = \sum_{k=-\infty}^{\infty} x(k)\ T[\delta(n-k)]$$

%given difference equation y(n)-y(n-1)+.9y(n-2)=x(n);

$$H(Z)= \frac{\sum_{k=0}^{M} b_k X(n-k)}{\sum_{k=1}^{N} a_k X(n-k)}$$

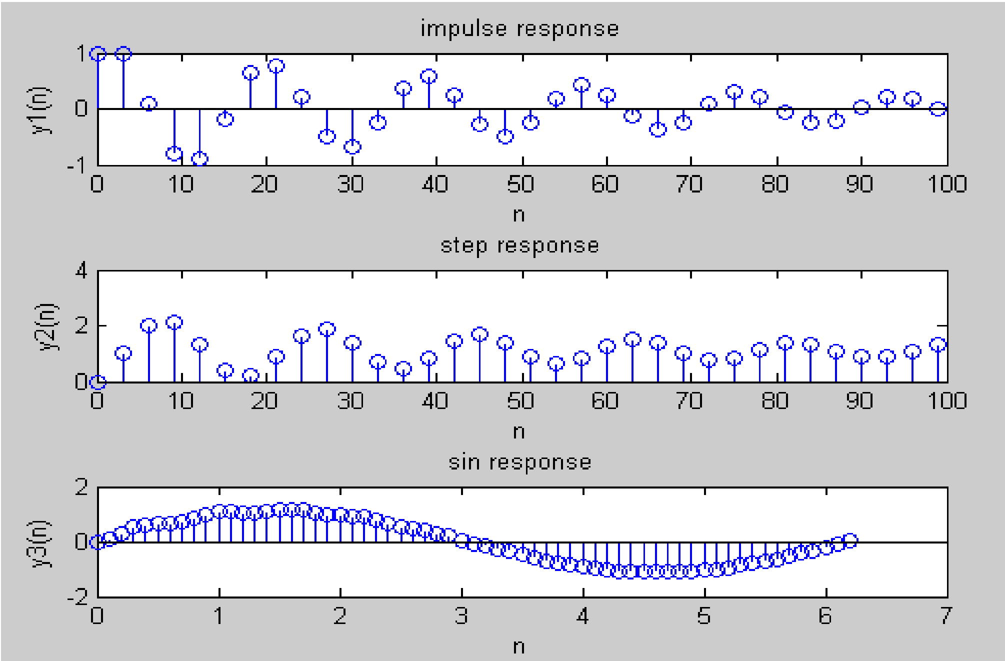
$$H(z)= \frac{b_0+b_1Z^{-1}+b_2Z^{-2}+\dots\dots\dots\dots b_{N-1}Z^{(N-1)}+b_NZ^{-N}}{1+\ a_1Z^{-1}+a_2Z^{-2}+\dots\dots\dots\dots a_{N-1}Z^{(N-1)}+a_NZ^{-N}}$$

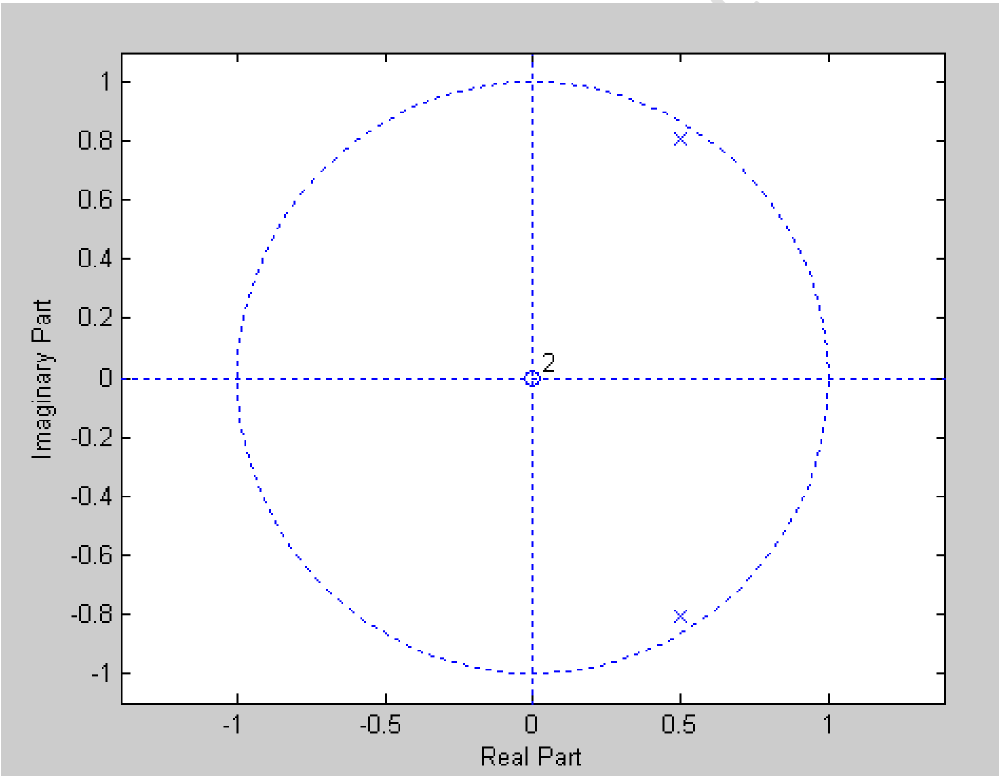
Program:

```
%given difference equation y(n)-y(n-1)+.9y(n-2)=x(n);
clc;
clear all;
close all;
b=[1];
a=[1,-1,.9];
n =0:3:100;

%generating impulse signal
x1=(n==0);
%impulse response
y1=filter(b,a,x1);
subplot(3,1,1);
stem(n,y1);
xlabel('n');
ylabel('y1(n)');
title('impulse response');

%generating step signal
x2=(n>0);
% step response
y2=filter(b,a,x2);
subplot(3,1,2);
stem(n,y2);
xlabel('n');
ylabel('y2(n)')
title('step response');
%generating sinusoidal signal
t=0:0.1:2*pi;
x3=sin(t);
% sinusoidal response
y3=filter(b,a,x3);
subplot(3,1,3);
stem(t,y3);
xlabel('n');
ylabel('y3(n)');
title('sin response');

% verifing stability
figure;
zplane(b,a);
```

Result: The Unit sample, unit step and sinusoidal response of the given LTI system is computed and its stability verified. Hence all the poles lie inside the unit circle, so system is stable.

Output:





VIVA QUESTIONS:-

1. What operations can be performed on signals and sequence?
2. Define causality and stability?
3. Define step response and impulse response of the system.
4. Define poles and zeros of the system?
5. What is the function of filter?

Experiment No-9
Gibbs phenomenon

AIM: Verify the Gibbs phenomenon.

Software Required: Matlab software

Theory:

The **Gibbs phenomenon,** the Fourier series of a piecewise continuously differentiable periodic function behaves at a jump discontinuity.The *n* the approximated function shows amounts of ripples at the points of discontinuity. This is known as the Gibbs Phenomina . partial sum of the Fourier series has large oscillations near the jump, which might increase the maximum of the partial sum above that of the function itself. The overshoot does not die out as the frequency increases, but approaches a finite limit

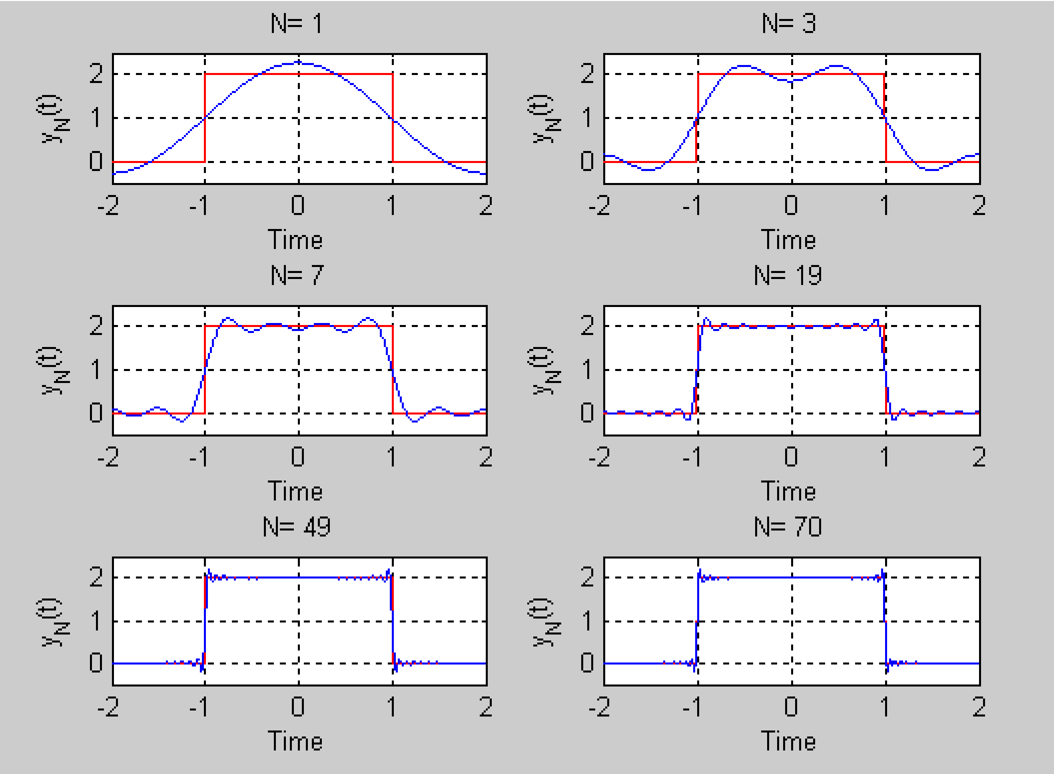
The Gibbs phenomenon involves both the fact that Fourier sums overshoot at a jump discontinuity, and that this overshoot does not die out as the frequency increases.

Program:

```
% Gibb's phenomenon..
clc;
clear all;
close all;
t=linspace(-2,2,2000);
u=linspace(-2,2,2000);
sq=[zeros(1,500),2*ones(1,1000),zeros(1,500)];
k=2;
N=[1,3,7,19,49,70];
for n=1:6;
an=[];
for  m=1:N(n)
    an=[an,2*k*sin(m*pi/2)/(m*pi)];
end;
fN=k/2;
for m=1:N(n)
    fN=fN+an(m)*cos(m*pi*t/2);
end;
nq=int2str(N(n));
subplot(3,2,n),plot(u,sq,'r');hold on;
plot(t,fN); hold off; axis([-2 2 -0.5 2.5]);grid;
xlabel('Time'), ylabel('y_N(t)');title(['N= ',nq]);
end;
```

Result: In this experiment Gibbs phenomenons have been demonstrated using MATLAB.

Output:



VIVA QUESTIONS:-

1. Define Gibb's Phenomenon?
2. What is the importance of Gibb's Phenomenon?
3. What is Static and Dynamic System?
4.Define Fourier series ?
5. What is Causality Condition of the Signal?

Experiment No-10

Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum

AIM: To find the Fourier Transform of a given signal and plotting its magnitude and phase spectrum.

Software Required: Matlab software

Theory:

Fourier Transform:

The Fourier transform as follows. Suppose that f is a function which is zero outside of some interval $[-L/2, L/2]$. Then for any $T \geq L$ we may expand f in a Fourier series on the interval $[-T/2, T/2]$, where the "amount" of the wave $e^{2\pi inx/T}$ in the Fourier series of f is given by

By definition Fourier Transform of signal f(t) is defined as

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\, dt$$

Inverse Fourier Transform of signal F(w) is defined as

$$f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}\ d\omega$$

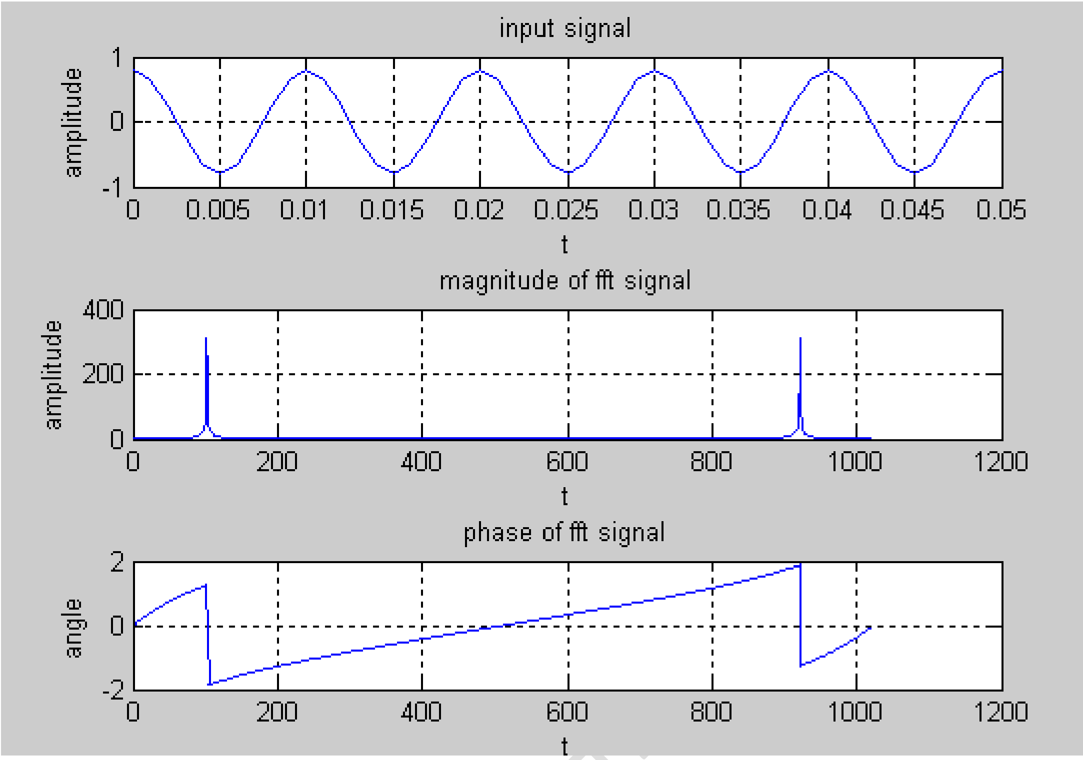
Program:

```
clc;
clear all;
close all;
 fs=1000;
 N=1024;   % length of fft sequence
t=[0:N-1]*(1/fs);
% input signal
x=0.8*cos(2*pi*100*t);
subplot(3,1,1);
plot(t,x);
axis([0 0.05 -1 1]);
grid;
xlabel('t');
ylabel('amplitude');
title('input signal');
% Fourier transformof given signal
x1=fft(x);
% magnitude spectrum
k=0:N-1;
Xmag=abs(x1);
subplot(3,1,2);
```

```
plot(k,Xmag);
grid;
xlabel('t');
ylabel('amplitude');
title('magnitude of fft signal')
%phase spectrum
Xphase=angle(x1);
subplot(3,1,3);
plot(k,Xphase);
grid;
xlabel('t');
ylabel('angle');
title('phase of fft signal');
```

Result: Magnitude and phase spectrum of FFT of a given signal is plotted.

Output:



VIVA QUESTIONS:

1. Define convolution property of Fourier transform?
2. What are the properties of Continuous-Time Fourier transform?
3. What is the sufficient condition for the existence of F.T?
4. Define the F.T of a signal?
5. What is the difference b/w F.T&F.S?

Experiment No-11
Waveform Synthesis Using Laplace transforms

AIM: Finding the Laplace transform & Inverse Laplace transform of some signals.

Software Required: Matlab software

Theory:

Bilateral Laplace transforms:

The Laplace transform of a signal f(t) can be defined as follows:

$$F(s) = \mathcal{L}\{f(t)\} = \int_{-\infty}^{\infty} e^{-st} f(t)\,dt.$$

Inverse Laplace transform

The inverse Laplace transform is given by the following formula :

$$f(t) = \mathcal{L}^{-1}\{F(s)\} = \frac{1}{2\pi i} \lim_{T\to\infty} \int_{\gamma-iT}^{\gamma+iT} e^{st} F(s)\,ds,$$

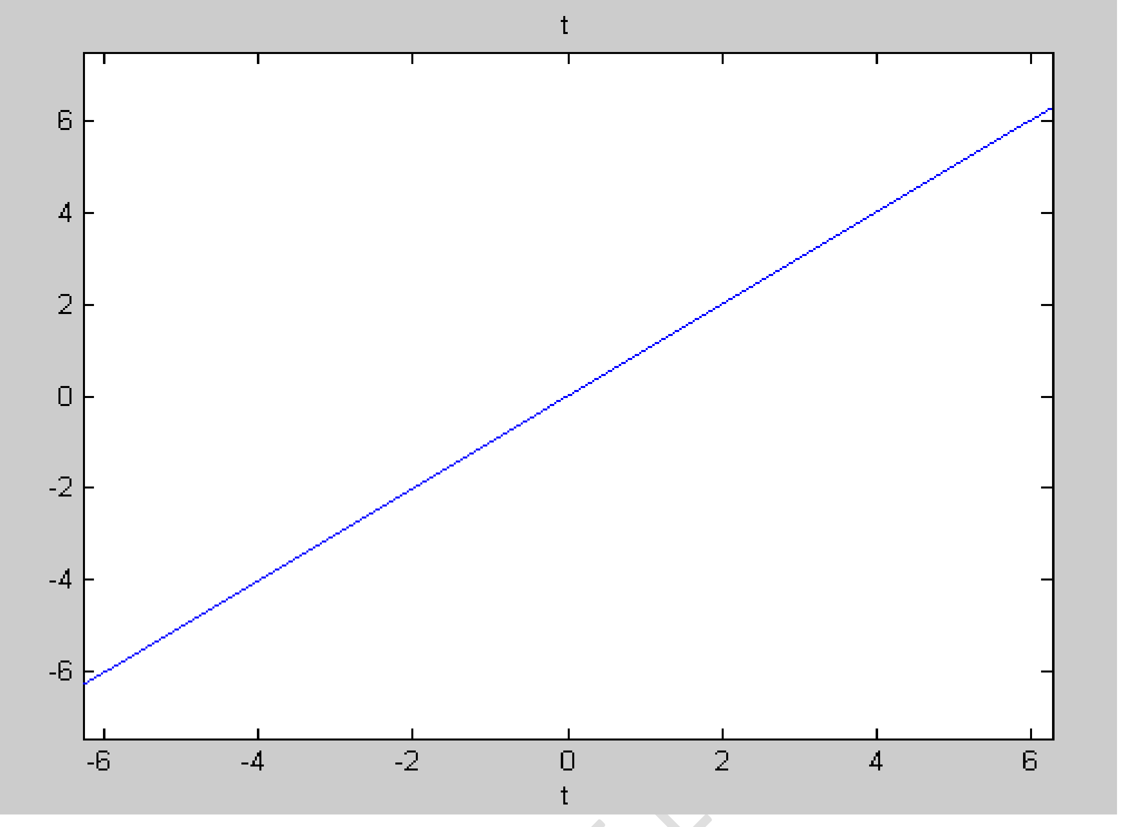
Program:

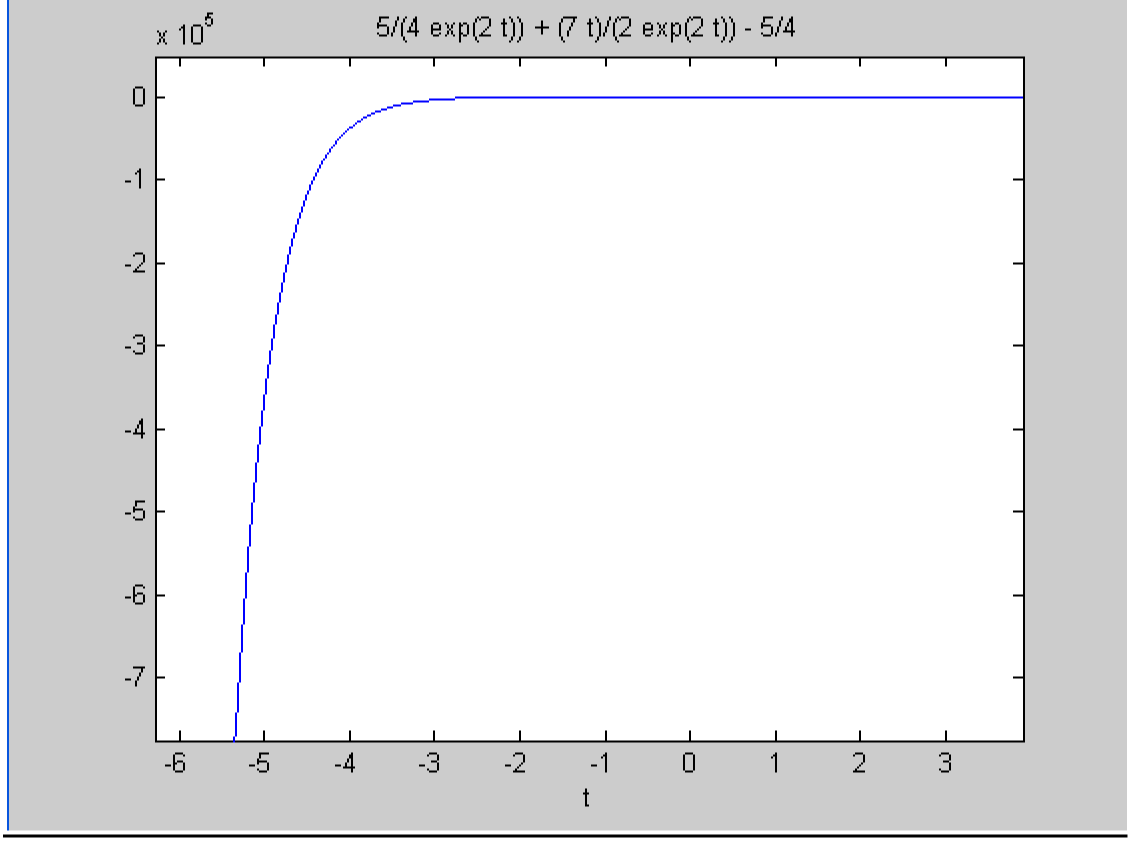
```
clc;
clear all;
close all;
%representation of symbolic variables
syms f t w s;
%laplace transform of t
f=t;
z=laplace(f);
disp('the laplace transform of f = ');
disp(z);

% laplace transform of a signal
%f1=sin(w*t);
f1=-1.25+3.5*t*exp(-2*t)+1.25*exp(-2*t);
v=laplace(f1);
disp('the laplace transform of f1 = ');
disp(v);
lv=simplify(v);
pretty(lv)
 %inverse laplace transform
y1=ilaplace(z);
disp('the inverse laplace transform of z = ');
disp(y1);
y2=ilaplace(v);
disp('the inverse laplace transform of v = ');
disp(y2);
ezplot(y1);
figure;
ezplot(y2)
```

Output:

```
the laplace transform of f =
1/s^2

the laplace transform of f1 =
5/(4*(s + 2)) + 7/(2*(s + 2)^2) - 5/(4*s)

    s - 5
  ----------
  s (s + 2)^2
the inverse laplace transform of z =
t

the inverse laplace transform of v =
5/(4*exp(2*t)) + (7*t)/(2*exp(2*t)) - 5/4
```

Output:


t
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6
t


x 10^5
5/(4 exp(2 t)) + (7 t)/(2 exp(2 t)) - 5/4
0
-1
-2
-3
-4
-5
-6
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
t

VIVA QUESTIONS:-

1. Define Laplace-Transform?
2. What is the Condition for Convergence of the L.T?
3. What is the Region of Convergence (ROC)?
4. State the Shifting property of L.T?
5. State convolution Property of L.T?

Experiment No-12
Locating Poles and Zeros in s-plane & z-plane

AIM: Write the program for locating poles and zeros and plotting pole-zero maps in s-plane and z-plane for the given transfer function.

Software Required: Matlab software

Theory:

Z-transforms
The Z-transform, like many other integral transforms, can be defined as either a *one-sided* or *two-sided* transform.

Bilateral Z-transform

The *bilateral* or *two-sided* Z-transform of a discrete-time signal *x[n]* is the function *X(z)* defined as

$$X(z) = \mathcal{Z}\{x[n]\} = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

Unilateral Z-transform

Alternatively, in cases where $x[n]$ is defined only for $n \geq 0$, the *single-sided* or *unilateral* Z-transform is defined as

$$X(z) = \mathcal{Z}\{x[n]\} = \sum_{n=0}^{\infty} x[n]z^{-n}$$

In signal processing, this definition is used when the signal is causal.

where $z = r.e^{j\omega}$

$$X(z) = \frac{P(z)}{Q(z)}$$

The roots of the equation P(z) = 0 correspond to the 'zeros' of X(z)
The roots of the equation Q(z) = 0 correspond to the 'poles' of X(z)

Example:

The zeros are: $\{-1\}$

$$H(z) = \frac{z+1}{(z-\frac{1}{2})(z+\frac{3}{4})}$$

The poles are: $\left\{ \frac{1}{2}, -\left(\frac{3}{4}\right) \right\}$

Program:
```
clc;
clear all;
close all;
%enter the numerator and denamenator cofficients in square brackets
num=input('enter numerator co-efficients');
```

```
den=input('enter denominator co-efficients');

% find poles and zeros
poles=roots(den)
zeros=roots(num)

% find transfer function H(s)
h=tf(num,den);

% plot the pole-zero map in s-plane
sgrid;
pzmap(h);
grid on;
title('locating poles and zeros on s-plane');

%plot the pole zero map in z-plane
figure
zplane(poles,zeros);
grid on;
title('locating poler and zeros on z-plane');
```

Result: Pole-zero maps are plotted in s-plane and z-plane for the given transfer function.

Output:

enter numerator co-efficients[1 -1 4 3.5]

enter denominator co-efficients[2 3 -2.5 6]

poles =

 -2.4874

 0.4937 + 0.9810i

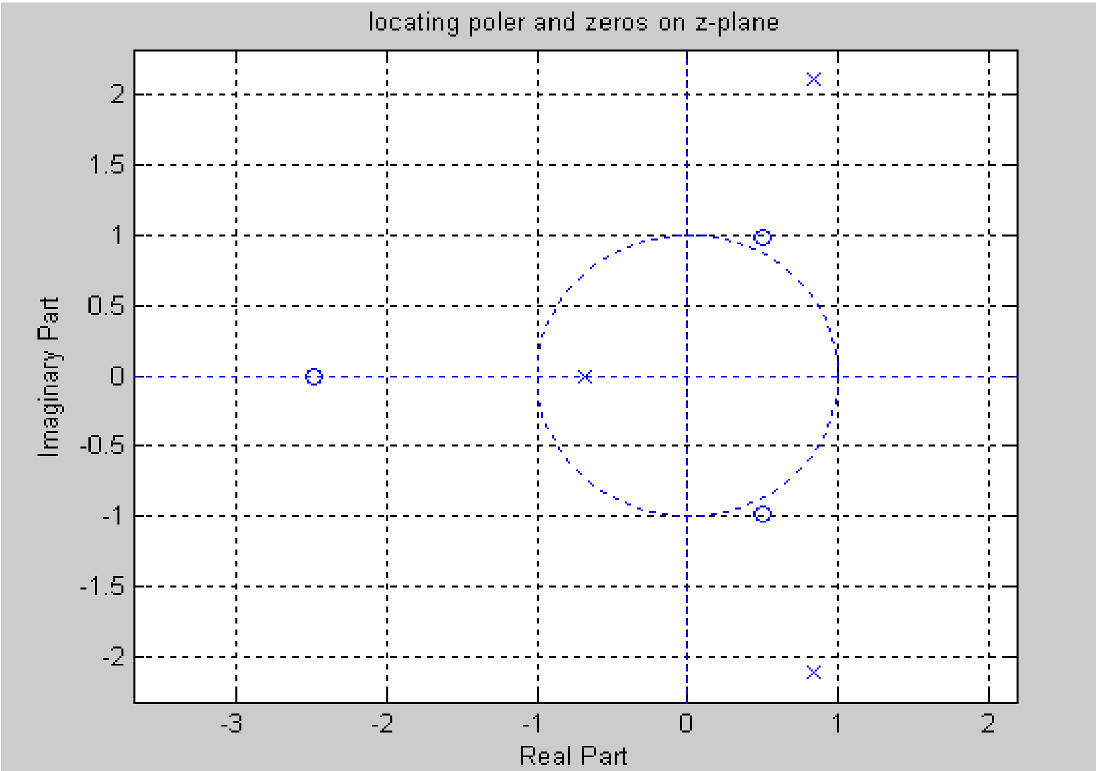
 0.4937 - 0.9810i

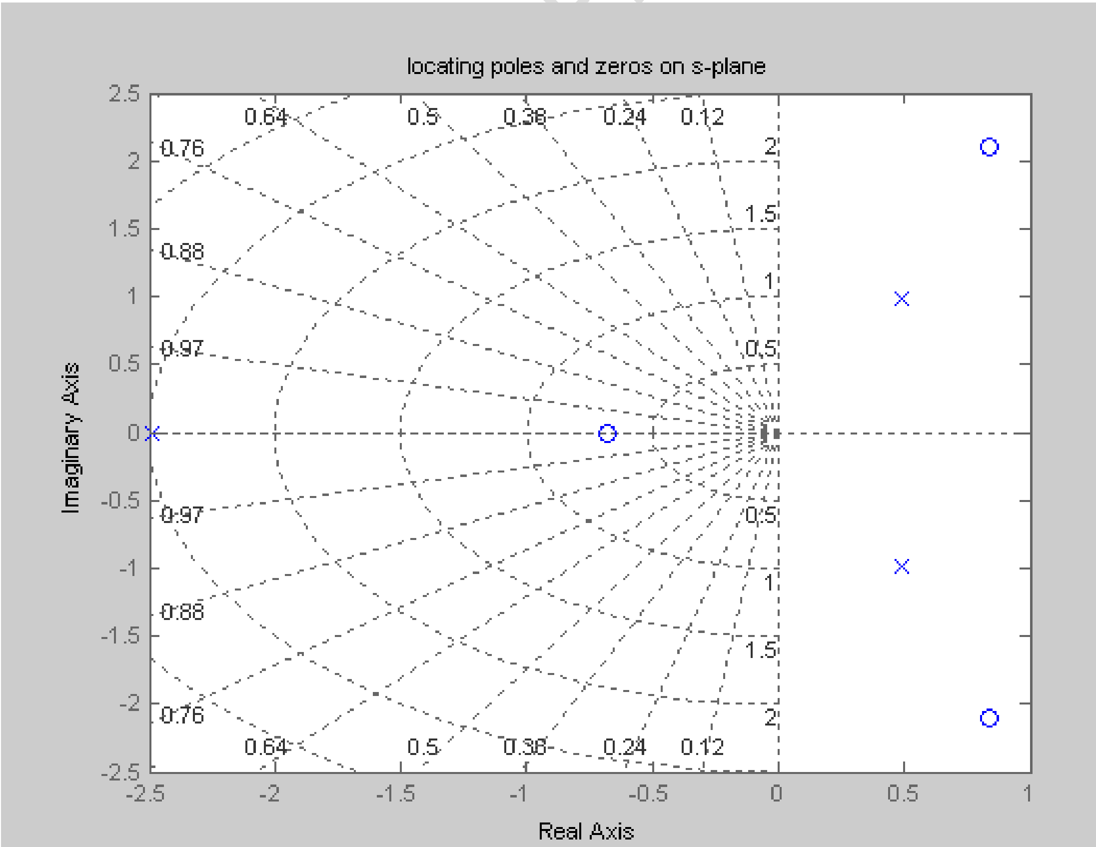
zeros =

 0.8402 + 2.1065i

 0.8402 - 2.1065i

 -0.6805


locating poler and zeros on z-plane
Imaginary Part
Real Part
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-3
-2
-1
0
1
2


locating poles and zeros on s-plane
Imaginary Axis
Real Axis
0.64
0.5
0.38
0.24
0.12
0.76
0.88
0.97
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-2
-1.5
-1
-0.5
0
0.5
1

VIVA QUESTIONS:-

1. Study the details of pzmap() and zplane() functions?
2. What are poles and zeros?
3. How you specify the stability based on poles and zeros?
4. Define S-plane and Z-plane?
5. Define transfer function of the system?

Experiment No-13
Generation of Gaussian Noise

AIM: Write the program for generation of Gaussian noise and computation of its mean, mean square value, standard deviation, variance, and skewness.

Software Required: Matlab software

Theory:

Gaussian noise is statistical noise that has a probability density function (abbreviated pdf) of the normal distribution (also known as Gaussian distribution). In other words, the valuestha the noise can take on are Gaussian-distributed. It is most commonly used as additive white noise to yield additive white Gaussian noise (AWGN).Gaussian noise is properly defined as the noise with a Gaussian amplitude distribution. says nothing of the correlation of the noise in time or of the spectral density of the noise. Labeling Gaussian noise as 'white' describes the correlation of the noise. It is necessary to use the term "white Gaussian noise" to be correct. Gaussian noise is sometimes misunderstood to be white Gaussian noise, but this is not the case.

Program:

```
clc;
clear all;
close all;

%generates a set of 2000 samples of Gaussian distributed random  numbers
x=randn(1,2000);
%plot the joint distribution of both the sets using dot.
subplot(211)
plot(x,'.');
title('scatter plot of gaussian distributed random numbers');
ymu=mean(x)
ymsq=sum(x.^2)/length(x)
ysigma=std(x)
yvar=var(x)
yskew=skewness(x)

p=normpdf(x,ymu,ysigma);
subplot(212);
stem(x,p);
title(' gaussian distribution');
```


Output:

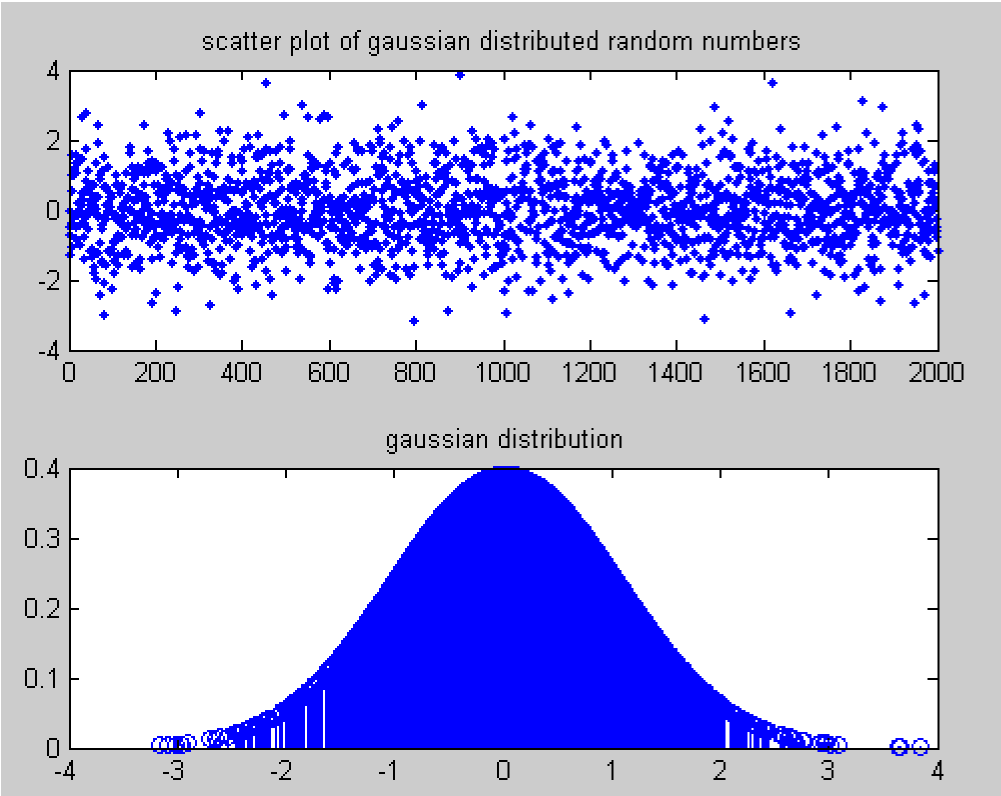
ymu = 0.0403

ymsq = 0.9727

ysigma = 0.9859

yvar = 0.9720

yskew = 0.0049



VIVA QUESTIONS:-

1. What is a noise and how many types of noises are there?
2. What is Gaussian noise?
3. What is correlation? How many types of correlation are there?
4. State Paeseval's energy theorem for a periodic signal?
5. What is Signum function?

Experiment No-14
Sampling theorem verification

AIM: Verify the sampling theorem.

Software Required: Matlab software

Theory:

Sampling Theorem:

\A bandlimited signal can be reconstructed exactly if it is sampled at a rate atleast twice the maximum frequency component in it." Figure 1 shows a signal g(t) that is bandlimited.

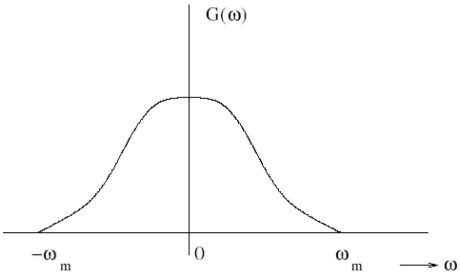


Figure 1: Spectrum of band limited signal g(t)

The maximum frequency component of g(t) is fm. To recover the signal g(t) exactly from its samples it has to be sampled at a rate fs ≥ 2fm.

The minimum required sampling rate fs = 2fm is called ' Nyquist rate

Proof: Let g(t) be a bandlimited signal whose bandwidth is fm (wm = 2πfm).

Figure 2: (a) Original signal g(t) (b) Spectrum G(w)

δ (t) is the sampling signal with fs = 1/T > 2fm.

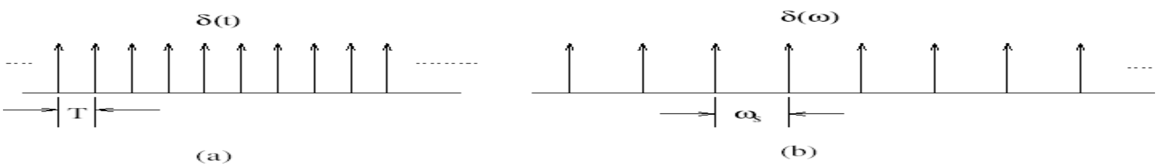


Figure 3: (a) sampling signal δ (t)) (b) Spectrum δ (w)

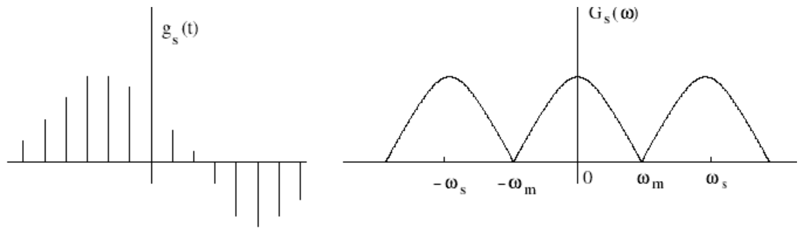


Figure 4: (a) sampled signal gs(t) (b) Spectrum Gs(w)

To recover the original signal G(w):

1. Filter with a Gate function, H2wm(w) of width 2wm

Scale it by T.

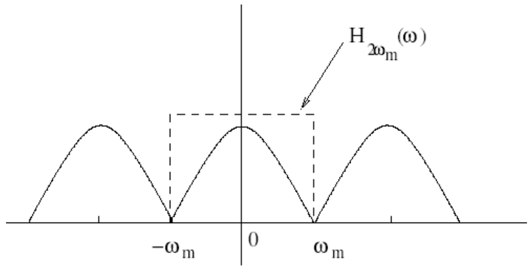


Figure 5: Recovery of signal by filtering with a fiter of width 2wm Aliasing ws < 2wm.

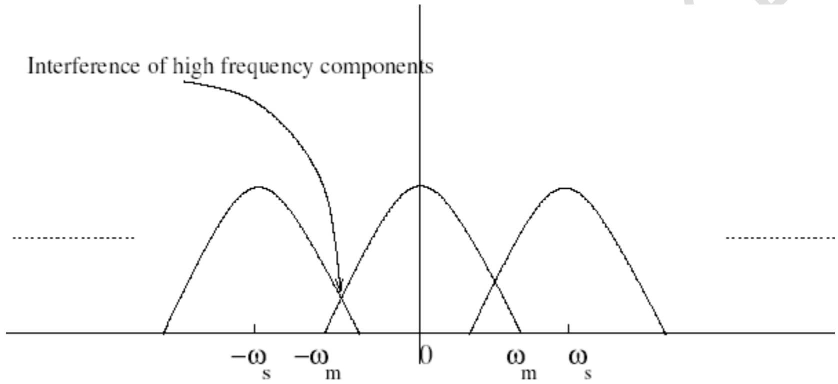


Figure 6: Aliasing due to inadequate sampling

Aliasing leads to distortion in recovered signal. This is the reason why sampling frequency should be atleast twice thebandwidth of the signal. Oversampling ws >2wm. This condition avoid aliasing.

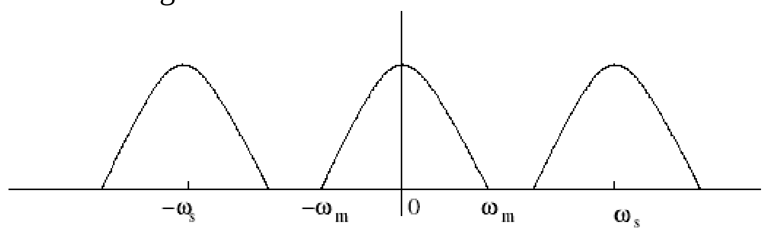


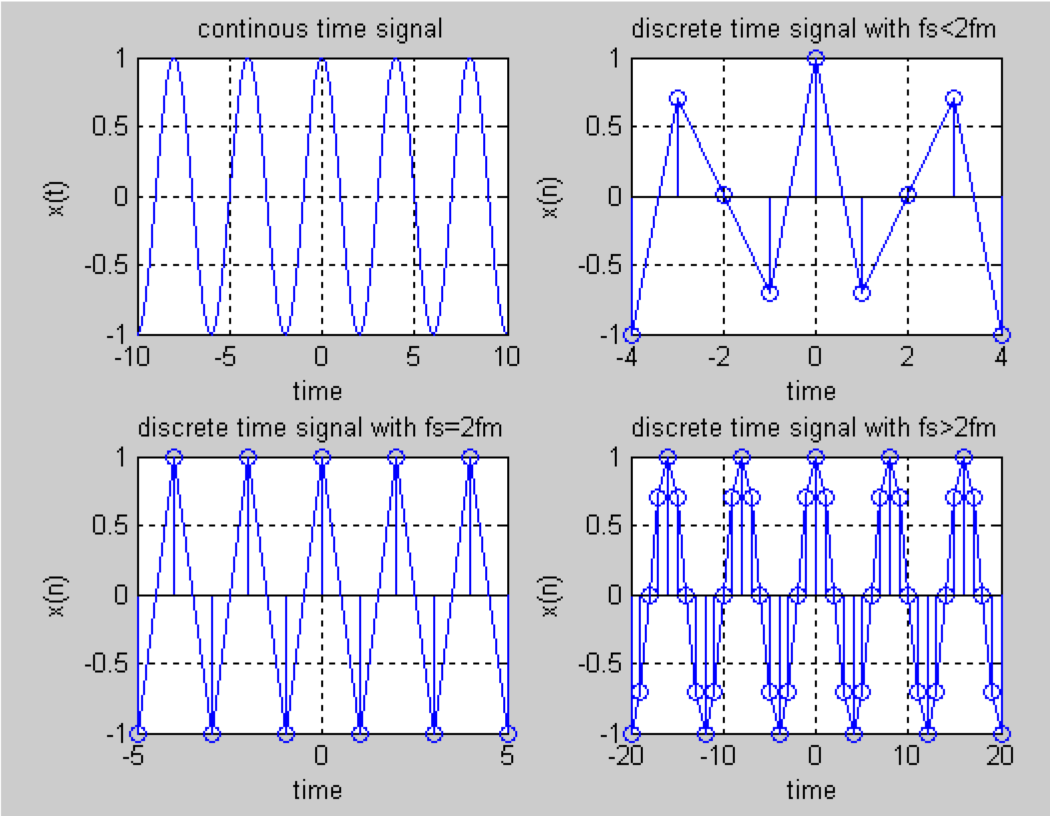
Figure 7: Oversampled signal-avoids aliasing

Program:

```
clc;
clear all;
close all;
t=-10:.01:10;
T=4;
fm=1/T;
x=cos(2*pi*fm*t);
subplot(2,2,1);
plot(t,x);
xlabel('time');
ylabel('x(t)');
title('continous time signal');
grid;
n1=-4:1:4;
fs1=1.6*fm;
fs2=2*fm;
fs3=8*fm;
x1=cos(2*pi*fm/fs1*n1);
subplot(2,2,2);
stem(n1,x1);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs<2fm');
hold on;
subplot(2,2,2);
plot(n1,x1);
grid;
n2=-5:1:5;
x2=cos(2*pi*fm/fs2*n2);
subplot(2,2,3);
stem(n2,x2);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs=2fm');
hold on;
subplot(2,2,3);
plot(n2,x2)
grid;
n3=-20:1:20;
x3=cos(2*pi*fm/fs3*n3);
subplot(2,2,4);
stem(n3,x3);
xlabel('time');
ylabel('x(n)');
title('discrete time signal with fs>2fm')
hold on;
subplot(2,2,4);
plot(n3,x3)
grid;
```

Result: Sampling theorem is verified.

OUTPUT:



VIVA QUESTIONS:-

1. State Paeseval's energy theorem for a periodic signal?
2. Define sampling Theorem?
3. What is Aliasing Effect?
4. What is under sampling?
5. What is over sampling?

EXP.No:15
REMOVAL OF NOISE BY AUTO CORRELATION/CROSS CORRELATION

AIM: Write the program for Removal of noise by using auto correlation.

Software Required: Matlab software

Theory:

Detection of a periodic signal masked by random noise is of great importance .The noise signal encountered in practice is a signal with random amplitude variations. A signal is uncorrelated with any periodic signal. If s(t) is a periodic signal and n(t) is a noise signal then

$$\lim_{T \to \infty} 1/T \int_{-T/2}^{T/2} S(t)n(t-T)\,dt = 0 \qquad \text{for all } T$$

$Q_{sn}(T)$= cross correlation function of s(t) and n(t) Then $Q_{sn}(T)=0$

Detection of noise by Auto-Correlation:

S(t)=Periodic Signal (Transmitted) , mixed with a noise signal n(t).

Then f(t) is received signal is [s(t) + n(t)]

Let $Q_{ff}(T)$ =Auto Correlation Function of f(t)
$Q_{ss}(t)$ = Auto Correlation Function of S(t)
$Q_{nn}(T)$ = Auto Correlation Function of n(t)

$$Q_{ff}(T) = \lim_{T \to \infty} 1/T \int_{-T/2}^{T/2} f(t)f(t-T)\,dt$$

$$= \lim_{T \to \infty} 1/T \int_{-T/2}^{T/2} [s(t)+n(t)]\,[s(t-T)+n(t-T)]\,dt$$

$$= Q_{ss}(T)+Q_{nn}(T)+Q_{sn}(T)+Q_{ns}(T)$$

The periodic signal s(t) and noise signal n(t) are uncorrelated

$Q_{sn}(t)=Q_{ns}(t)=0$;

Then $Q_{ff}(t)=Q_{ss}(t)+Q_{nn}(t)$

The Auto correlation function of a periodic signal is periodic of the same frequency and the Auto correlation function of a non periodic signal is tends to zero for large value of T since s(t) is a periodic signal and n(t) is non periodic signal so $Q_{ss}(T)$ is a periodic where as $aQ_{nn}(T)$ becomes small for large values of T Therefore for sufficiently large values of T $Q_{ff}(T)$ is equal to $Q_{ss}(T)$.

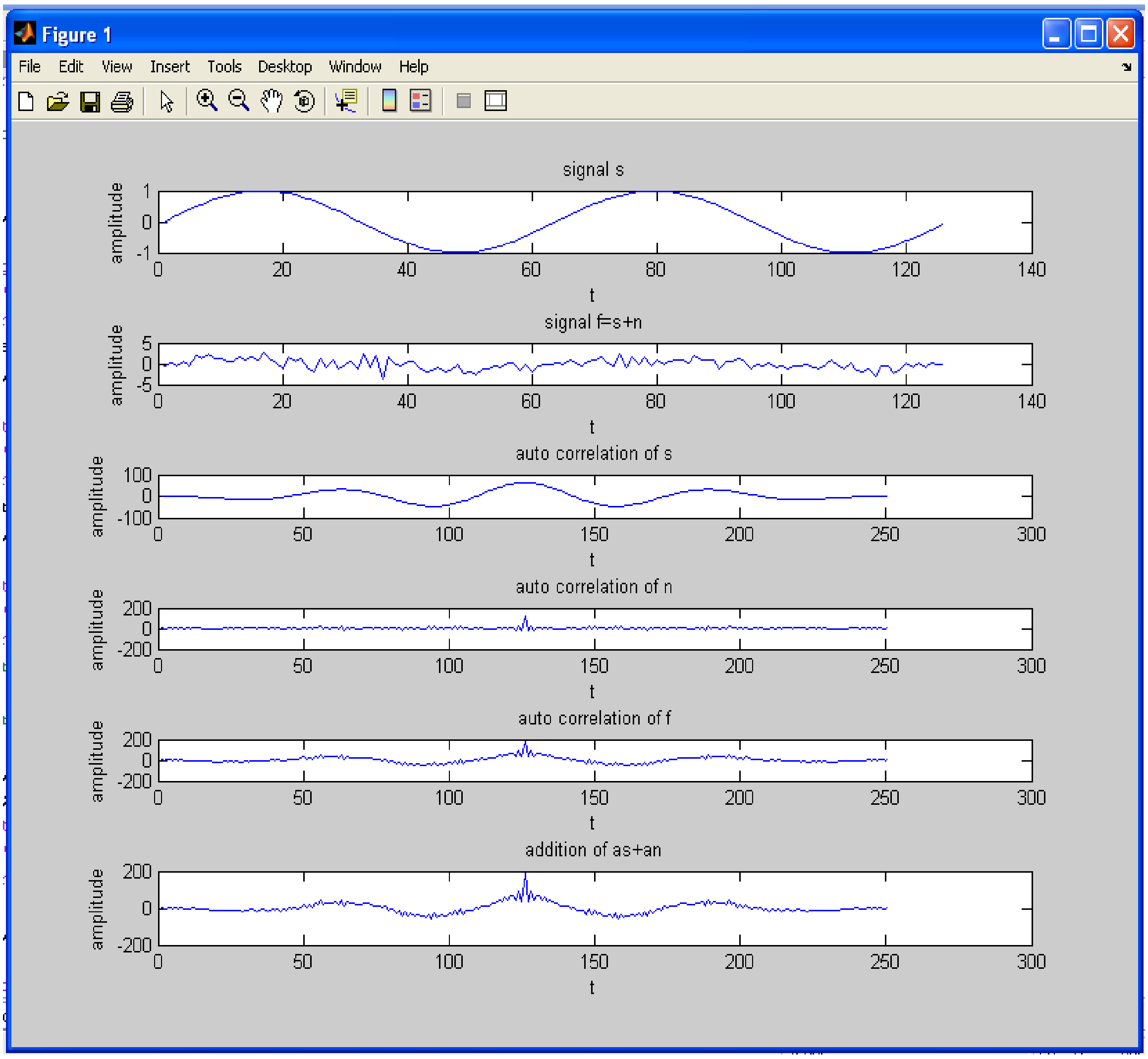
Program:

```
clc;
clear all;
close all;
t=0:0.2:pi*8;
%input signal
s=sin(t);
subplot(6,1,1);
plot(s);
title('signal s');
xlabel('t');
ylabel('amplitude');
%generating noise
n = randn([1 126]);
%noisy signal
f=s+n;
subplot(6,1,2)
plot(f);
title('signal f=s+n');
xlabel('t');
ylabel('amplitude');
%aucorrelation of input signal
as=xcorr(s,s);
subplot(6,1,3);
plot(as);
title('auto correlation of s');
xlabel('t');
ylabel('amplitude');
%aucorrelation of noise signal
an=xcorr(n,n);
subplot(6,1,4)
plot(an);
title('auto correlation of n');
xlabel('t');
ylabel('amplitude');
%aucorrelation of transmitted signal
cff=xcorr(f,f);
subplot(6,1,5)
```

```
plot(cff);
title('auto correlation of f');
xlabel('t');
ylabel('amplitude');

%aucorrelation of received signal
hh=as+an;
subplot(6,1,6)
plot(hh);
title('addition of as+an');
xlabel('t');
ylabel('amplitude');
```

Result:Removal of noise using autocorrelation is performed.

Output:



VIVA QUESTIONS:-

1. Define Auto correlation function?
2. What are the Different types of noise signals?
3. Define cross correlation function?
4. What is Signum function?
5. What is Static and Dynamic System?

EXP.No:16
EXTRACTION OF PERIODIC SIGNAL MASKED BY NOISE USING CORRELATION

AIM: Write the program for extraction of periodic signal using correlation.

Software Required: Matlab software

Theory:

A signal is masked by noise can be detected either by correlation techniques or by filtering.Actually, the two techniques are equivalent. The correlation technique is a measure of extraction of a given signal in the time domain whereas filtering achieves exactly the same results in frequency domain.

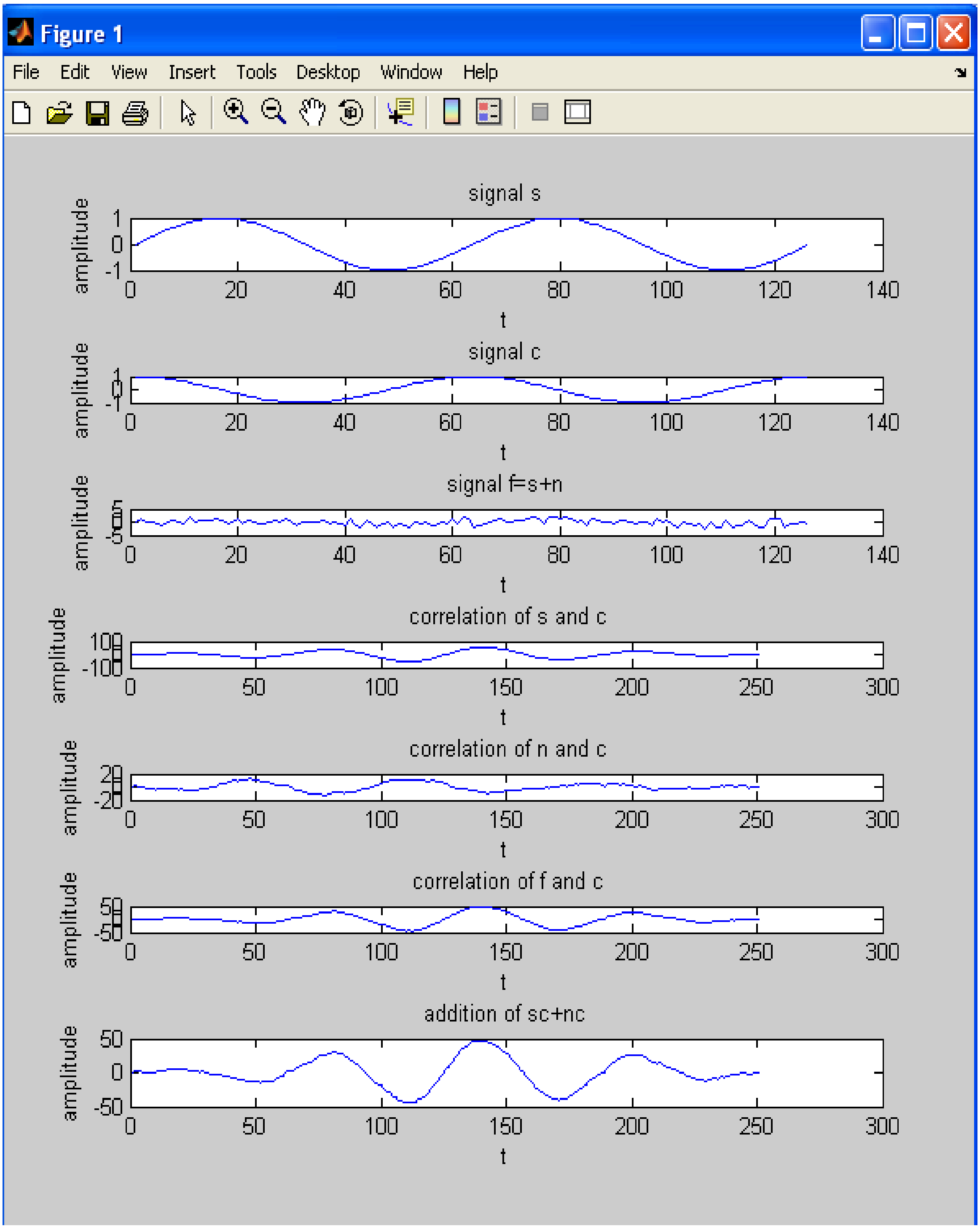
Program:

```
clear all;
close all;
clc;
t=0:0.1: pi*4;
%input signal1
s=sin(t);
subplot(7,1,1)
plot(s);
title('signal s');
xlabel('t');
ylabel('amplitude');
%input signal2
c=cos(t);
subplot(7,1,2)
plot(c);
title('signal c');
xlabel('t');
ylabel('amplitude');

%generating noise signal
n = randn([1 126]);
%signal+noise
f=s+n;
subplot(7,1,3);
plot(f);
title('signal f=s+n');
xlabel('t');
ylabel('amplitude');

%crosscorrelation of signal1&signal2
```

```
asc=xcorr(s,c);
subplot(7,1,4)
plot(asc);
title(' correlation of s and c');
xlabel('t');
ylabel('amplitude');
%crosscorrelation of noise&signal2
anc=xcorr(n,c);
subplot(7,1,5)
plot(anc);
title(' correlation of n and c');
xlabel('t');
ylabel('amplitude');
%crosscorrelation of f&signal2
cfc=xcorr(f,c);
subplot(7,1,6)
plot(cfc);
title(' correlation of f and c');
xlabel('t');
ylabel('amplitude');
%extracting periodic signal
hh=asc+anc;
subplot(7,1,7)
plot(hh);
title('addition of sc+nc');
xlabel('t');
ylabel('amplitude');
```


Result: Periodic signal is extracted by using correlation.

Output:



VIVA QUESTIONS:-

1. State the relationship between PSD and ACF?
2. What is the integration of ramp signal?
3. Difference between vectors and signals?
4. Define PSD?
5. Define Hilbert transforms?

EXP.No:17
VERIFICATION OF WIENER-KHINCHIN RELATION

AIM: Verification of wiener-khinchin relation

Software Required: Matlab software

Theory:

The wiener-khinchin theorem states that the power spectral density of a wide sense stationary random process is the flourier transform of the corresponding autocorrelation function.

PSD= $S_{XX}(\omega) = FT[R_{XX}(\tau)] = \int_{-\infty}^{\infty} R_{XX}(\tau)e^{-j\omega t}dt$

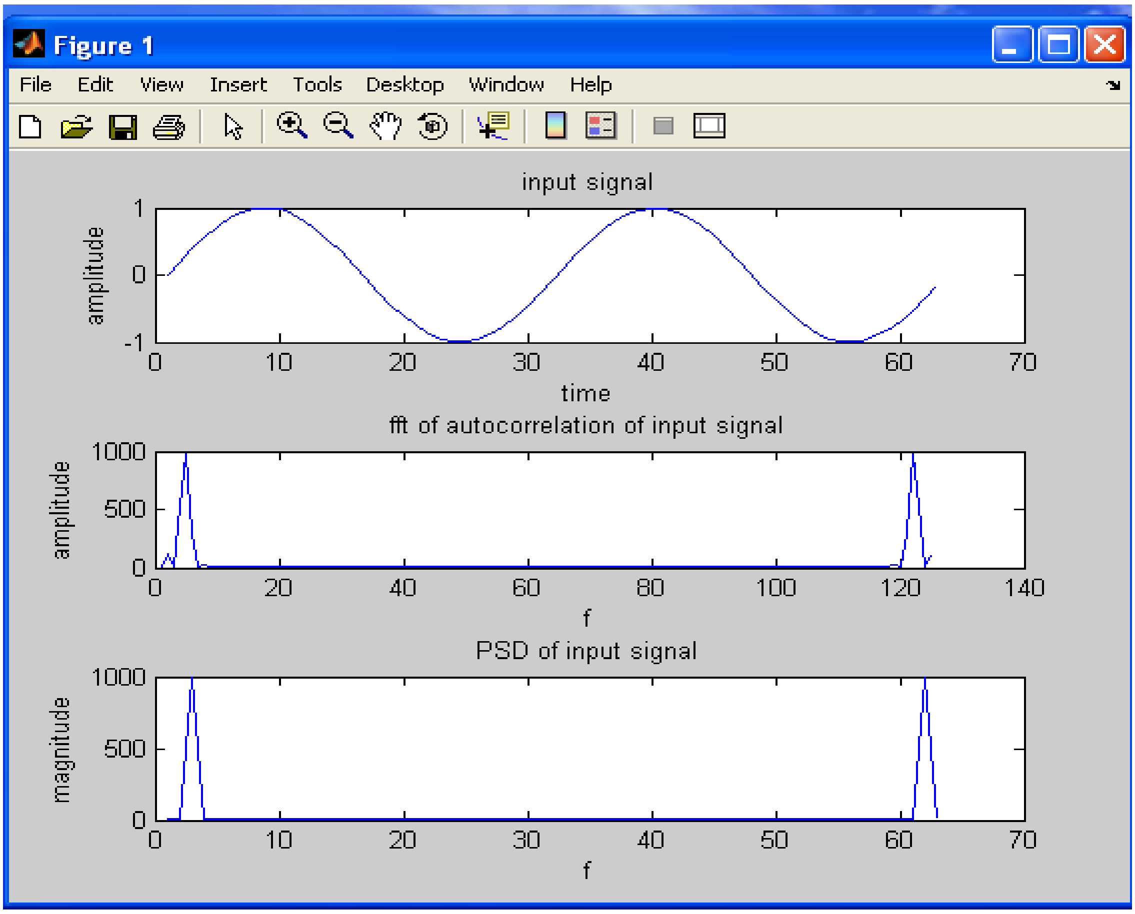
ACF= $R_{XX}(\tau) = IFT[S_{XX}(\omega)] = \frac{1}{2\pi}\int_{-\infty}^{\infty} S_{XX}(\omega)e^{j\omega t}d\omega$

Program:

```
clc;
clear all;
close all;
t=0:0.1:2*pi;
%input signal
x=sin(2*t);
subplot(3,1,1);
plot(x);
xlabel('time');
ylabel('amplitude');
title('input signal');
%autocorrelation of input signal
xu=xcorr(x,x);
%fft of autocorrelation signal
y=fft(xu);
subplot(3,1,2);
plot(abs(y));
xlabel('f');
ylabel('amplitude');
title('fft of autocorrelation of input signal');
%fourier transform of input signal
y1=fft(x);
%finding the power spectral density
y2=(abs(y1)).^2;
subplot(3,1,3);
plot(y2);
xlabel('f');
```

ylabel('magnitude');
title('PSD of input signal');

Result: wiener-khinchin relation is verified.
Output:



VIVA QUESTIONS:-
1. What is mean wiener□khinchine relation?
2. Define fourier transform and its inverse?
3. What is the difference b/w convolution and correlation?
4. What is the importance of power spectrum?
5. What is the importance of correlation?

ELECTRONIC DEVICES & CIRCUITS

LABORATORY MANUAL

II – I SEMESTER

Prepared By

Mr.R.Chinna Rao, **Assistant Professor**
Mr. T.Vinaya Simha Reddy, **Assistant Professor**

DEPARTMENT OF ELECTRONICS AND COMMUNICATIONS ENGG

MALLA REDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
(Sponsored by CMR Educational Society)
(Affiliated to JNTU, Hyderabad)
Secunderabad-100.

BASIC REQUIREMENT FOR EDC LAB

LIST OF EXPERIMENTS

VISION

To evolve into a center of excellence in Engineering Technology through creative and innovative practices in teaching-learning, promoting academic achievement & research excellence to produce internationally accepted competitive and world class professionals.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry institute interaction aimed at employability, entrepreneurship, leadership and research aptitude among students.

QUALITY POLICY

- Impart up-to-date knowledge to the students in Electronics & Communication area to make them quality engineers.
- Make the students experience the applications on quality equipment and tools.
- Provide systems, resources and training opportunities to achieve continuous improvement.
- Maintain global standards in education, training and services.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: PROFESSIONALISM & CITIZENSHIP To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
PEO2: TECHNICAL ACCOMPLISHMENTS To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
PEO3: INVENTION, INNOVATION AND CREATIVITY To make the students to design, experiment, analyze, interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
PEO4: PROFESSIONAL DEVELOPMENT To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
PEO5: HUMAN RESOURCE DEVELOPMENT To graduate the students in building national capabilities in technology, education and research.

CODE OF CONDUCT FOR THE LABORATORIES

- All students must observe the Dress Code while in the laboratory.
- Sandals or open-toed shoes are NOT allowed.
- Foods, drinks and smoking are NOT allowed.
- All bags must be left at the indicated place.
- The lab timetable must be strictly followed.
- Be PUNCTUAL for your laboratory session.
- Program must be executed within the given time.
- Noise must be kept to a minimum.
- Workspace must be kept clean and tidy at all time.
- Handle the systems and interfacing kits with care.
- All students are liable for any damage to the accessories due to their own negligence.
- All interfacing kits connecting cables must be RETURNED if you taken from the lab supervisor.
- Students are strictly PROHIBITED from taking out any items from the laboratory.
- Students are NOT allowed to work alone in the laboratory without the Lab Supervisor
- USB Ports have been disabled if you want to use USB drive consult lab supervisor.
- Report immediately to the Lab Supervisor if any malfunction of the accessories, is there.

Before leaving the lab

- Place the chairs properly.
- Turn off the system properly
- Turn off the monitor.
- Please check the laboratory notice board regularly for updates.

1. BASIC ELECTRONIC COMPONENTS

1.1. COLOUR CODING OF RESISTOR:

Colour Codes are used to identify the value of resistor. The numbers to the Colour are identified in the following sequence which is remembered as **BBROY GREAT BRITAN VERY GOOD WIFE (BBROYGBVGW)** and their assignment is listed in following table.

Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
0	1	2	3	4	5	6	7	8	9

Table1: Colour codes of resistor

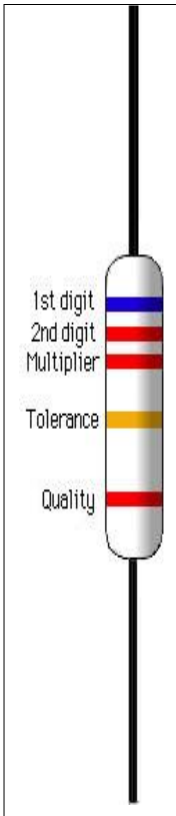
	First find the tolerance band, it will typically be gold (5%) and sometimes silver (10%).
	Starting from the other end, identify the first band - write down the number associated with that color
	Now read the next color, so write down a its vale next to the first value.
	Now read the third or 'multiplier exponent' band and write down that as the number of zeros.
	If the 'multiplier exponent' band is Gold move the decimal point one to the left. If the 'multiplier exponent' band is Silver move the decimal point two places to the left. If the resistor has one more band past the tolerance band it is a quality band.
	Read the number as the '% Failure rate per 1000 hour' This is rated assuming full wattage being applied to the resistors. (To get better failure rates, resistors are typically specified to have twice the needed wattage dissipation that the circuit produces). Some resistors use this band for temco information. 1% resistors have three bands to read digits to the left of the multiplier. They have a different temperature coefficient in order to provide the 1% tolerance. At 1% the temperature coefficient starts to become an important factor. at +/-200 ppm a change in temperature of 25 Deg C causes a value change of up to 1%

Table2: procedure to find the value of resistor using Colour codes

1.2. COLOUR CODING OF CAPACITORS

An electrical device capable of storing electrical energy. In general, a capacitor consists of two metal plates insulated from each other by a dielectric. The capacitance of a capacitor depends primarily upon its shape and size and upon the relative permittivity ε_r of the medium between the plates. In vacuum, in air, and in most gases, ε_r ranges from one to several hundred..

One classification of capacitors comes from the physical state of their dielectrics, which may be gas (or vacuum), liquid, solid, or a combination of these. Each of these classifications may be subdivided according to the specific dielectric used. Capacitors may be further classified by their ability to be used in alternating-current (ac) or direct-current (dc) circuits with various current levels.

- **Capacitor Identification Codes:** There are no international agreements in place to standardize capacitor identification. Most plastic film types (Figure1) have printed values and are normally in microfarads or if the symbol is n, Nanofarads. Working voltage is easily identified. Tolerances are upper case letters: M = 20%, K = 10%, J = 5%, H = 2.5% and F = ± 1pF.

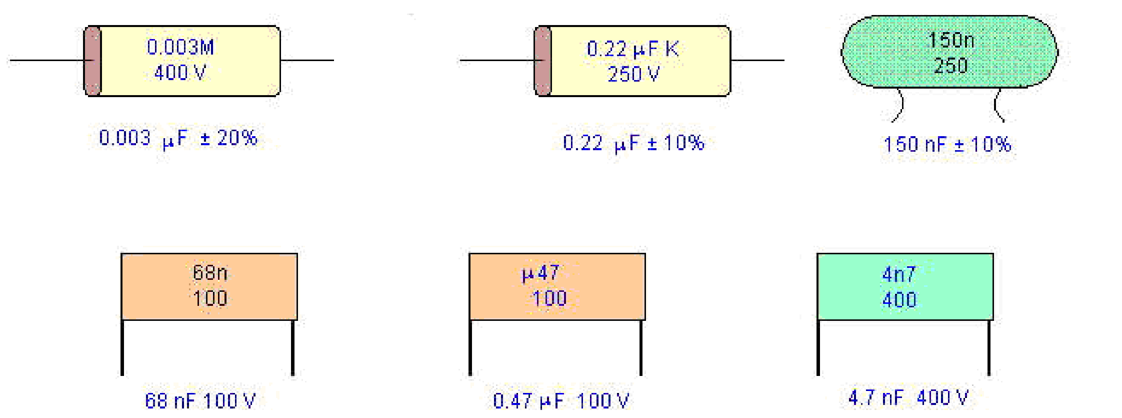


Figure 1: Plastic Film Types

A more difficult scheme is shown in Figure 2 where K is used for indicating Picofarads. The unit is picofarads and the third number is a multiplier. A capacitor coded 474K63 means 47 × 10000 pF which is equivalent to 470000 pF or 0.47 microfarads. K indicates 10% tolerance. 50, 63 and 100 are working volts.

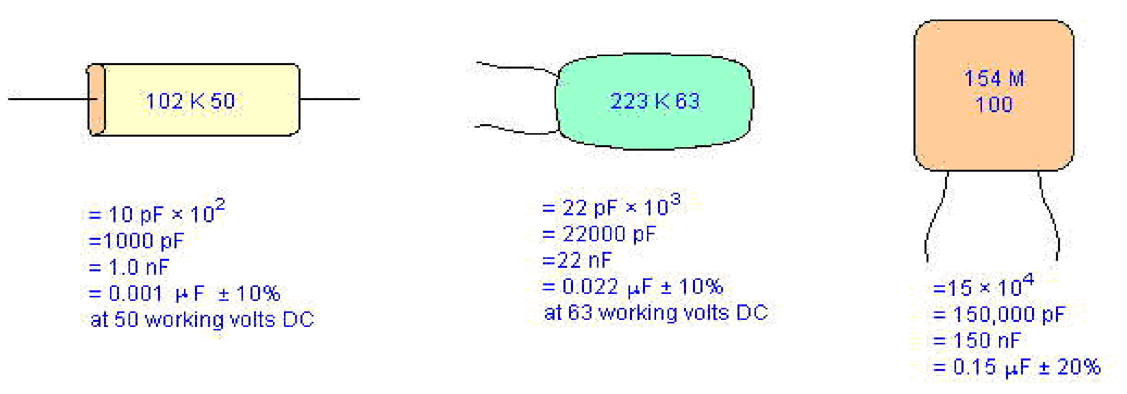


Figure 2: Picofarads Representation

Ceramic disk capacitors have many marking schemes. Capacitance, tolerance, working voltage and temperature coefficient may be found. which is as shown in figure 3. Capacitance values are given as number without any identification as to units. (uF, nF, pF) Whole numbers usually indicate pF and decimal numbers such as 0.1 or 0.47 are microfarads. Odd looking numbers such as 473 is the previously explained system and means 47 nF.

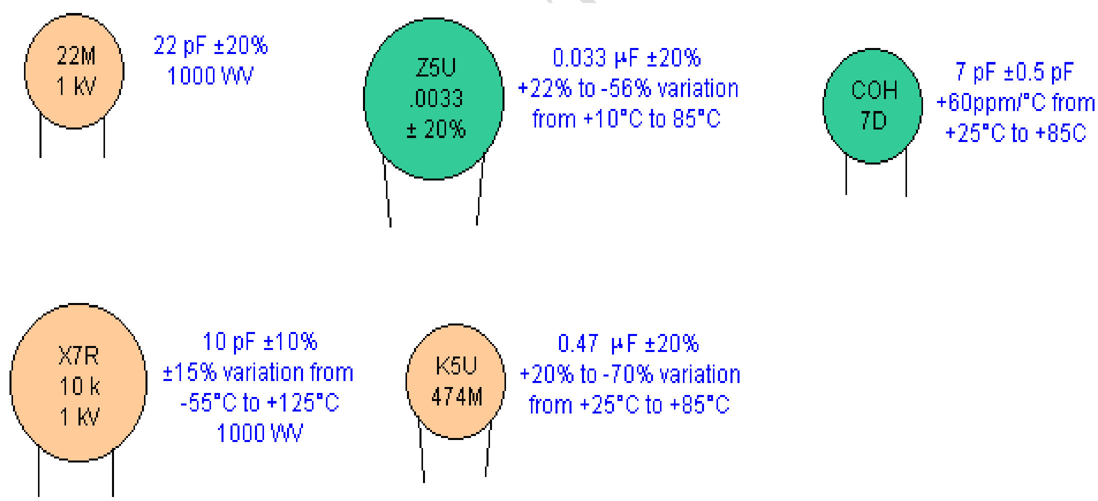


Figure3: ceramic Disk capacitor

Figure 4 shows some other miscellaneous schemes.

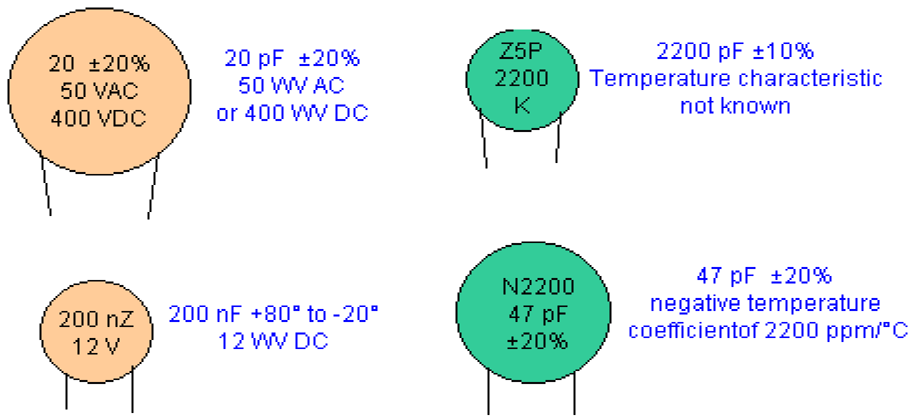


Figure 4: miscellaneous schemes.

➢ Electrolytic capacitor properties

There are a number of parameters of importance beyond the basic capacitance and capacitive reactance when using electrolytic capacitors. When designing circuits using electrolytic capacitors it is necessary to take these additional parameters into consideration for some designs, and to be aware of them when using electrolytic capacitors

- **ESR Equivalent series resistance:** Electrolytic capacitors are often used in circuits where current levels are relatively high. Also under some circumstances and current sourced from them needs to have low source impedance, for example when the capacitor is being used in a power supply circuit as a reservoir capacitor. Under these conditions it is necessary to consult the manufacturers' datasheets to discover whether the electrolytic capacitor chosen will meet the requirements for the circuit. If the ESR is high, then it will not be able to deliver the required amount of current in the circuit, without a voltage drop resulting from the ESR which will be seen as a source resistance.
- **Frequency response:** One of the problems with electrolytic capacitors is that they have a limited frequency response. It is found that their ESR rises with frequency and this generally limits their use to frequencies below about 100 kHz. This is particularly true for large capacitors, and even the smaller electrolytic capacitors should not be relied upon at high frequencies. To gain exact details it is necessary to consult the manufacturer's data for a given part.
- **Leakage:** Although electrolytic capacitors have much higher levels of capacitance for a given volume than most other capacitor technologies, they can also have a higher level of leakage. This is not a problem for most applications, such as when

they are used in power supplies. However under some circumstances they are not suitable. For example they should not be used around the input circuitry of an operational amplifier. Here even a small amount of leakage can cause problems because of the high input impedance levels of the op-amp. It is also worth noting that the levels of leakage are considerably higher in the reverse direction.

- **Ripple current:** When using electrolytic capacitors in high current applications such as the reservoir capacitor of a power supply, it is necessary to consider the ripple current it is likely to experience. Capacitors have a maximum ripple current they can supply. Above this they can become too hot which will reduce their life. In extreme cases it can cause the capacitor to fail. Accordingly it is necessary to calculate the expected ripple current and check that it is within the manufacturer's maximum ratings.
- **Tolerance:** Electrolytic capacitors have a very wide tolerance. Typically this may be -50% + 100%. This is not normally a problem in applications such as decoupling or power supply smoothing, etc. However they should not be used in circuits where the exact value is of importance.
- **Polarization:** Unlike many other types of capacitor, electrolytic capacitors are polarized and must be connected within a circuit so that they only see a voltage across them in a particular way.

The physical appearance of electrolytic capacitor is as shown in Figure 5.The capacitors themselves are marked so that polarity can easily be seen. In addition to this it is common for the can of the capacitor to be connected to the negative terminal.

Figure 5: Electrolytic capacitor

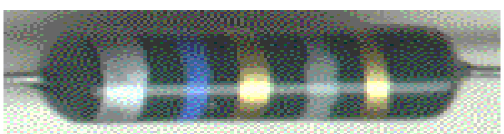
It is absolutely necessary to ensure that any electrolytic capacitors are connected within a circuit with the correct polarity. A reverse bias voltage will cause the centre oxide layer forming the dielectric to be destroyed as a result of electrochemical reduction. If this occurs a short circuit will appear and excessive current can cause the capacitor to become very hot. If this occurs the component may leak the electrolyte, but under some circumstances they can explode. As this is not uncommon, it is very wise to take precautions and ensure the capacitor is fitted correctly, especially in applications where high current capability exists.

1.3. COLOUR CODING OF INDUCTORS

Inductor is just coil wound which provides more reactance for high frequencies and low reactance for low frequencies.

Molded inductors follow the same scheme except the units are usually micro henries. A brown-black-red inductor is most likely a 1000 uH. Sometimes a silver or gold band is used as a decimal point. So a red-gold-violet inductor would be a 2.7 uH. Also expect to see a wide silver or gold band before the first value band and a thin tolerance band at the end. The typical Colour codes and their values are shown in Figure 6.

1000uH (1millihenry), 2%

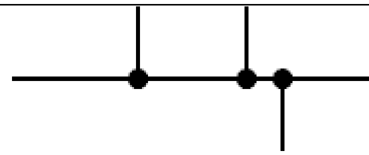
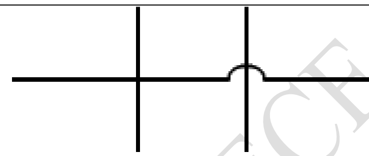


6.8 uH, 5%

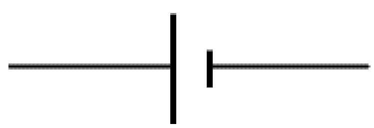
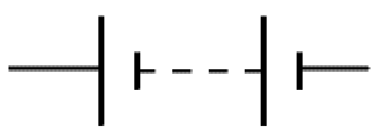
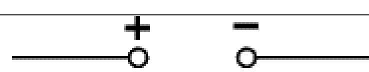
Figure 6: Typical inductors Colour coding and their values.

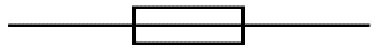
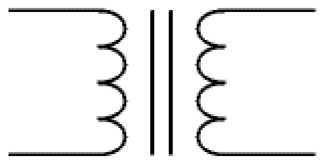
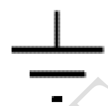
2. CIRCUIT SYMBOLS

WIRES AND CONNECTIONS

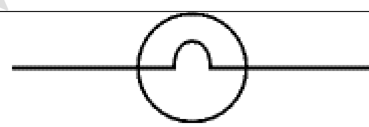
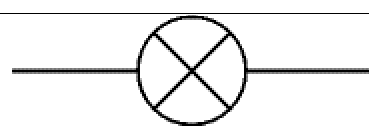
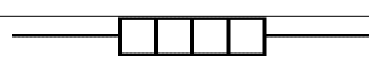
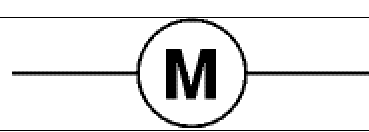
S.NO.	COMPONENT NAME	CIRCUIT SYMBOL	FUNCTION
1	WIRE		To pass current very easily from one part of a circuit to another.
2	WIRES JOINED		A 'blob' should be drawn where wires are connected (joined), but it is sometimes omitted. Wires connected at 'crossroads' should be staggered slightly to form two T-junctions, as shown on the right.
3	WIRES NOT JOINED		In complex diagrams it is often necessary to draw wires crossing even though they are not connected. I prefer the 'bridge' symbol shown on the right because the simple crossing on the left may be misread as a join where you have forgotten to add a 'blob'.

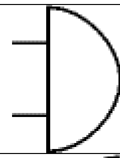
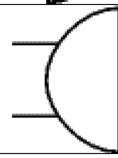
POWER SUPPLIES

S.NO	COMPONENT NAME	CIRCUIT SYMBOL	FUNCTION
1.	CELL		Supplies electrical energy. The larger terminal (on the left) is positive (+). A single cell is often called a battery, but strictly a battery is two or more cells joined together
2.	BATTERY		Supplies electrical energy. A battery is more than one cell. The larger terminal (on the left) is positive (+).
3.	DC SUPPLY		Supplies electrical energy. DC = Direct Current, always flowing in one direction.

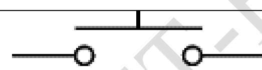
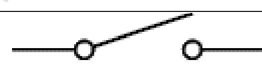
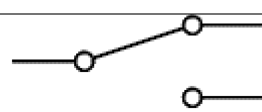
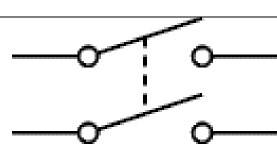
4.	AC SUPPLY		Supplies electrical energy. AC = Alternating Current, continually changing direction.
5.	FUSE		A safety device which will 'blow' (melt) if the current flowing through it exceeds a specified value.
6.	TRANSFORMER		Two coils of wire linked by an iron core. Transformers are used to step up (increase) and step down (decrease) AC voltages. Energy is transferred between the coils by the magnetic field in the core. There is no electrical connection between the coils.
7.	EARTH(GROUND)		A connection to earth. For many electronic circuits this is the 0V (zero volts) of the power supply, but for mains electricity and some radio circuits it really means the earth. It is also known as ground.

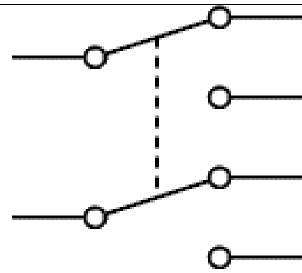
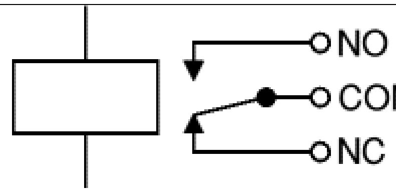
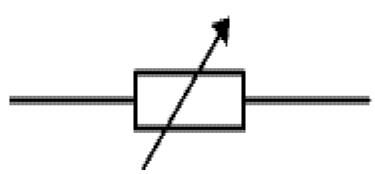
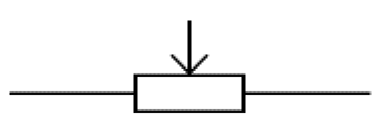
Output Devices: Lamps, Heater, Motor, etc.

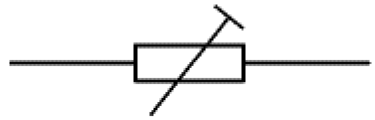
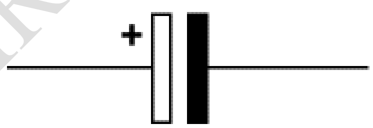
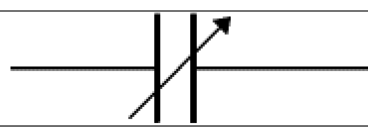
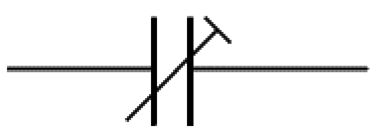
S.NO	COMPONENT NAME	CIRCUIT SYMBOL	FUNCTION
1.	LAMP(LIGHTING)		A transducer which converts electrical energy to light. This symbol is used for a lamp providing illumination, for example a car headlamp or torch bulb
2.	LAMP(INDICATOR)		A transducer which converts electrical energy to light. This symbol is used for a lamp which is an indicator, for example a warning light on a car dashboard.
3.	HEATER		A transducer which converts electrical energy to heat.
4.	MOTOR		A transducer which converts electrical energy to kinetic energy (motion).

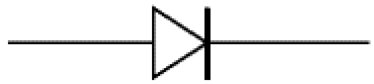
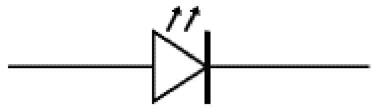
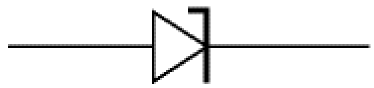
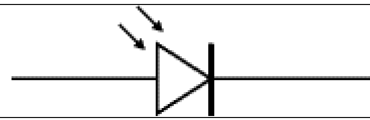
5.	BELL		A transducer which converts electrical energy to sound.
6.	BUZZER		A transducer which converts electrical energy to sound.
7.	INDUCTOR(SOLIN OID,COIL)		A coil of wire which creates a magnetic field when current passes through it. It may have an iron core inside the coil. It can be used as a transducer converting electrical energy to mechanical energy by pulling on something.

Switches

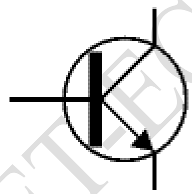
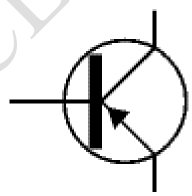
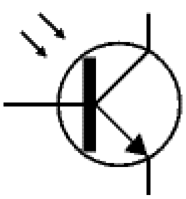
S.NO	COMPONENT NAME	CIRCUIT SYMBOL	FUNCTION
1.	PUSH SWITCH(PUSH TO MAKE)		A push switch allows current to flow only when the button is pressed. This is the switch used to operate a doorbell.
2.	PUSH TO BREAK SWITCH		This type of push switch is normally closed (on), it is open (off) only when the button is pressed.
3.	ON/OFF SWITCH(SPST)		SPST = Single Pole, Single Throw. An on-off switch allows current to flow only when it is in the closed (on) position.
4.	2 WAY SWITCH(SPDT)		SPDT = Single Pole, Double Throw. A 2-way changeover switch directs the flow of current to one of two routes according to its position. Some SPDT switches have a central off position and are described as 'on-off-on'.
5.	DUAL ON-OFF SWITCH(DPST)		DPST = Double Pole, Single Throw. A dual on-off switch which is often used to switch mains

			electricity because it can isolate both the live and neutral connections.
6.	REVERSING SWITCH(DPDT)		DPDT = Double Pole, Double Throw. This switch can be wired up as a reversing switch for a motor. Some DPDT switches have a central off position.
7.	RELAY		An electrically operated switch, for example a 9V battery circuit connected to the coil can switch a 230V AC mains circuit. NO = Normally Open, COM = Common, NC = Normally Closed.
		RESISTORS	
S.NO	**COMPONENT NAME**	**CIRCUIT SYMBOL**	**FUNCTION**
1.	RESISTOR	 **Or** 	A resistor restricts the flow of current, for example to limit the current passing through an LED. A resistor is used with a capacitor in a timing circuit.
2.	VARIABLE RESISTOR(RHEOSTAT)		This type of variable resistor with 2 contacts (a rheostat) is usually used to control current. Examples include: adjusting lamp brightness, adjusting motor speed, and adjusting the rate of flow of charge into a capacitor in a timing circuit.
3.	VARIABLE RESISTOR(POTENTIOMETER)		This type of variable resistor with 3 contacts (a potentiometer) is usually used to control voltage. It can be used like this as a transducer converting position (angle of the control

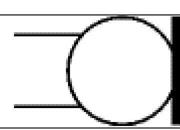
			spindle) to an electrical signal
4.	VARIABLE RESISTER(PRESET)		This type of variable resistor (a preset) is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment. Presets are cheaper than normal variable resistors so they are often used in projects to reduce the cost
		CAPACITORS	
S.NO	**NAME OF THE COMPONENT**	**CIRCUIT SYMBOL**	**FUNCTION OF THE COMPONENT**
1.	CAPACITOR		A capacitor stores electric charge. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC signals but pass AC signals.
2.	CAPACITOR POLARISED		A capacitor stores electric charge. This type must be connected the correct way round. A capacitor is used with a resistor in a timing circuit. It can also be used as a filter, to block DC signals but pass AC signals.
3.	VARIABLE CAPACITOR		A variable capacitor is used in a radio tuner.
3.	TRIMMER CAPACITOR		This type of variable capacitor (a trimmer) is operated with a small screwdriver or similar tool. It is designed to be set when the circuit is made and then left without further adjustment
		DIODES	

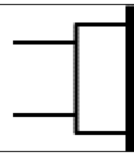
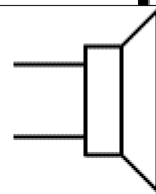
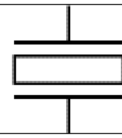
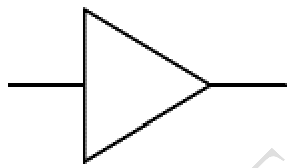
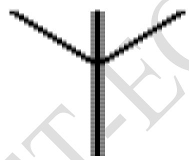
S.NO	NAME OF THE COMPONENT	CIRCUIT SYMBOL	FUNCTION OF THE COMPONENT
1.	DIODE		A device which only allows current to flow in one direction
2.	LED(LIGHT EMITTING DIODE)		A transducer which converts electrical energy to light.
3.	ZENER DIODE		A special diode which is used to maintain a fixed voltage across its terminals
4.	Photodiode		A light-sensitive diode.

TRANSISTORS

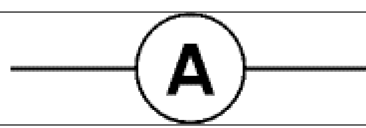
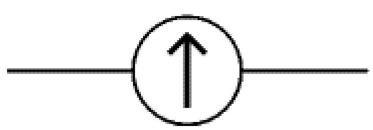
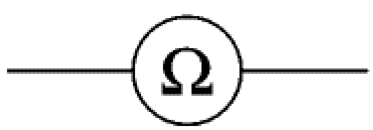
S.NO	NAME OF THE COMPONENT	CIRCUIT SYMBOL	FUNCTION OF THE COMPONENT
5.	TRANSISTOR NPN		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
6.	TRANSISTOR PNP		A transistor amplifies current. It can be used with other components to make an amplifier or switching circuit.
7.	PHOTO TRANSISTOR		A light-sensitive transistor.

AUDIO AND RADIO DEVICES

S.NO	NAME OF THE COMPONENT	CIRCUIT SYMBOL	FUNCTION OF THE COMPONENT
1.	MICROPHONE		A transducer which converts sound to electrical energy.

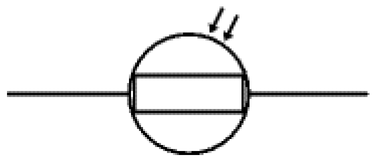
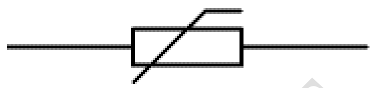
2.	EARPHONE		A transducer which converts electrical energy to sound.
3.	LOUD SPEAKER		A transducer which converts electrical energy to sound.
4.	PIEZO TRANSDUCER		A transducer which converts electrical energy to sound.
5.	AMPLIFIER(GENERAL SYMBOL)		An amplifier circuit with one input. Really it is a block diagram symbol because it represents a circuit rather than just one component.
6.	ARIEL (ANTENNA)		A device which is designed to receive or transmit radio signals. It is also known as an antenna

Meters and Oscilloscope

S.NO	NAME OF THE COMPONENT	CIRCUIT SYMBOL	FUNCTION OF THE COMPONENT
1.	VOLTMETER		A voltmeter is used to measure voltage. The Proper name for voltage is 'potential difference', but most people prefer to say voltage.
2.	AMMETTER		An ammeter is used to measure current
3.	GALVANOMETER		A galvanometer is a very sensitive meter which is used to measure tiny currents, usually 1mA or less
4.	OHEMMETER		An ohmmeter is used to measure resistance. Most multimeters have an ohmmeter setting.

5.	OSCILLOSCOPE		An oscilloscope is used to display the shape of electrical signals and it can be used to measure their voltage and time period.

Sensors (input devices)

S.NO	NAME OF THE COMPONENT	CIRCUIT SYMBOL	FUNCTION OF THE COMPONENT
1.	LDR		A transducer which converts brightness (light) to resistance (an electrical property). LDR = Light Dependent Resistor
2.	THERMISTOR		A transducer which converts temperature (heat) to resistance (an electrical property).

3. STUDY OF CRO

An oscilloscope is a test instrument which allows us to look at the 'shape' of electrical signals by displaying a graph of voltage against time on its screen. It is like a voltmeter with the valuable extra function of showing how the voltage varies with time. A graticule with a 1cm grid enables us to take measurements of voltage and time from the screen.

The graph, usually called the trace, is drawn by a beam of electrons striking the phosphor coating of the screen making it emit light, usually green or blue. This is similar to the way a television picture is produced.

Oscilloscopes contain a vacuum tube with a cathode (negative electrode) at one end to emit electrons and an anode (positive electrode) to accelerate them so they move rapidly down the tube to the screen. This arrangement is called an electron gun. The tube also contains electrodes to deflect the electron beam up/down and left/right.

The electrons are called cathode rays because they are emitted by the cathode and this gives the oscilloscope its full name of cathode ray oscilloscope or CRO.

A dual trace oscilloscope can display two traces on the screen, allowing us to easily compare the input and output of an amplifier for example. It is well worth paying the modest extra cost to have this facility.

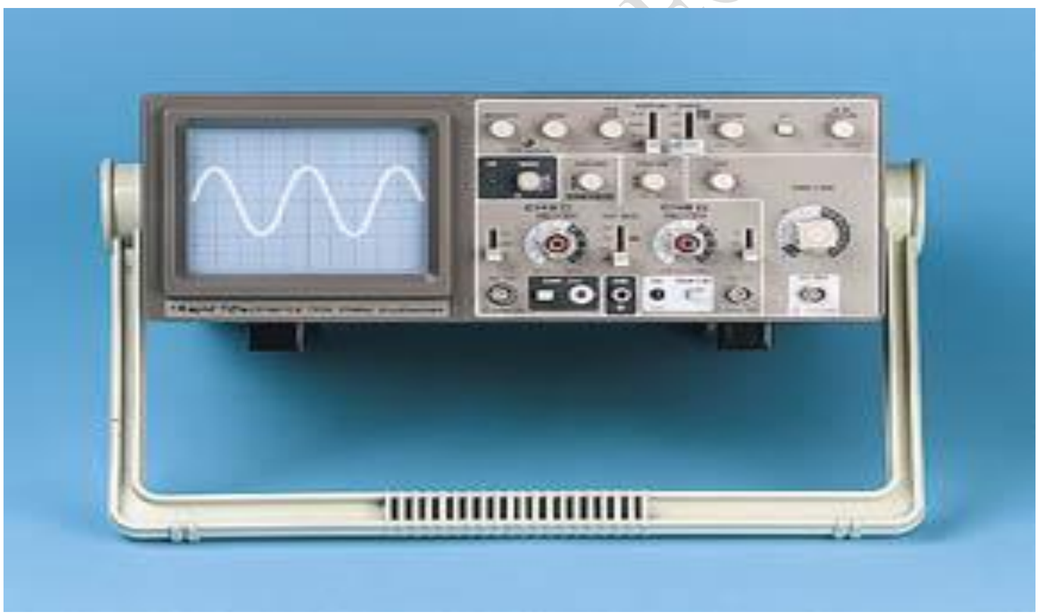


Figure1: Front Panel of CRO

- **BASIC OPERATION:**

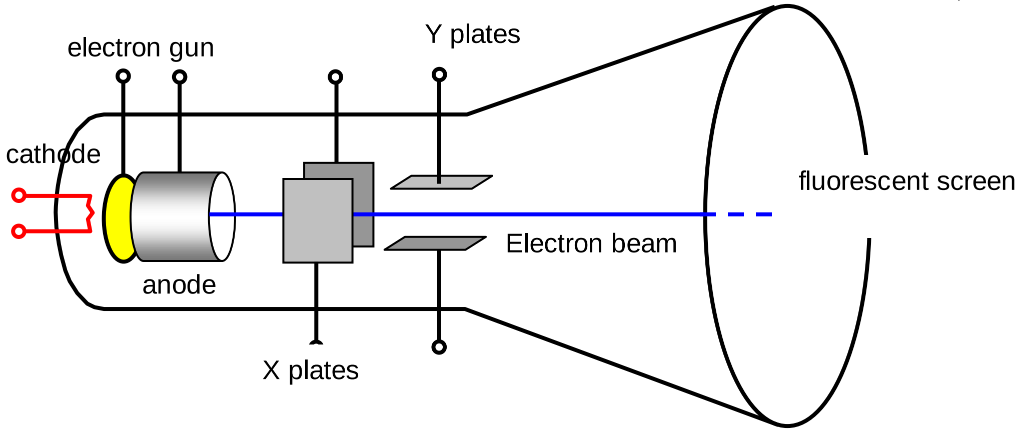


Figure2: Internal Blocks of CRO

➢ Setting up an oscilloscope:

Oscilloscopes are complex instruments with many controls and they require some care to set up and use successfully. It is quite easy to 'lose' the trace off the screen if controls are set wrongly.

There is some variation in the arrangement and labeling of the many controls so the following instructions may need to be adapted for this instrument.

1. Switch on the oscilloscope to warm up (it takes a minute or two).
2. Do not connect the input lead at this stage.
3. Set the AC/GND/DC switch (by the Y INPUT) to DC.
4. Set the SWP/X-Y switch to SWP (sweep).
5. Set Trigger Level to AUTO.
6. Set Trigger Source to INT (internal, the y input).
7. Set the Y AMPLIFIER to 5V/cm (a moderate value).
8. Set the TIMEBASE to 10ms/cm (a moderate speed).
9. Turn the time base VARIABLE control to 1 or CAL.
10. Adjust Y SHIFT (up/down) and X SHIFT (left/right) to give a trace across the middle of the screen, like the picture.
11. Adjust INTENSITY (brightness) and FOCUS to give a bright, sharp trace.

The following type of trace is observed on CRO after setting up, when there is no input signal connected.

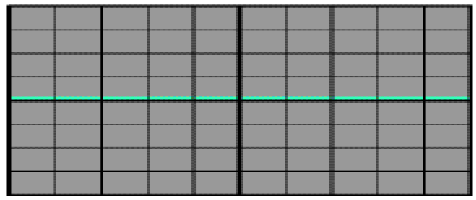


Figure 3: Absence of input signal

➢ Connecting an oscilloscope:

The Y INPUT lead to an oscilloscope should be a co-axial lead and the figure 4 shows its construction. The central wire carries the signal and the screen is connected to earth (0V) to shield the signal from electrical interference (usually called noise).

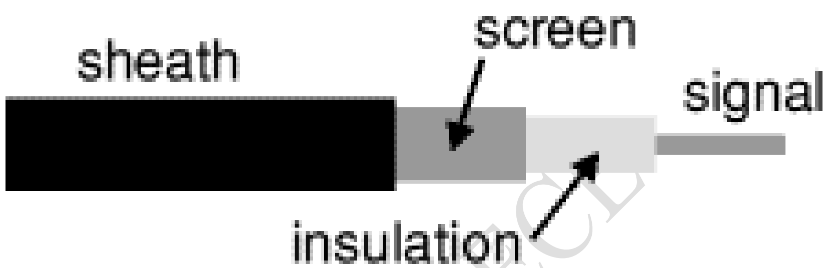


Figure4: Construction of a co-axial lead

Most oscilloscopes have a BNC socket for the y input and the lead is connected with a push and twist action, to disconnect we need to twist and pull. Professionals use a specially designed lead and probes kit for best results with high frequency signals and when testing high resistance circuits, but this is not essential for simpler work at audio frequencies (up to 20 kHz).

Figure 5: Oscilloscope lead and probes kit

➢ Obtaining a clear and stable trace:

Once if we connect the oscilloscope to the circuit, it is necessary to adjust the controls to obtain a clear and stable trace on the screen in order to test it.

- The Y AMPLIFIER (VOLTS/CM) control determines the height of the trace. Choose a setting so the trace occupies at least half the screen height, but does not disappear off the screen.
- The TIMEBASE (TIME/CM) control determines the rate at which the dot sweeps across the screen. Choose a setting so the trace shows at least one cycle of the signal across the screen. Note that a steady DC input signal gives a horizontal line trace for which the time base setting is not critical.
- The TRIGGER control is usually best left set to AUTO.

The trace of an AC signal with the oscilloscope controls correctly set is as shown in Figure 6.

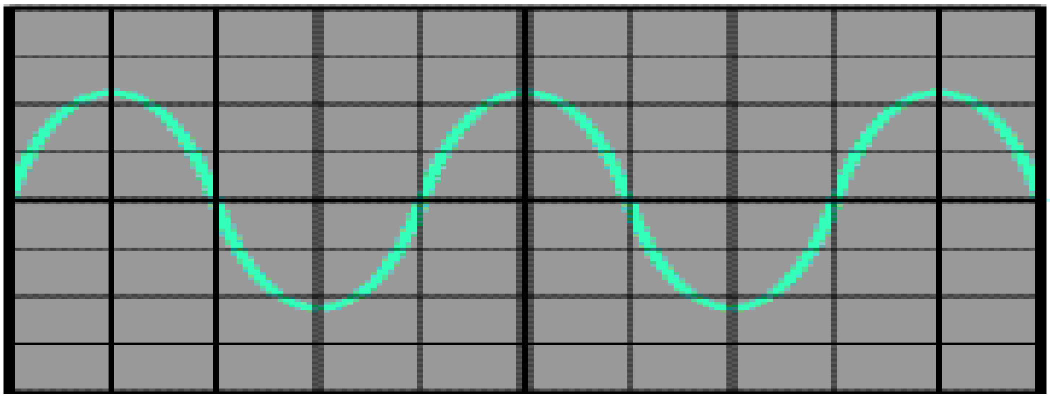


Figure 6 : Stable waveform

➢ Measuring voltage and time period

The trace on an oscilloscope screen is a graph of voltage against time. The shape of this graph is determined by the nature of the input signal. In addition to the properties labeled on the graph, there is frequency which is the number of cycles per second. The diagram shows a sine wave but these properties apply to any signal with a constant shape

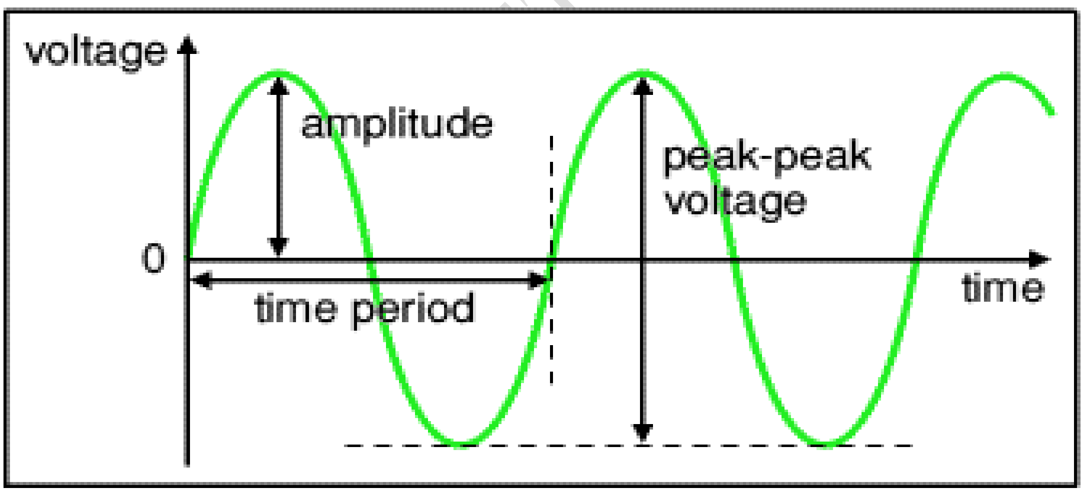


Figure7: Properties of trace

- **Amplitude** is the maximum voltage reached by the signal. It is measured in volts.
- **Peak voltage** is another name for amplitude.

- **Peak-peak voltage** is twice the peak voltage (amplitude). When reading an oscilloscope trace it is usual to measure peak-peak voltage.
- **Time period** is the time taken for the signal to complete one cycle.
  It is measured in seconds (s), but time periods tend to be short so milliseconds (ms) and microseconds (µs) are often used. 1ms = 0.001s and 1µs = 0.000001s.
- **Frequency** is the number of cycles per second. It is measured in hertz (Hz), but frequencies tend to be high so kilohertz (kHz) and megahertz (MHz) are often used. 1kHz = 1000Hz and 1MHz = 1000000Hz.

$$\text{Frequency} = \frac{1}{\text{Time period}}$$

$$\text{Time period} = \frac{1}{\text{Frequency}}$$

A) Voltage: Voltage is shown on the vertical y-axis and the scale is determined by the Y AMPLIFIER (VOLTS/CM) control. Usually peak-peak voltage is measured because it can be read correctly even if the position of 0V is not known. The amplitude is half the peak-peak voltage.

Voltage = distance in cm × volts/cm

B) Time period: Time is shown on the horizontal x-axis and the scale is determined by the TIMEBASE (TIME/CM) control. The time period (often just called period) is the time for one cycle of the signal. The frequency is the number of cycles per second, frequency = 1/time period.

Time = distance in cm × time/cm

4. STUDY OF FUNCTION GENERATOR

A function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. It is used to test the response of circuits to common input signals. The electrical leads from the device are attached to the ground and signal input terminals of the device under test.

Figure 1: A typical low-cost function generator.

- **Features and controls :**

Most function generators allow the user to choose the shape of the output from a small number of options.

- Square wave - The signal goes directly from high to low voltage.

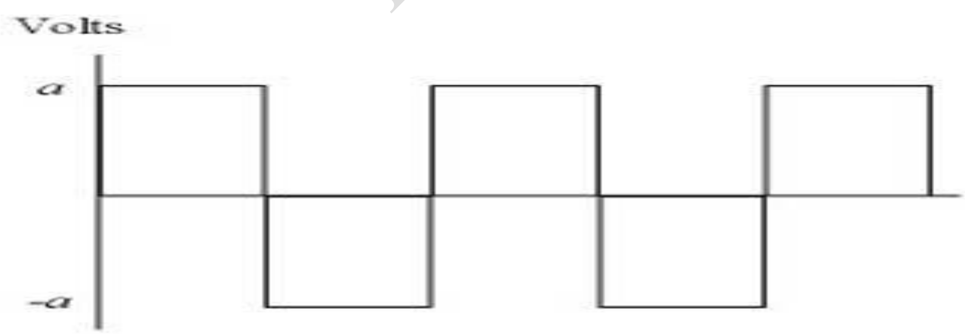


Figure 2: Square wave

The duty cycle of a signal refers to the ratio of high voltage to low voltage time in a square wave signal.

- Sine wave - The signal curves like a sinusoid from high to low voltage.

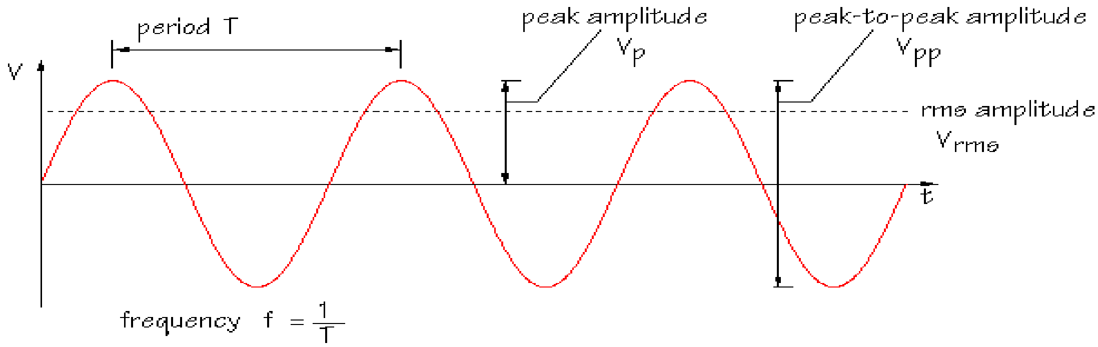


Figure3: Sine Wave

- Triangle wave - The signal goes from high to low voltage at a fixed rate.

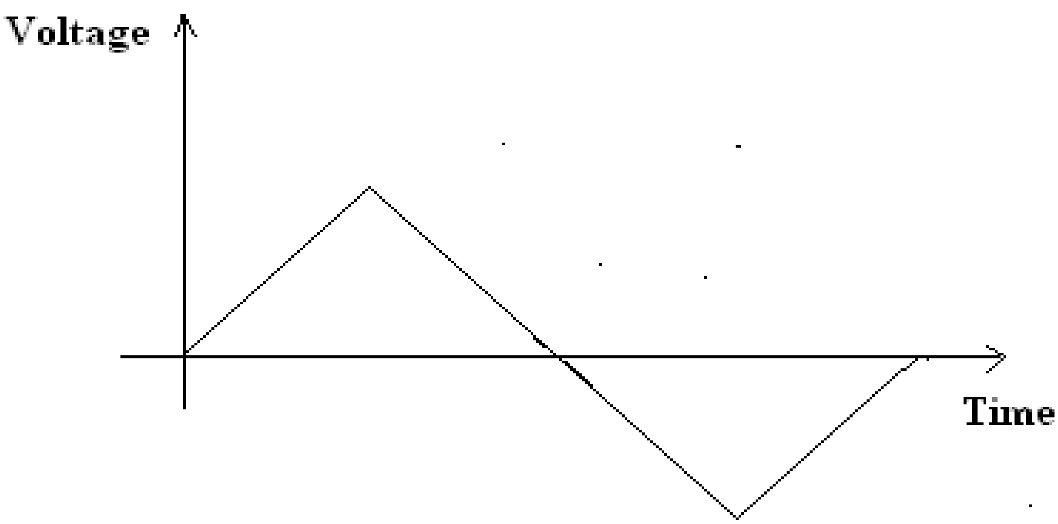


Figure4: Triangular Wave

The amplitude control on a function generator varies the voltage difference between the high and low voltage of the output signal. The direct current (DC) offset control on a function generator varies the average voltage of a signal relative to the ground.

The frequency control of a function generator controls the rate at which output signal oscillates. On some function generators, the frequency control is a combination of different controls. One set of controls chooses the broad frequency range (order of magnitude) and the other selects the precise frequency. This allows the function generator to handle the enormous variation in frequency scale needed for signals.

- **How to use a function generator**

After powering on the function generator, the output signal needs to be configured to the desired shape. Typically, this means connecting the signal and ground leads to an oscilloscope to check the controls. Adjust the function generator until the output signal is correct, then attach the signal and ground leads from the function generator to the input and ground of the device under test. For some applications, the negative lead of the function generator should attach to a negative input of the device, but usually attaching to ground is sufficient.

5. STUDY OF REGULATED POWER SUPPLY

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply:

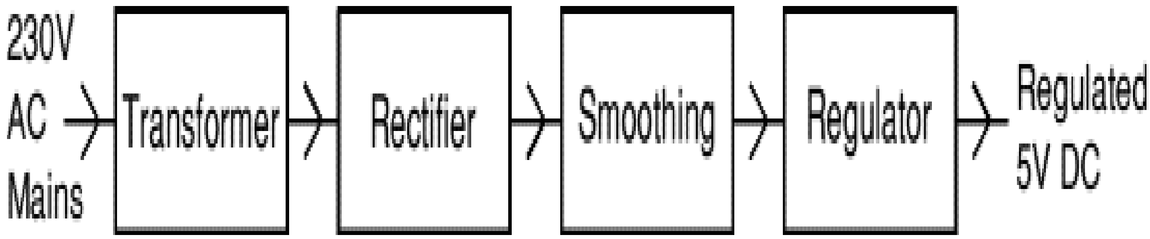


Figure1: Block Diagram of Regulated power supply

Each of the blocks is described in more detail below:

- Transformer: Steps down high voltage AC mains to low voltage AC.
- Rectifier: Converts AC to DC, but the DC output is varying.
- Smoothing: Smooths the DC from varying greatly to a small ripple.
- Regulator: Eliminates ripple by setting DC output to a fixed voltage.

- **Dual Supplies:** Some electronic circuits require a power supply with positive and negative outputs as well as zero volts (0V). This is called a 'dual supply' because it is like two ordinary supplies connected together as shown in the diagram. Dual supplies have three outputs, for example a ±9V supply has +9V, 0V and -9V outputs.

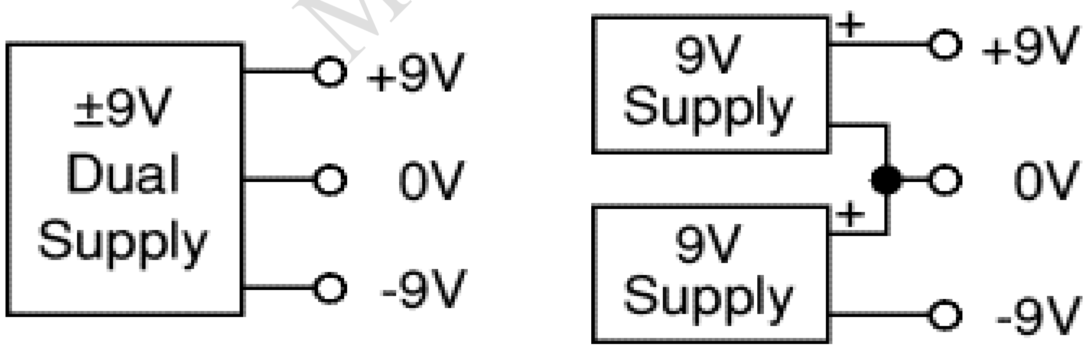


Figure 2: Dual Supply

6. TYPES OF CIRCUIT BOARD

- **Breadboard:** This is a way of making a temporary circuit, for testing purposes or to try out an idea. No soldering is required and all the components can be re-used afterwards. It is easy to change connections and replace components. Almost all the Electronics Club projects started life on a breadboard to check that the circuit worked as intended. The following figure depicts the appearance of Bread board in which the holes in top and bottom stribes are connected horizontally that are used for power supply and ground connection conventionally and holes on middle stribes connected vertically. And that are used for circuit connections conventionally**.**

Figure 1: Bread board

- **Strip board:**

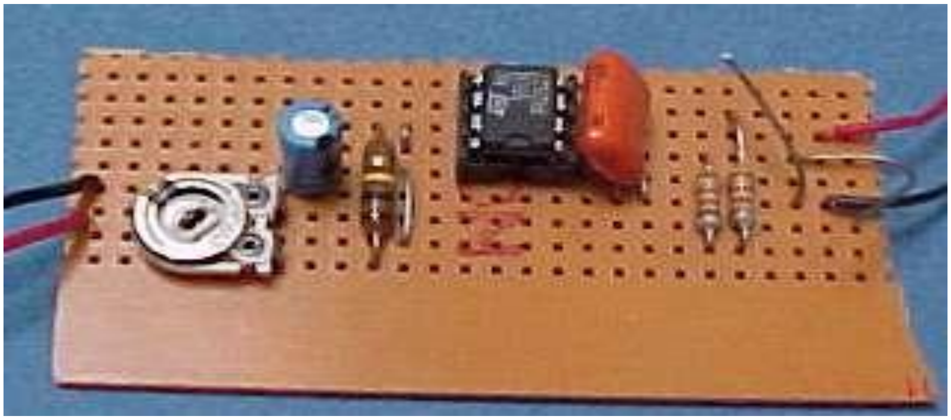


Figure 2: Strib board

Stripboard has parallel strips of copper track on one side. The strips are 0.1" (2.54mm) apart and there are holes every 0.1" (2.54mm). Stripboard requires no special preparation other than cutting to size. It can be cut with a junior hacksaw, or simply snap it along the lines of holes by putting it over the edge of a bench or table and pushing hard.

Printed Circuit Board: A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed wiring board (PWB) or etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA).

Printed circuit boards have copper tracks connecting the holes where the components are placed. They are designed specially for each circuit and make construction very easy. However, producing the PCB requires special equipment so this method is not recommended if you are a beginner unless the PCB is provided for you.

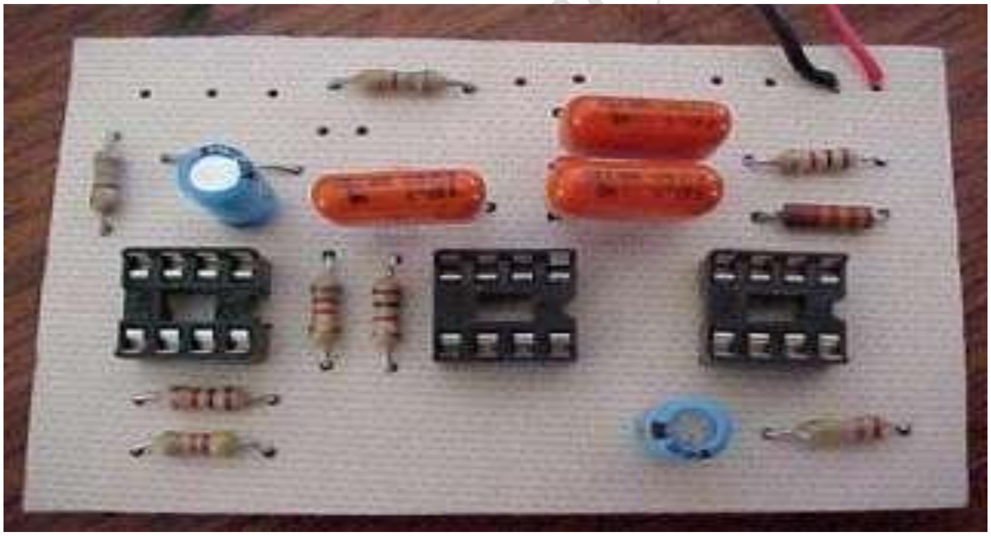


Figure 3: Printed circuit board

PCBs are inexpensive, and can be highly reliable. They require much more layout effort and higher initial cost than either wire-wrapped or point-to-point constructed circuits, but are much cheaper and faster for high-volume production. Much of the electronics industry's PCB design, assembly, and quality control needs are set by standards that are published by the IPC organization.

1. P-N JUNCTION DIODE CHARACTERISTICS

AIM: 1. To observe and draw the Forward and Reverse bias V-I Characteristics of a P-N Junction diode.
2. To calculate static and dynamic resistance in both forward and Reverse Bias Conditions.

APPARATUS:

1. P-N Diode IN4007 - 1No.
2. Regulated Power supply (0-30V) - 1No.
3. Resistor 1KΩ - 1No.
4. Ammeter (0-20 mA) - 1No
5. Ammeter (0-200µA) - 1No.
6. Voltmeter (0-20V) - 2No.
7. Bread board
8. Connecting wires

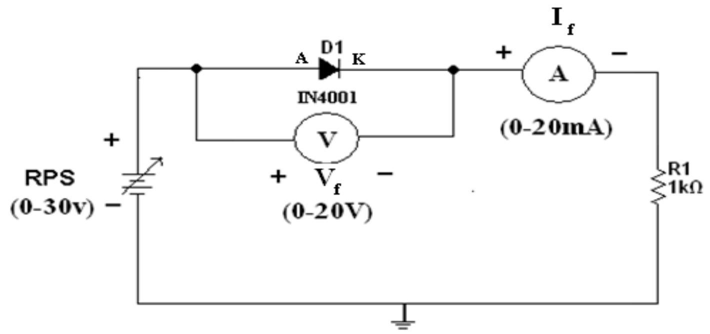
THEORY:

A P-N junction diode conducts only in one direction. The V-I characteristics of the diode are curve between voltage across the diode and current flowing through the diode. When external voltage is zero, circuit is open and the potential barrier does not allow the current to flow. Therefore, the circuit current is zero. When P-type (Anode) is connected to +ve terminal and n- type (cathode) is connected to –ve terminal of the supply voltage is known as forward bias. The potential barrier is reduced when diode is in the forward biased condition. At some forward voltage, the potential barrier altogether eliminated and current starts flowing through the diode and also in the circuit. Then diode is said to be in ON state. The current increases with increasing forward voltage.

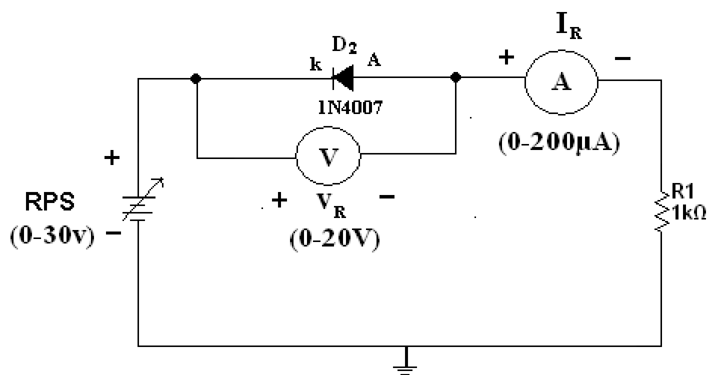
When N-type (cathode) is connected to +ve terminal and P-type (Anode) is connected –ve terminal of the supply voltage is known as reverse bias and the potential barrier across the junction increases. Therefore, the junction resistance becomes very high and a very small current (reverse saturation current) flows in the circuit. Then diode is said to be in OFF state. The reverse bias current is due to minority charge carriers.

CIRCUIT DIAGRAM:

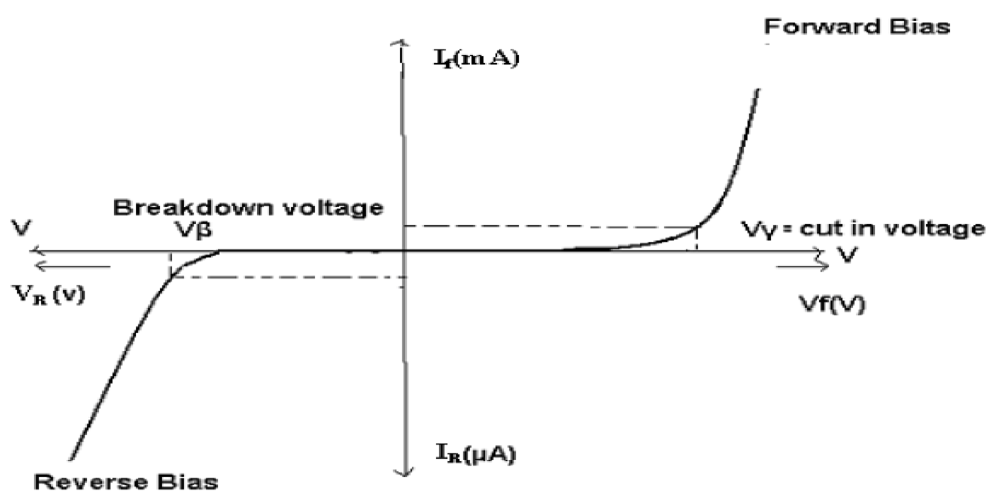
A) Forward bias:



B) Reverse Bias:



MODEL GRAPH:



OBSERVATIONS:

A) FORWARD BIAS:

S.NO	Applied Voltage(V)	Forward Voltage(V_f)	Forward Current(I_f(mA))

B) REVERSE BIAS:

S.NO	Applied Voltage(V)	Reverse Voltage(V_R)	Reverse Current(I_R(μA))

Calcutions:

Calculation of Static and Dynamic Resistance for a given diode.

In forward bias condition:

Static Resistance , $R_s = Vf/I_f =$
Dynamic Resistance, $R_D = \Delta V_f / \Delta I_f =$

In Reverse bias condition:

Static Resistance , $R_s = V_R/I_R =$
Dynamic Resistance, $RD = \Delta V_R / \Delta I_R =$

PROCEDURE:

A) FORWARD BIAS:

1. Connections are made as per the circuit diagram.
2. For forward bias, the RPS +ve is connected to the anode of the diode and RPS –ve is connected to the cathode of the diode
3. Switch on the power supply and increases the input voltage (supply voltage) in Steps of 0.1V
4. Note down the corresponding current flowing through the diode and voltage across the diode for each and every step of the input voltage.
5. The reading of voltage and current are tabulated.
6. Graph is plotted between voltage (V_f) on X-axis and current (I_f) on Y-axis.

B) REVERSE BIAS:

1. Connections are made as per the circuit diagram
2. For reverse bias, the RPS +ve is connected to the cathode of the diode and RPS –ve is connected to the anode of the diode.
3. Switch on the power supply and increase the input voltage (supply voltage) in Steps of 1V.
4. Note down the corresponding current flowing through the diode voltage across the diode for each and every step of the input voltage.
5. The readings of voltage and current are tabulated
6. Graph is plotted between voltage(V_R) on X-axis and current (I_R) on Y-axis.

PRECAUTIONS:

1. All the connections should be correct.
2. Parallax error should be avoided while taking the readings from the Analog meters.

RESULT:

VIVA QUESTIONS:

1. Define depletion region of a diode?
2. What is meant by transition & space charge capacitance of a diode?
3. Is the V-I relationship of a diode Linear or Exponential?
4. Define cut-in voltage of a diode and specify the values for Si and Ge diodes?
5. What are the applications of a p-n diode?
6. Draw the ideal characteristics of P-N junction diode?
7. What is the diode equation?
8. What is PIV?
9. What is the break down voltage?
10. What is the effect of temperature on PN junction diodes?

2. ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR

AIM:

a) To observe and draw the static characteristics of a zener diode
b) To find the voltage regulation of a given zener diode

APPARATUS:

1. Zener diode - 1No.
2. Regulated Power Supply (0-30v) - 1No.
3. Voltmeter (0-20v) - 1No.
4. Ammeter (0-20mA) - 1No.
5. Resistor (1K ohm)
6. Bread Board
7. Connecting wires

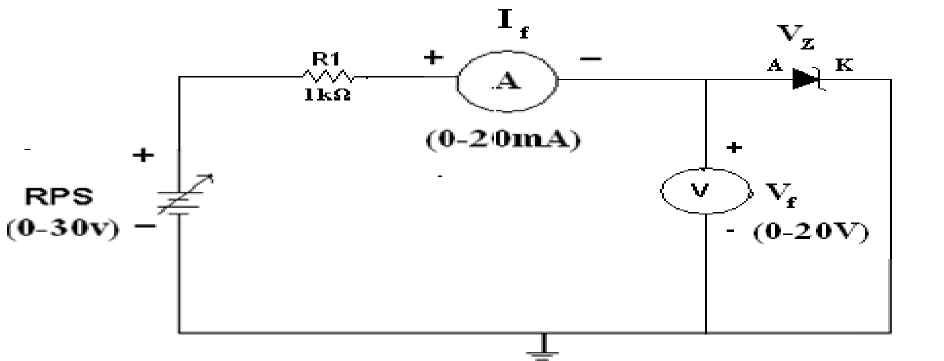
THEORY:

A zener diode is heavily doped p-n junction diode, specially made to operate in the break down region. A p-n junction diode normally does not conduct when reverse biased. But if the reverse bias is increased, at a particular voltage it starts conducting heavily. This voltage is called Break down Voltage. High current through the diode can permanently damage the device

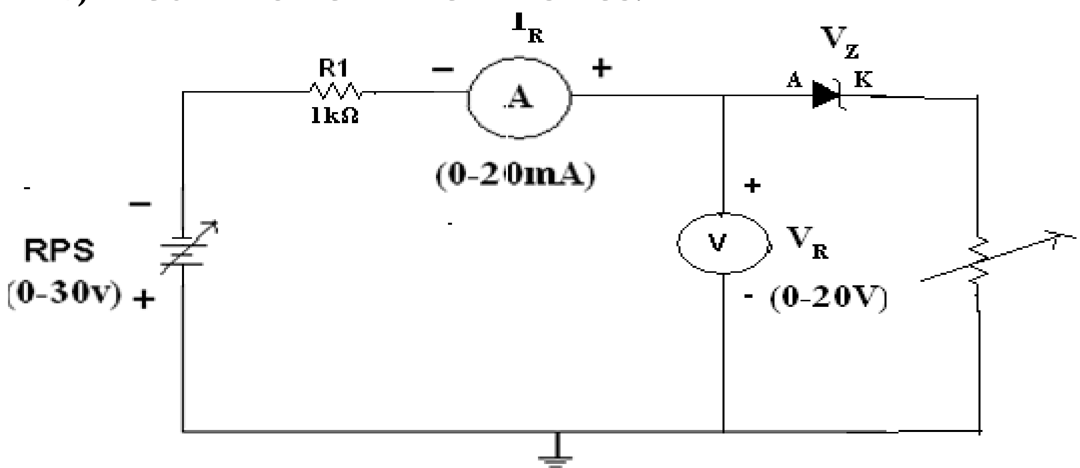
To avoid high current, we connect a resistor in series with zener diode. Once the diode starts conducting it maintains almost constant voltage across the terminals whatever may be the current through it, i.e., it has very low dynamic resistance. It is used in voltage regulators.

CIRCUIT DIAGRAM

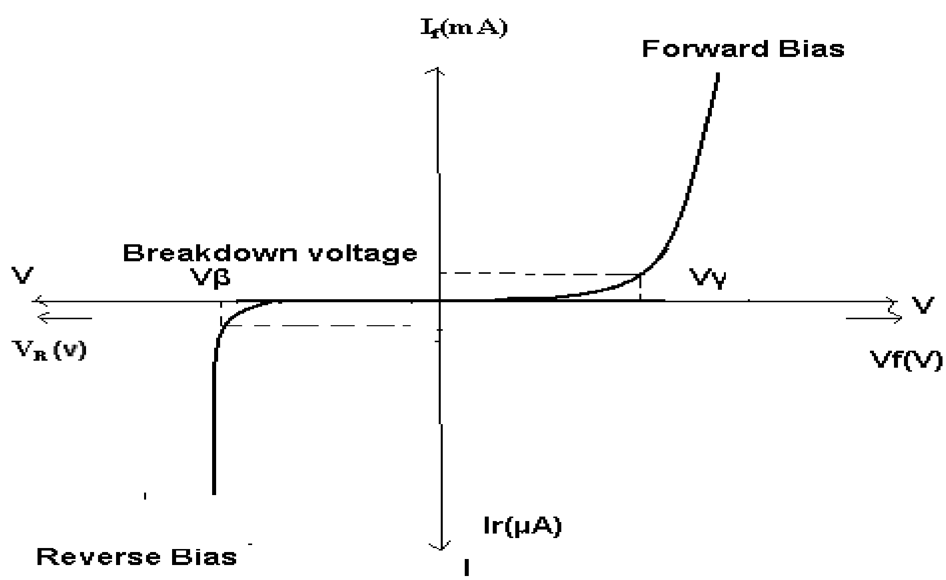
A) STATIC CHARACTERISTICS :



B) REGULATION CHARACTERISTICS:



Model Graph:



OBSERVATIONS:

A) Static characteristics:

S.NO	Applied Voltage(V)	Forward Voltage(V_f)	Forward Current(I_f(mA))

B) Regulation Characteristics:

S.N0	Applied Voltage,Vs	V_{NL} (VOLTS)	V_{FL} (VOLTS)	R_L (KΩ)	% REGULATION

PROCEDURE:

A) Static characteristics:

1. Connections are made as per the circuit diagram.
2. The Regulated power supply voltage is increased in steps.
3. The Forward current (l_f), and the forward voltage (V_f.) are observed and then noted in the tabular form.
4. A graph is plotted between Forward current (l_f) on X-axis and the forward voltage (V_f) on Y-axis.

B) Regulation characteristics:

1. Connection are made as per the circuit diagram
2. The load is placed in full load condition and the zener voltage (Vz), Zener current (lz), load current (I_L) are measured.
3. The above step is repeated by decreasing the value of the load in steps.
4. All the readings are tabulated.
5. The percentage regulation is calculated using the below formula
6. The voltage regulation of any device is usually expressed as percentage regulation.

CALCULATIONS:

The percentage regulation is given by the formula

$$((V_{NL}-V_{FL})/V_{FL})X100$$

V_{NL}=Voltage across the diode, when no load is connected.
V_{FL}=Voltage across the diode, when load is connected.

PRECAUTIONS:

1. The terminals of the zener diode should be properly identified
2. While determined the load regulation, load should not be immediately shorted.
3. Should be ensured that the applied voltages & currents do not exceed the ratings of the diode.

RESULT:

VIVAQUESTIONS:

1. What type of temp coefficient does the zener diode have?
2. If the impurity concentration is increased, how the depletion width effected?
3. Does the dynamic impendence of a zener diode vary?
4. Explain briefly about avalanche and zener breakdowns?
5. Draw the zener equivalent circuit?
6. Differentiate between line regulation & load regulation?
7. In which region zener diode can be used as a regulator?
8. How the breakdown voltage of a particular diode can be controlled?
9. What type of temperature coefficient does the Avalanche breakdown has?
10. By what type of charge carriers the current flows in zener and avalanche breakdown diodes?

3. INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR IN COMMON-BASE CONFIGURATION

AIM: 1.To observe and draw the input and output characteristics of a transistor connected in common base configuration.
2. To find α of the given transistor and also its input and output Resistances.

APPARATUS:

Transistor, BC107	-1No.
Regulated power supply (0-30V)	-1No.
Voltmeter (0-20V)	- 2No.
Ammeters (0-10mA)	-2No.
Resistor, 1KΩ	-2No
Bread board	
Connecting wires	

THEORY:

A transistor is a three terminal active device. The terminals are emitter, base, collector. In CB configuration, the base is common to both input (emitter) and output (collector). For normal operation, the E-B junction is forward biased and C-B junction is reverse biased. In CB configuration, I_E is +ve, I_C is –ve and I_B is –ve. So,

$$\mathbf{V_{EB} = F1\,(V_{CB}, I_E)\text{ and}}$$

$$\mathbf{I_C = F_2\,(V_{EB}, I_B)}$$

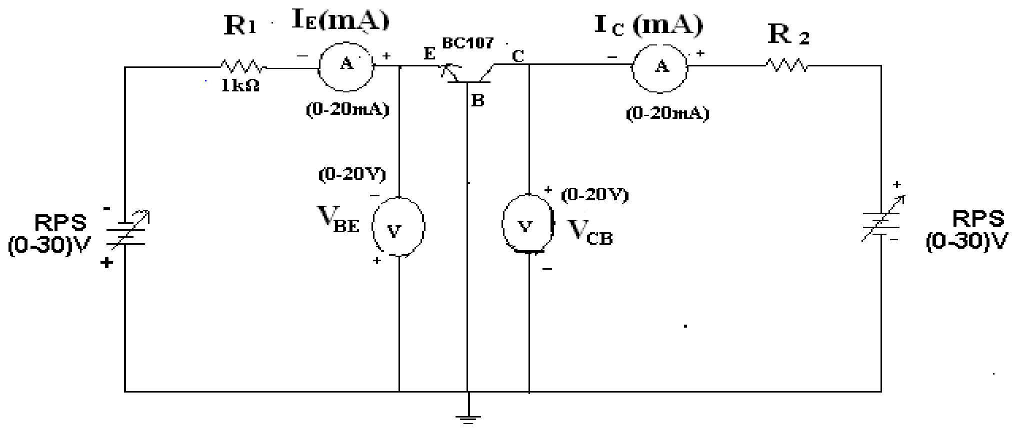
With an increasing the reverse collector voltage, the space-charge width at the output junction increases and the effective base width 'W' decreases. This phenomenon is known as "Early effect". Then, there will be less chance for recombination within the base region. With increase of charge gradient with in the base region, the current of minority carriers injected across the emitter junction increases.
The current amplification factor of CB configuration is given by,

$$\boldsymbol{\alpha = \Delta I_C / \Delta I_E}$$

Input Resistance, r_i = $\Delta \mathbf{V_{BE}} / \Delta \mathbf{I_E}$ at Constant V_{CB}

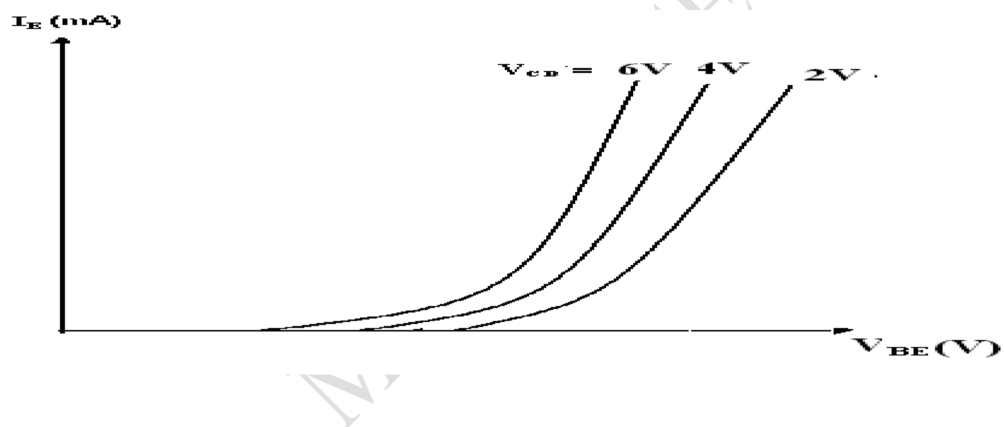
Output Résistance, r_o = $\Delta \mathbf{V_{CB}} / \Delta \mathbf{I_C}$ at Constant I_E

CIRCUIT DIAGRAM:

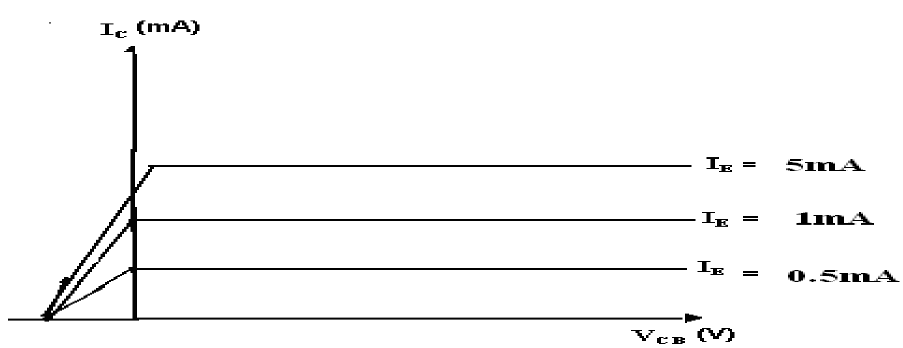


MODEL GRAPHS:

A) INPUT CHARACTERISTICS



B) OUTPUTCHARACTERISTICS



OBSERVATIONS:

A) INPUT CHARACTERISTICS:

V_{EE}(V)	$V_{CB=}$1V		$V_{CB=}$ = 2V		$V_{CB=}$ 4V	
	V_{EB}(V)	I_E(mA)	V_{EB}(V)	$I_{E(}$mA)	V_{EB}(V)	$I_{E(}$mA)

B) OUTPUT CHARACTERISTICS:

V_{cc}(V)	$I_{E=}$10mA		$I_{E=}$20mA		I_E=30mA	
	V_{CB}(V)	$I_{C(}$mA)	V_{CB}(V)	$I_{C(}$mA)	V_{CB}(V)	$I_{C(}$mA)

PROCEDURE:

A) INPUT CHARACTERISTICS:

1. Connections are made as per the circuit diagram.
2. For plotting the input characteristics, the output voltage V_{CE} is kept constant at 0V and for different values of V_{EE} ,note down the values of I_E and V_{BE}
3. Repeat the above step keeping V_{CB} at 2V, 4V, and 6V and all the readings are tabulated.
4. A graph is drawn between V_{EB} and I_E for constant $V_{CB.}$

B) OUTPUT CHARACTERISTICS:

1. Connections are made as per the circuit diagram.
2. For plotting the output characteristics, the input I_E is kept constant at 0.5mA and for different values of V_{CC}, note down the values of I_C and V_{CB}.
3. Repeat the above step for the values of I_E at 1mA, 5mA and all the readings are tabulated.
4. A graph is drawn between V_{CB} and Ic for constant I_E

PRECAUTIONS:

1. The supply voltages should not exceed the rating of the transistor.
2. Meters should be connected properly according to their polarities.

RESULT:

VIVA QUESTIONS:

1. What is the range of α for the transistor?
2. Draw the input and output characteristics of the transistor in CB configuration?
3. Identify various regions in output characteristics?
4. What is the relation between α and β?
5. What are the applications of CB configuration?
6. What are the input and output impedances of CB configuration?
7. Define α (alpha)?
8. What is early effect?
9. Draw Circuit diagram of CB configuration for PNP transistor?
10. What is the power gain of CB configuration?

4. INPUT AND OUTPUT CHARACTERISTICS OF TRASISTOR IN CE CONFIGURATION

AIM:

1. To draw the input and output characteristics of transistor connected in CE configuration
2. To find β of the given transistor and also its input and output Resistances

APPARATUS:

Transistor, BC107	-1No.
Regulated power supply (0-30V)	-1No.
Voltmeter (0-20V)	- 2No.
Ammeters (0-20mA)	-1No.
Ammeters (0-200μA)	-1No.
Resistor, 100Ω	-1No
Resistor, 1KΩ	-1No.
Bread board	
Connecting wires	

THEORY:

In common emitter configuration, input voltage is applied between base and emitter terminals and out put is taken across the collector and emitter terminals. Therefore the emitter terminal is common to both input and output.

The input characteristics resemble that of a forward biased diode curve. This is expected since the Base-Emitter junction of the transistor is forward biased. As compared to CB arrangement I_B increases less rapidly with $V_{BE.}$ Therefore input resistance of CE circuit is higher than that of CB circuit.

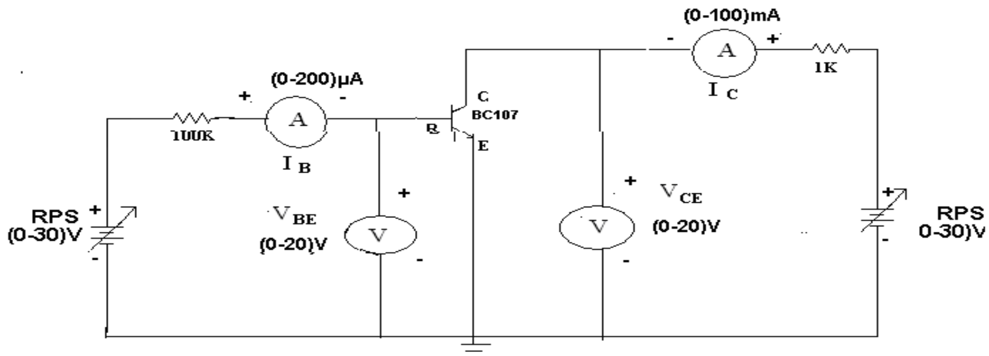
The output characteristics are drawn between I_c and V_{CE} at constant $I_{B.}$ the collector current varies with V_{CE} upto few volts only. After this the collector current becomes almost constant, and independent of $V_{CE.}$ The value of V_{CE} up to which the collector current changes with V_{CE} is known as Knee voltage. The transistor always operated in the region above Knee voltage, $I_{C\ is}$ always constant and is approximately equal to $I_{B.}$The current amplification factor of CE configuration is given by

$$\beta = \Delta I_C/\Delta I_B$$

Input Resistance, r_i = $\Delta \mathbf{V_{BE}} / \Delta \mathbf{I_B}$ (μA) at Constant V_{CE}

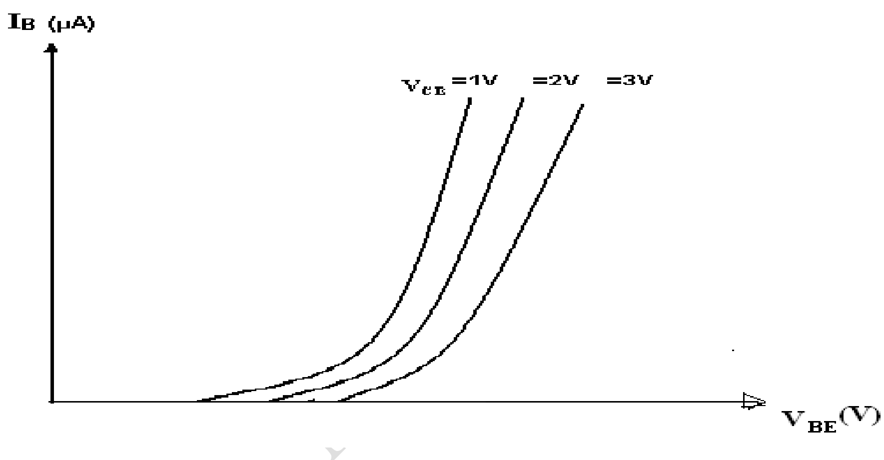
Output Résistance, r_o = $\Delta \mathbf{V_{CE}} / \Delta \mathbf{I_C}$ at Constant I_B (μA)

CIRCUIT DIAGRAM:

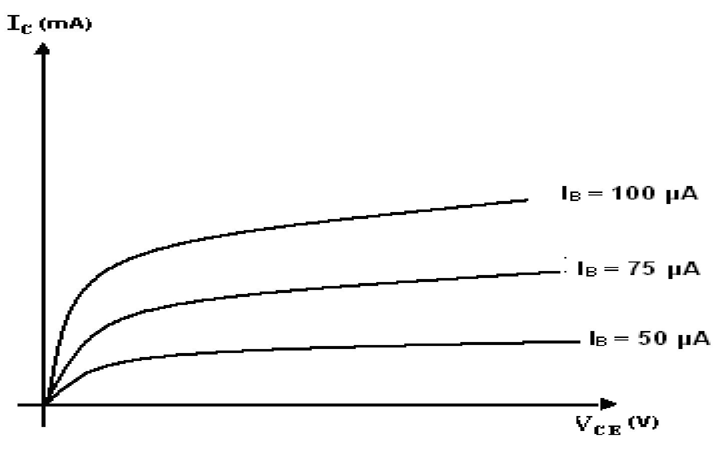


MODEL GRAPHS:

A) INPUT CHARACTERISTICS:



B) OUTPUT CHARACTERSITICS:



OBSERVATIONS:

A) INPUT CHARACTERISTICS:

V_{BB}	V_{CE} = 1V		V_{CE} = 2V		V_{CE} = 4V	
	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)

B) OUTPUT CHAREACTARISTICS:

S.NO	I_B = 50 μA		I_B = 75 μA		I_B = 100 μA	
	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)	V_{CE}(V)	I_C(mA)

PROCEDURE:

A) **INPUT CHARECTERSTICS:**

1. Connect the circuit as per the circuit diagram.
2. For plotting the input characteristics the output voltage V_{CE} is kept constant at 1V and for different values of V_{BB} , note down the values of I_B and V_{BE}
3. Repeat the above step by keeping V_{CE} at 2V and 4V and tabulate all the readings.
4. plot the graph between V_{BE} and I_B for constant V_{CE}

B) **OUTPUT CHARACTERSTICS:**

2. Connect the circuit as per the circuit diagram
3. for plotting the output characteristics the input current I_B is kept constant at 50μA and for different values of V_{CC} note down the values of I_C and V_{CE}
4. Repeat the above step by keeping I_B at 75 μA and 100 μA and tabulate the all the readings
5. plot the graph between V_{CE} and I_C for constant I_B

PRECAUTIONS:

1. The supply voltage should not exceed the rating of the transistor
2. Meters should be connected properly according to their polarities

RESULT:

VIVA QUESTIONS:

1. What is the range of β for the transistor?
2. What are the input and output impedances of CE configuration?
3. Identify various regions in the output characteristics?
4. What is the relation between α and β?
5. Define current gain in CE configuration?
6. Why CE configuration is preferred for amplification?
7. What is the phase relation between input and output?
8. Draw diagram of CE configuration for PNP transistor?
9. What is the power gain of CE configuration?
10. What are the applications of CE configuration?

5. HALF -WAVE RECTIFIER WITH AND WITHOUT FILTER

AIM: To examine the input and output waveforms of half wave Rectifier and also calculate its load regulation and ripple factor.

1. with Filter
2. without Filter

APPARATUS:

Digital multimetersMultimeter	- 1No.
Transformer (6V-0-6V)	- 1No.
Diode, 1N4007	- 1No.
Capacitor 100µf/470 µf	- 1No.
Decade Resistance Box	- 1No.
Breadboard	
CRO and CRO probes	
Connecting wires	

THEORY:

In Half Wave Rectification, When AC supply is applied at the input, only Positive Half Cycle appears across the load whereas, the negative Half Cycle is suppressed. How this can be explained as follows:

During positive half-cycle of the input voltage, the diode D1 is in forward bias and conducts through the load resistor R_L. Hence the current produces an output voltage across the load resistor R_L, which has the same shape as the +ve half cycle of the input voltage.

During the negative half-cycle of the input voltage, the diode is reverse biased and there is no current through the circuit. i.e., the voltage across R_L is zero. The net result is that only the +ve half cycle of the input voltage appears across the load. The average value of the half wave rectified o/p voltage is the value measured on dc voltmeter.

For practical circuits, transformer coupling is usually provided for two reasons.

1. The voltage can be stepped-up or stepped-down, as needed.
2. The ac source is electrically isolated from the rectifier. Thus preventing shock hazards in the secondary circuit.

The efficiency of the Half Wave Rectifier is 40.6%

Theoretical calculations for Ripple factor:

Without Filter:

Vrms=Vm/2

Vm=2Vrms

Vdc=Vm/Π

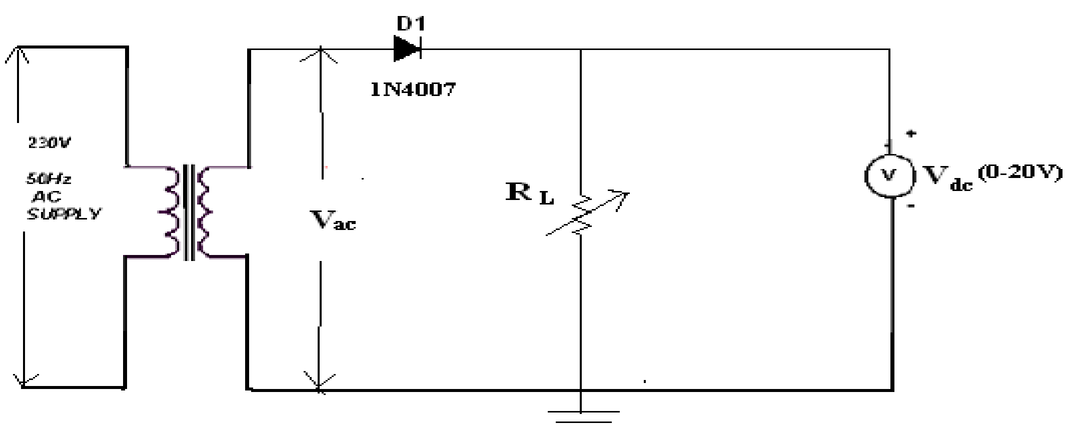
Ripple factor $r=\sqrt{(Vrms/Vdc)^2-1}=1.21$

With Filter:

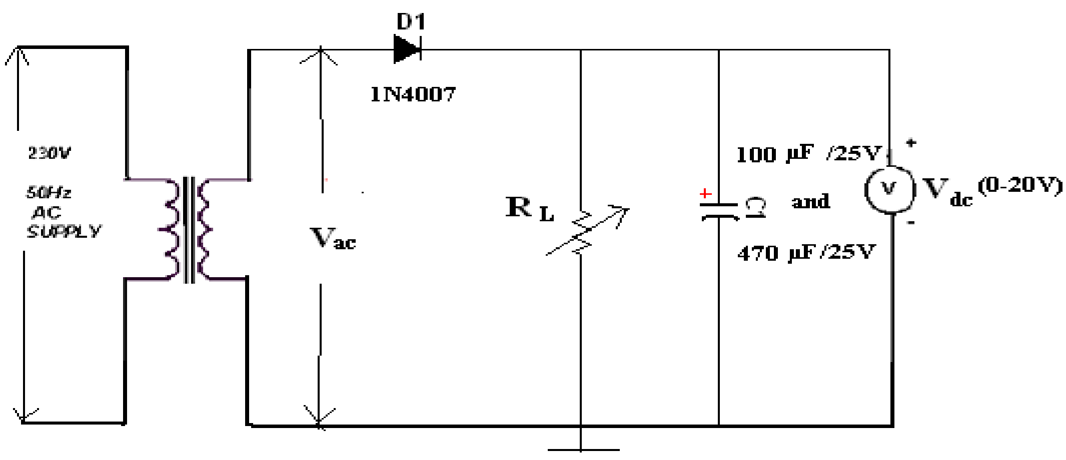
Ripple factor, $r=1/(2\sqrt{3}\,f\,C\,R)$

CIRCUIT DIAGRAM:

A) Half wave Rectifier without filter:

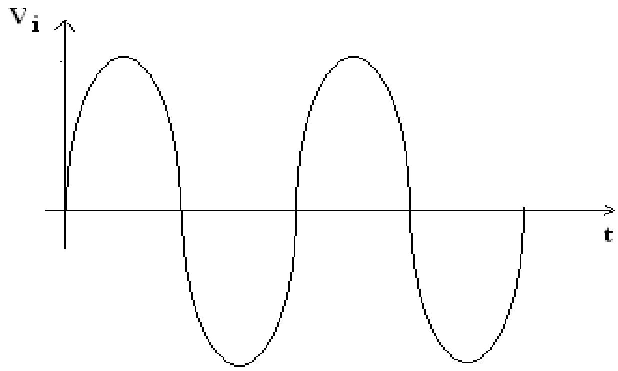


B) Half wave Rectifier with filter

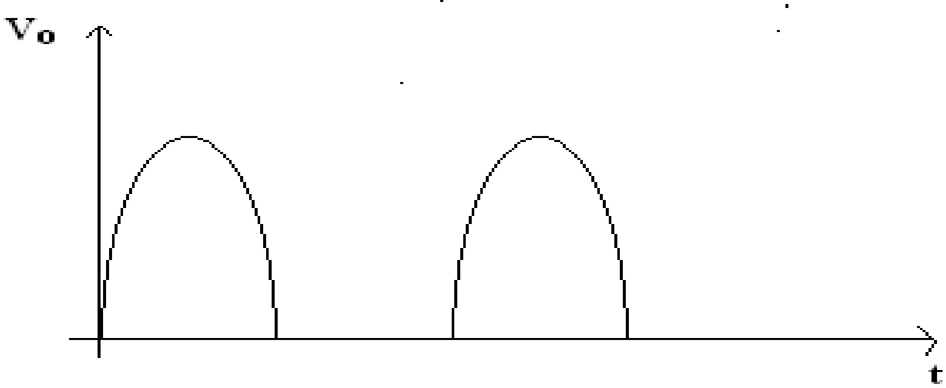


MODEL WAVEFORMS:

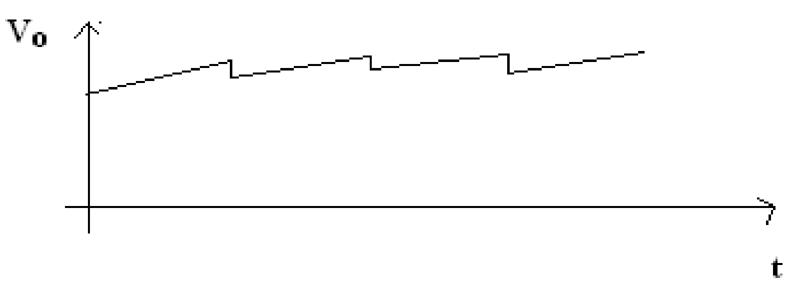
A) INPUT WAVEFORM



B) OUTPUT WAVFORM WITHOUT FILTER



C) OUTPUT WAVEFORM WITH FILTER:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Connect the primary side of the transformer to ac mains and the secondary side to the rectifier input.
3. By the multimeter, measure the ac input voltage of the rectifier and, ac and dc voltage at the output of the rectifier.
4. Find the theoretical of dc voltage by using the formula,

$$V_{dc}=V_m/\Pi$$

Where, Vm=2Vrms, (Vrms=output ac voltage.)

5. The Ripple factor is calculated by using the formula

r = ac output voltage/dc output voltage.

REGULATION CHARACTERSTICS:

1. Connections are made as per the circuit diagram.
2. By increasing the value of the rheostat, the voltage across the load and current flowing through the load are measured.
3. The reading is tabulated.
4. From the value of no-load voltages, the %regulation is calculated using the formula,

$$\%\text{Regulation} = [(V_{NL}-V_{FL})/V_{FL}]*100$$

PRECAUTIONS:

1. The primary and secondary side of the transformer should be carefully identified
2. The polarities of all the diodes should be carefully identified.
3. While determining the % regulation, first Full load should be applied and then it should be decremented in steps.

RESULT:

VIVA QUESTIONS:

1. What is the PIV of Half wave rectifier?
2. What is the efficiency of half wave rectifier?
3. What is the rectifier?
4. What is the difference between the half wave rectifier and full wave Rectifier?
5. What is the o/p frequency of Bridge Rectifier?
6. What are the ripples?
7. What is the function of the filters?
8. What is TUF?
9. What is the average value of o/p voltage for HWR?
10. What is the peak factor?

6. FULL-WAVE RECTIFIER WITH AND WITHOUT FILTER

AIM: To Examine the input and output waveforms of Full Wave Rectifier and also calculate its load regulation and ripple factor.

1. with Filter
2. without Filter

APPARATUS:

Digital multimetersMultimeter	- 1No.
Transformer (6V-0-6V)	- 1No.
Diode, 1N4007	- 2No.
Capacitor 100µf/470 µf	- 1No.
Decade Resistance Box	- 1No.
Breadboard	
CRO and CRO probes	
Connecting wires	

THEORY:

The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2is reverse biased. So the diode D1 conducts and current flows through load resistor R_L.

During negative half cycle, diode D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor R_L in the same direction. There is a continuous current flow through the load resistor R_L, during both the half cycles and will get unidirectional current as show in the model graph. The difference between full wave and half wave rectification is that a full wave rectifier allows unidirectional (one way) current to the load during the entire 360 degrees of the input signal and half-wave rectifier allows this only during one half cycle (180 degree).

THEORITICAL CALCULATIONS:

$$V_{rms} = V_m/\sqrt{2}$$
$$V_m = V_{rms}\sqrt{2}$$
$$V_{dc} = 2V_m/\Pi$$

(i)Without filter:

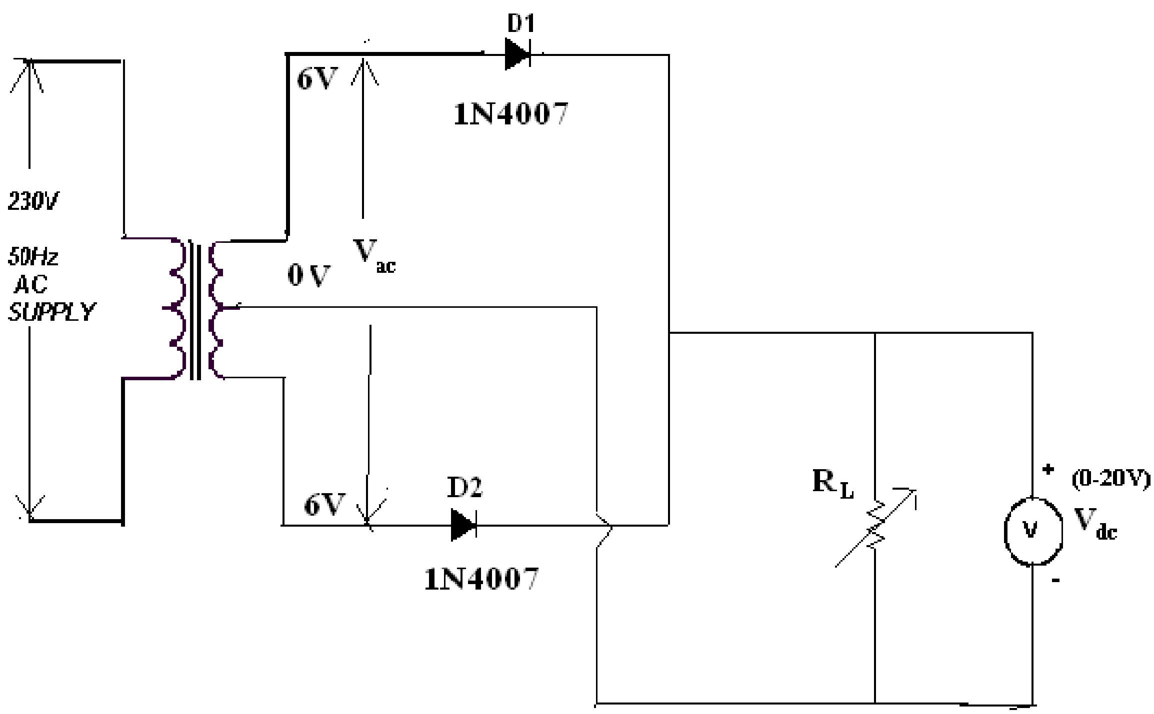
Ripple factor, $r = \sqrt{(V_{rms}/V_{dc})^2 - 1} = 0.812$

(ii)With filter:

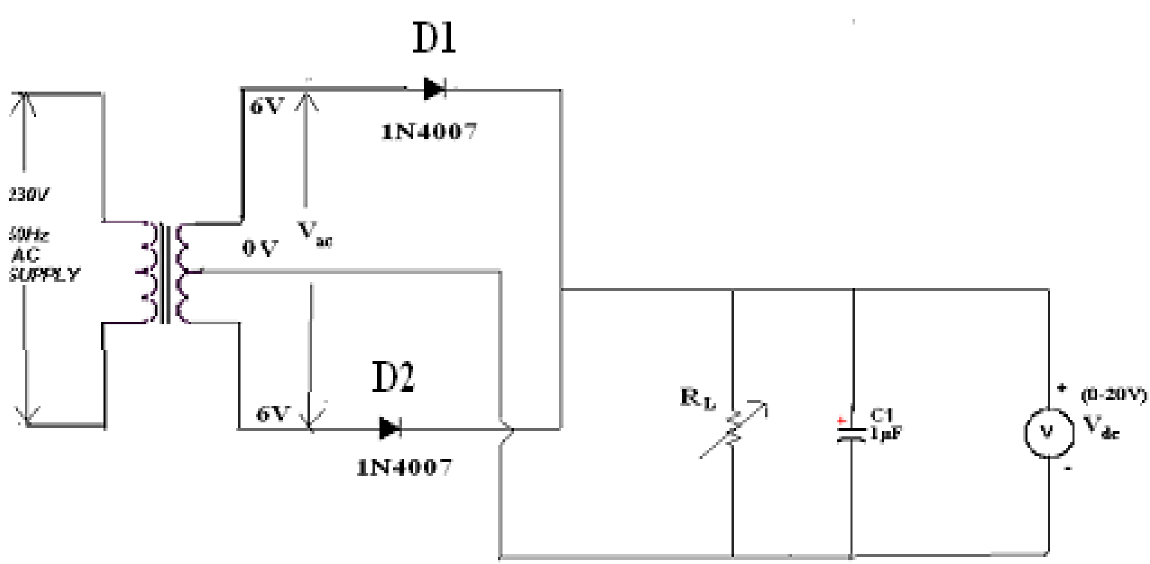
Ripple factor, $r = 1/(4\sqrt{3}\, f\, C\, R_L)$

CIRCUIT DIAGRAM:

A) FULL WAVE RECTIFIER WITHOUT FILTER:

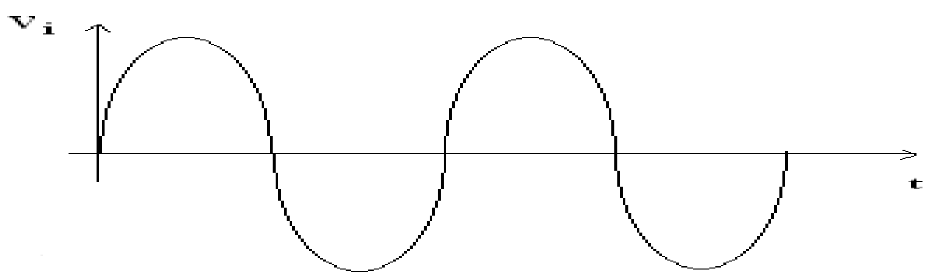


B) FULL WAVE RECTIFIER WITH FILTER:

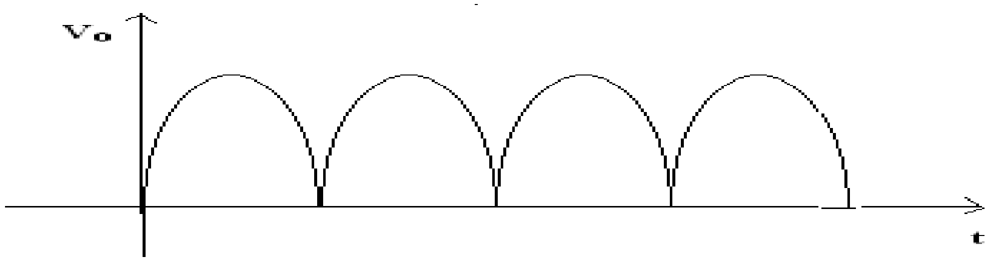


MODEL WAVEFORMS:

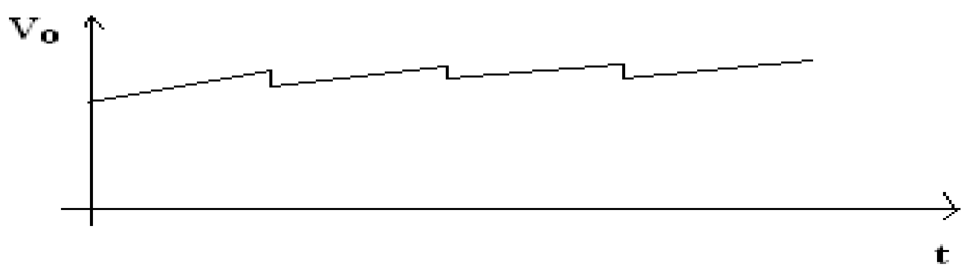
A) INPUT WAVEFORM



B) OUTPUT WAVEFORM WITHOUT FILTER:



C) OUTPUT WAVEFORM WITHOUT FILTER:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Connect the ac mains to the primary side of the transformer and the secondary side to the rectifier.
3. Measure the ac voltage at the input side of the rectifier.
4. Measure both ac and dc voltages at the output side the rectifier.
5. Find the theoretical value of the dc voltage by using the formula Vdc=2Vm/Π
6. Connect the filter capacitor across the load resistor and measure the values of Vac and Vdc at the output.

7. The theoretical values of Ripple factors with and without capacitor are calculated.
8. From the values of Vac and Vdc practical values of Ripple factors are calculated. The practical values are compared with theoretical values.

PRECAUTIONS:

1. The primary and secondary side of the transformer should be carefully identified.
2. The polarities of all the diodes should be carefully identified.

RESULT:

VIVA QUESTIONS:

1. Define regulation of the full wave rectifier?
2. Define peak inverse voltage (PIV)? And write its value for Full-wave rectifier?
3. If one of the diode is changed in its polarities what wave form would you get?
4. Does the process of rectification alter the frequency of the waveform?
5. What is ripple factor of the Full-wave rectifier?
6. What is the necessity of the transformer in the rectifier circuit?
7. What are the applications of a rectifier?
8. What is meant by ripple and define Ripple factor?
9. Explain how capacitor helps to improve the ripple factor?
10. Can a rectifier made in INDIA (V=230v, f=50Hz) be used in USA (V=110v, f=60Hz)?

7. FET CHARACTERISTICS

AIM: a). To draw the drain and transfer characteristics of a given FET.

b). To find the drain resistance (r_d) amplification factor (μ) and TransConductance (g_m) of the given FET.

APPARATUS:

FET BFW11	-1No.
Regulated power supply (0-30V)	-1No.
Voltmeter (0-20V)	-2No.
Ammeter (0-20mA)	-1No.
Bread board	
Connecting wires	

THEORY:

A FET is a three terminal device, in which current conduction is by majority carriers only. The flow of current is controlled by means of an Electric field. The three terminals of FET are Gate, Drain and Source. It is having the characteristics of high input impedance and less noise, the Gate to Source junction of the FETs always reverse biased. In response to small applied voltage from drain to source, the n-type bar acts as sample resistor, and the drain current increases linearly with $V_{DS.}$ With increase in I_D the ohmic voltage drop between the source and the channel region reverse biases the junction and the conducting position of the channel begins to remain constant. The V_{DS} at this instant is called "pinch of voltage". If the gate to source voltage (V_{GS}) is applied in the direction to provide additional reverse bias, the pinch off voltage ill is decreased. In amplifier application, the FET is always used in the region beyond the pinch-off.

FET parameters:

AC Drain Resistance, $\mathbf{r_d} = \Delta \mathbf{V_{DS}} / \Delta \mathbf{I_D}$ at constant V_{GS}

Tran conductance, $\mathbf{g_m} = \Delta \mathbf{I_D} / \Delta \mathbf{V_{GS}}$ at constant V_{DS}

Amplification, $\boldsymbol{\mu} = \Delta \mathbf{V_{DS}} / \Delta \mathbf{V_{GS}}$ at constant I_D

Relation between above parameters

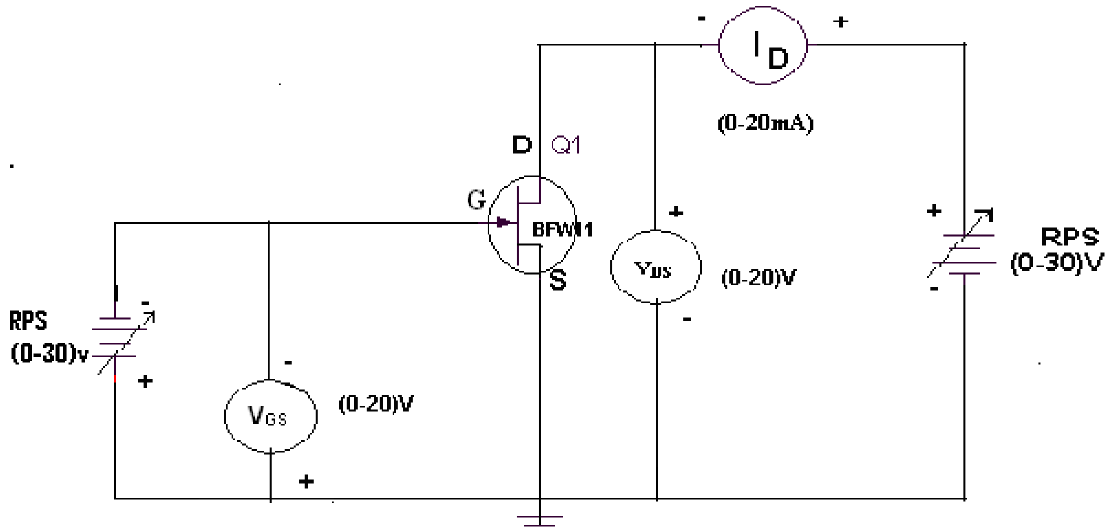
$$\boldsymbol{\mu} = \mathbf{rd * g_m}$$

The drain current is given by

.

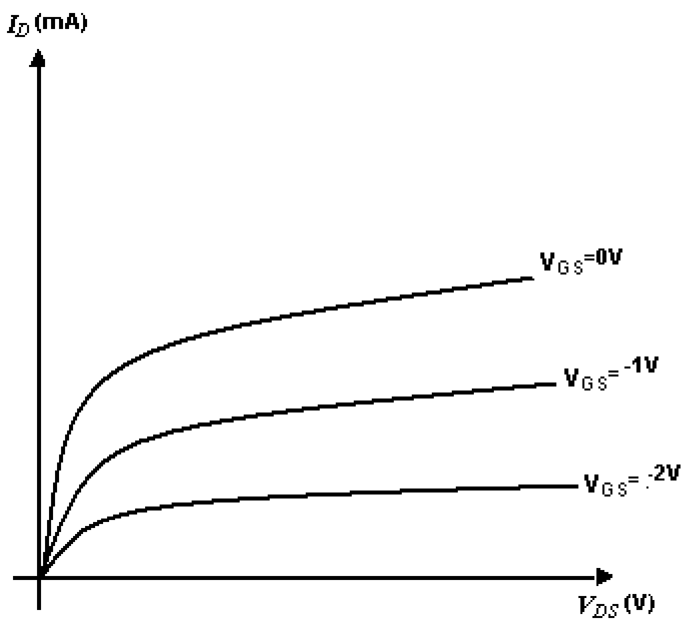
$$\mathbf{I_D = I_{DSS} (1 - V_{GS}/V_P)^2}$$

CIRCUIT DIAGRAM:

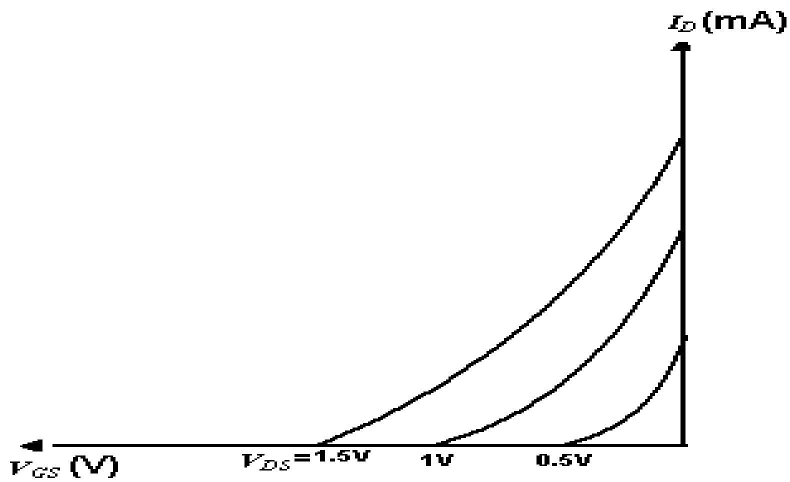


MODEL GRAPH:

A) DRAIN CHARCTERISTICS:



B) TRANSFER CHARACTERISTICS:



OBSERVATIONS:

A) DRAIN CHARACTERISTICS:

S.NO	V_{GS} = 0V		V_{GS} = 0.1V		V_{GS} = 0.2V	
	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)

B) TRANSFER CHARACTERISTICS:

S.NO	V_{DS} =0.5V		V_{DS} = 1V		V_{DS} = 1.5V	
	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)	V_{GS} (V)	I_D(mA)

PROCEDURE:

1. All the connections are made as per the circuit diagram.
2. To plot the drain characteristics, keep V_{GS} constant at 0V.
3. Vary the V_{DD} and observe the values of V_{DS} and I_D.
4. Repeat the above steps 2, 3 for different values of V_{GS} at 0.1V and 0.2V.
5. All the readings are tabulated.
6. To plot the transfer characteristics, keep V_{DS} constant at 1V.
7. Vary V_{GG} and observe the values of V_{GS} and I_D.
8. Repeat steps 6 and 7 for different values of V_{DS} at 1.5 V and 2V.
9. The readings are tabulated.
10. From drain characteristics, calculate the values of dynamic resistance (r_d)
11. From transfer characteristics, calculate the value of transconductace (g_m)
12. And also calculate Amplification factor (μ).

PRECAUTIONS:

1. The three terminals of the FET must be care fully identified
2. Practically FET contains four terminals, which are called source, drain, Gate, substrate.
3. Source and case should be short circuited.
4. Voltages exceeding the ratings of the FET should not be applied.

RESULT:

VIVA QUESTIONS:

1. What are the advantages of FET?
2. Different between FET and BJT?
3. Explain different regions of V-I characteristics of FET?
4. What are the applications of FET?
5. What are the types of FET?
6. Draw the symbol of FET.
7. What are the disadvantages of FET?
8. What are the parameters of FET?

8. h-PARAMETERS OF CE CONFIGURATION

AIM: To calculate the H-parameters of transistor in CE configuration.

APPRATUS:

Transistor BC107	- 1No.
Resistors 100 K Ω 100 Ω	- 1No.Each
Ammeter (0-200μA)	- 1No.
Ammeter(0-200mA	-1No.
Voltmeter (0-20V)	- 2Nos
Regulated Power Supply (0-30V)	- 2Nos
Breadboard	

THEORY:

A) INPUT CHARACTERISTICS:

The two sets of characteristics are necessary to describe the behaviour of the CE configuration, in which one for input or base emitter circuit and other for the output or collector emitter circuit. In input characteristics the emitter base junction forward biased by a very small voltage V_{BB} where as collector base junction reverse biased by a very large voltage V_{CC}. The input characteristics are a plot of input current I_B Versus$_s$ the input voltage V_{BE} for a range of values of output voltage V_{CE} . The following important points can be observed from these characteristics curves.

1. Input resistance is high as I_B increases less rapidly with V_{BE}
2. The input resistance of the transistor is the ratio of change in base emitter voltage ΔV_{BE} to change in base current ΔI_B at constant collector emitter voltage (VCE) i.e... Input resistance or input impedance hie = $\Delta V_{BE} / \Delta I_B$ at V_{CE} constant.

B) OUTPUT CHARACTERISTICS:

A set of output characteristics or collector characteristics are a plot of out put current I_C V_S output voltage V_{CE} for a range of values of input current I_B .The following important points can be observed from these characteristics curves.

1. The transistor always operates in the active region. i.e. the collector current I_C increases with V_{CE} very slowly. For low values of the V_{CE} the I_C increases rapidly with a small increase in V_{CE} .The transistor is said to be working in saturation region.

2. Output resistance is the ratio of change of collector emitter voltage ΔV_{CE} , to change in collector current ΔI_C with constant I_B. Output resistance or Output impedance hoe = $\Delta V_{CE} / \Delta I_C$ at I_B constant.

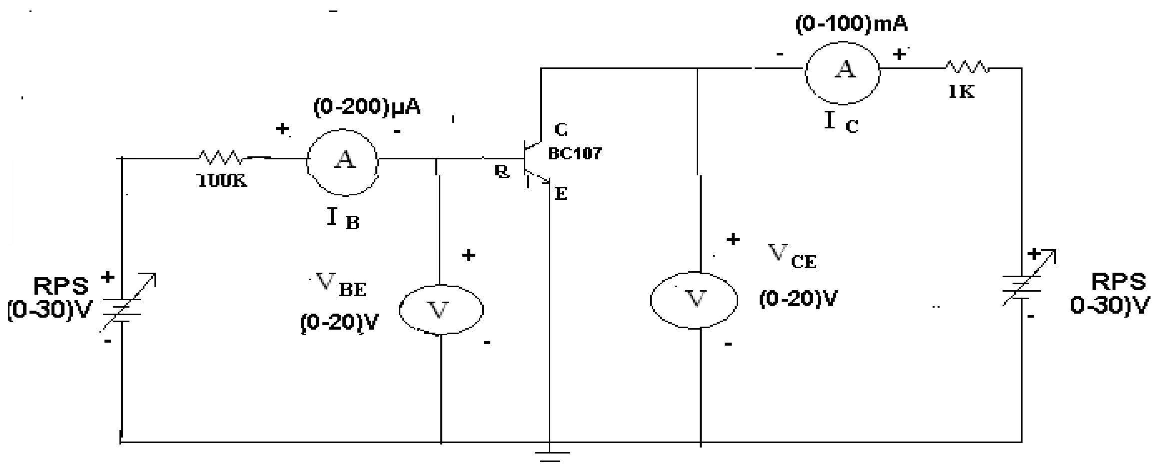
Input Impedance hie = $\Delta V_{BE} / \Delta I_B$ at V_{CE} constant

Output impedance hoe = $\Delta V_{CE} / \Delta I_C$ at I_B constant

Reverse Transfer Voltage Gain hre = $\Delta V_{BE} / \Delta V_{CE}$ at I_B constant

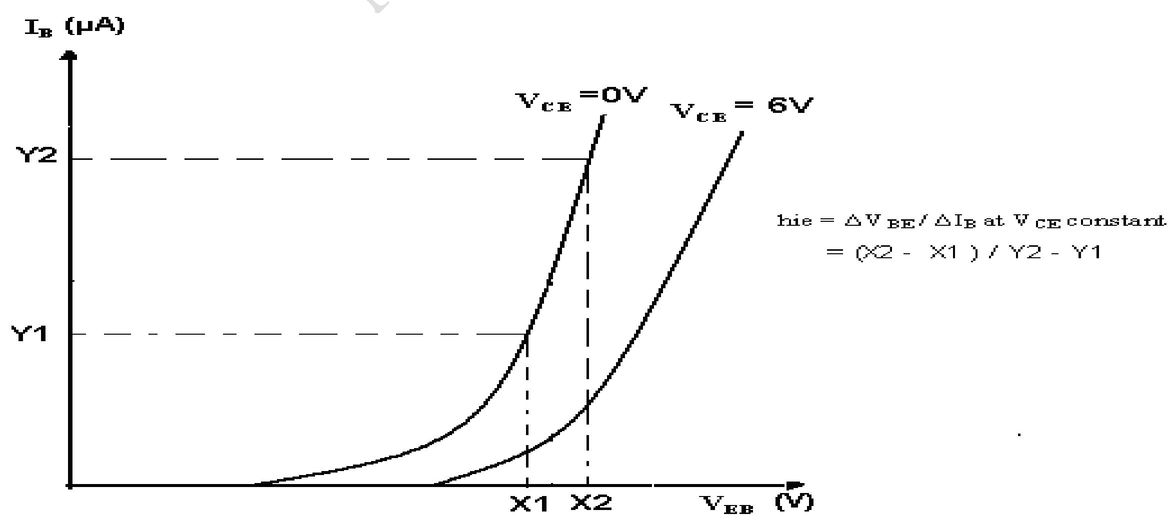
Forward Transfer Current Gain hfe = $\Delta I_C / \Delta I_B$ at constant V_{CE}

CIRCUIT DIAGRAM:

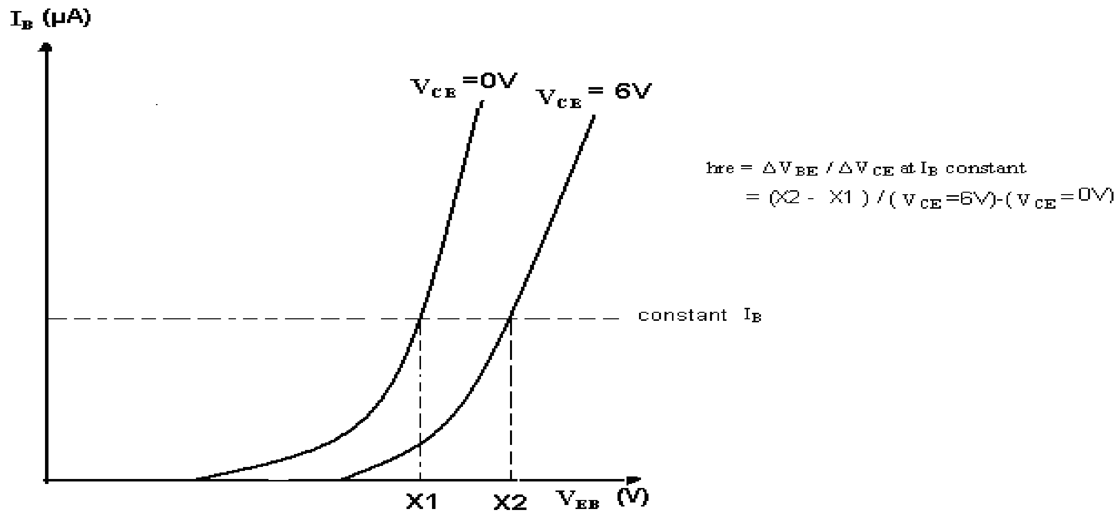


MODEL GRAPH:

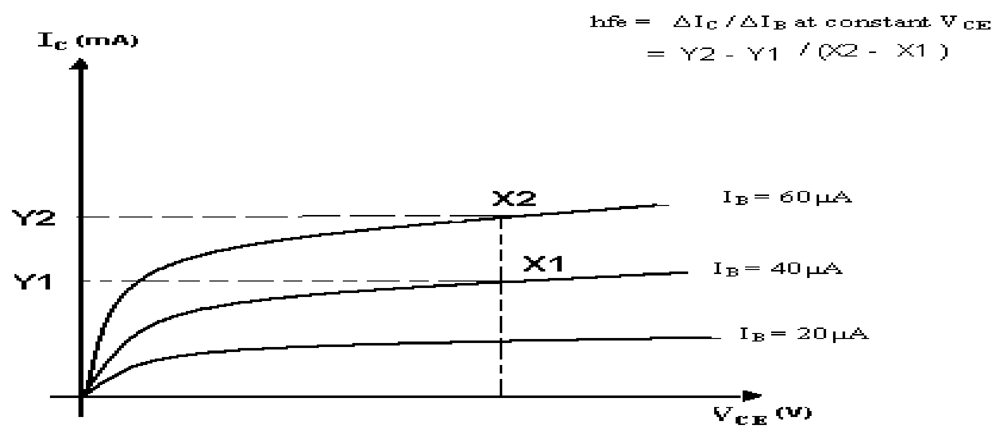
A) INPUT CHARACTERSITICS: **i) calculation of h_{ie}**



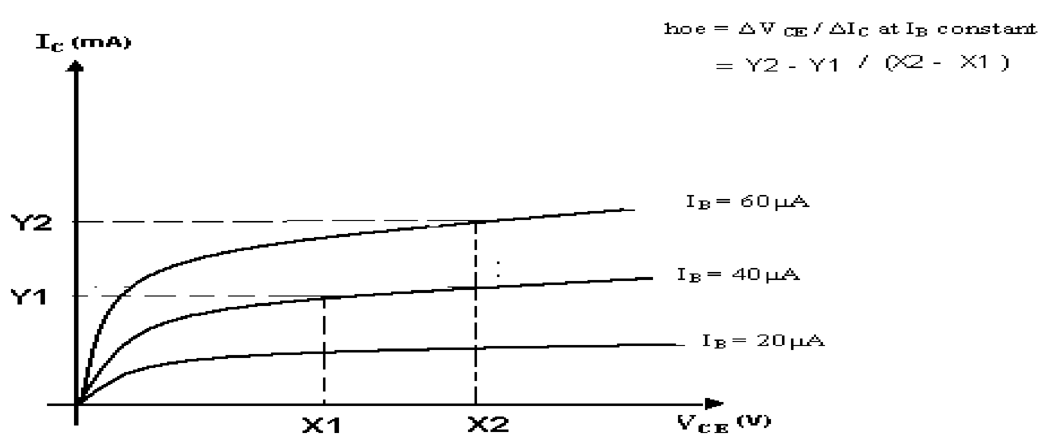
ii) **calculation of h_{re}**



OUPUT CHARACTERISITCS: i)calculation of h_{fe}



ii) calculation of h_{oe}



TABULAR FORMS:

A) Input Characteristics

S.NO	V_{CE}=0V		V_{CE}=6V	
	V_{BE}(V)	I_B(μA)	V_{BE}(V)	I_B(μA)

B) Output Characteristics:

S.NO	I_B = 20 μA		I_B = 40 μA		I_B = 60 μA	
	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)	V_{CE} (V)	I_C(mA)

PROCEDURE:

1. Connect a transistor in CE configuration circuit for plotting its input and output characteristics.
2. Take a set of readings for the variations in I_B with V_{BE} at different fixed values of output voltage V_{CE} .
3. Plot the input characteristics of CE configuration from the above readings.
4. From the graph calculate the input resistance h_{ie} and reverse transfer ratio h_{re} by taking the slopes of the curves.
5. Take the family of readings for the variations of I_C with V_{CE} at different values of fixed $I_{B.}$
6. Plot the output Characteristics from the above readings.
7. From the graphs calculate h_{fe} and h_{oe} by taking the slope of the curves.

RESULT:

VIVA QUESTIONS:

1. What are the h-parameters?
2. What are the limitations of h-parameters?
3. What are its applications?
4. Draw the Equivalent circuit diagram of H parameters?
5. Define H parameter?
6. What are tabular forms of H parameters monoculture of a transistor?
7. What is the general formula for input impedance?
8. What is the general formula for Current Gain?
9. What is the general formula for Voltage gain?

9. FREQUENCY RESPONSE OF CE AMPLIFIER

AIM: 1. To Measure the voltage gain of a CE amplifier
2. To draw the frequency response curve of the CE amplifier

APPARATUS:

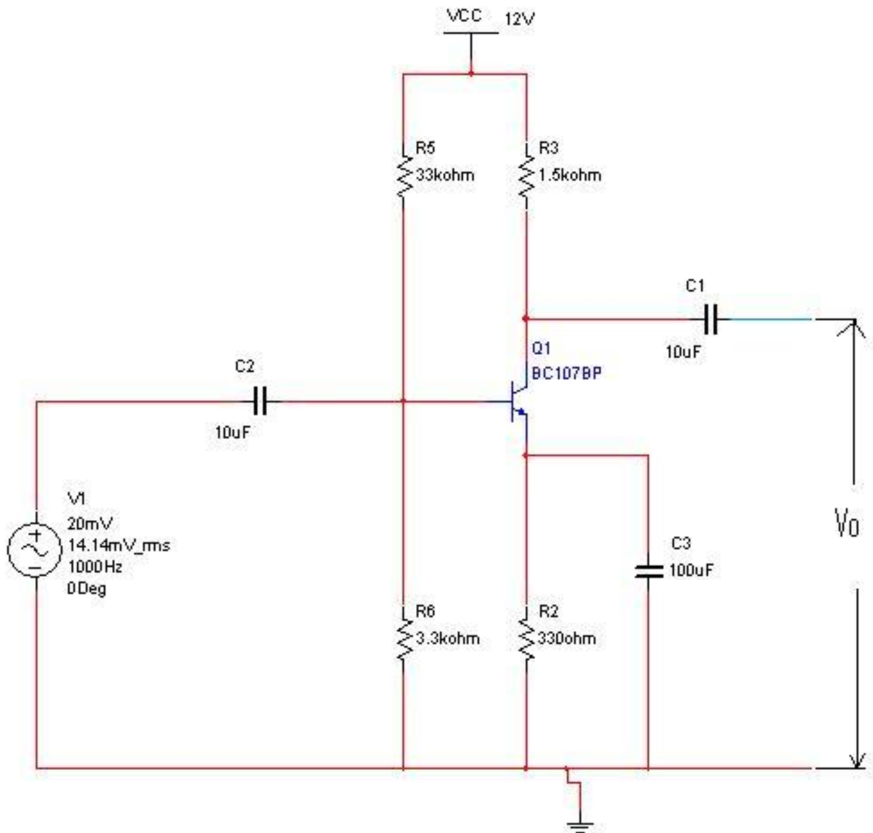
Transistor BC107	-1No.
Regulated power Supply (0-30V)	-1No.
Function Generator	-1No.
CRO	-1No.
Resistors [33KΩ, 3.3KΩ, 330Ω, 1.5KΩ, 1KΩ, 2.2KΩ, 4.7KΩ]	-1No.Each
Capacitors, 10µF	-2No
100µF	-1No.
Bread Board	
Connecting Wires	

THEORY:

The CE amplifier provides high gain &wide frequency response. The emitter lead is common to both input & output circuits and is grounded. The emitter-base circuit is forward biased. The collector current is controlled by the base current rather than emitter current. When a transistor is biased in active region it acts like an amplifier. The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. When positive half-cycle is fed to the input circuit, it opposes the forward bias of the circuit which causes the collector current to decrease; it decreases the voltage more negative. Thus when input cycle varies through a negative half-cycle, increases the forward bias of the circuit, which causes the collector current to increases thus the output signal is common emitter amplifier is in out of phase with the input signal. An amplified output signal is obtained when this fluctuating collector current flows through a collector resistor,Rc.

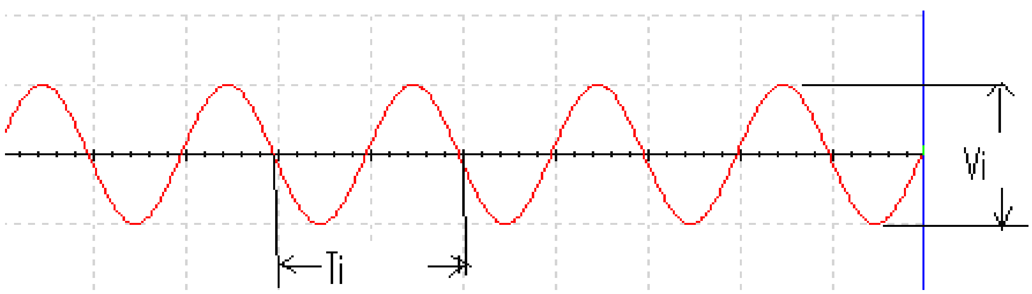
The capacitor across the collector resistor Rc will act as a bypass capacitor. This will improve high frequency response of amplifier.

CIRCUIT DIAGRAM:

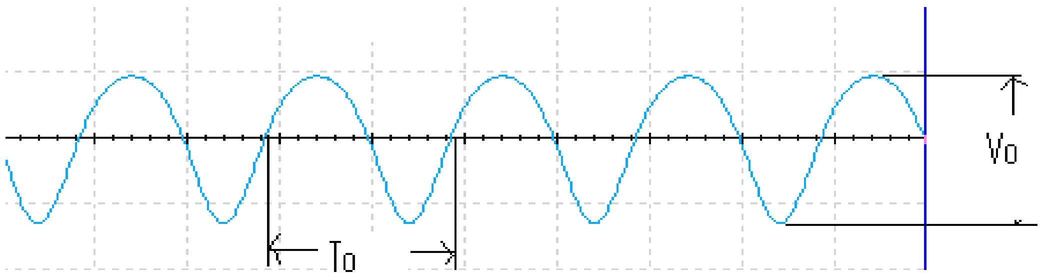


MODELWAVE FORMS:

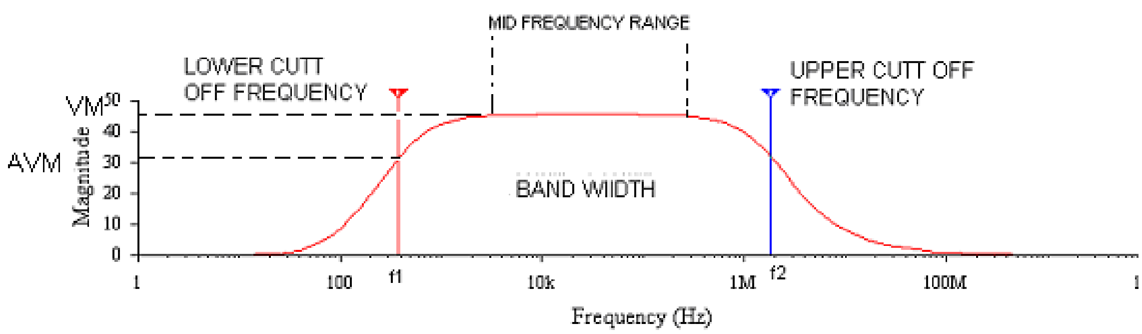
A) INPUT WAVE FORM:



B) OUTPUT WAVE FORM



FREQUENCY RESPONSE



OBSERVATIONS:

FREQUENCY RESPONSE: Vi=20mv

Frequency in KHZ	OUTPUT VOLTAGE(Vo)	GAIN IN dB=20log$_{10}$(vo/vi)

PROCEDURE:

1. Connect the circuit as shown in circuit diagram
2. Apply the input of 20mV peak-to-peak and 1 KHz frequency using Function Generator
3. The voltage gain can be calculated by using the expression , $A_v= (V_0/V_i)$
4. For plotting the frequency response the input voltage is kept Constant at 20mV peak-to-peak and the frequency is varied from 100Hz to 1MHz Using function generator
5. Note down the value of output voltage for each frequency.
6. All the readings are tabulated and voltage gain in dB is calculated by Using The expression $A_v=20 \log_{10} (V_0/V_i)$
7. A graph is drawn by taking frequency on x-axis and gain in dB on y-axis On Semi-log graph.
10. The band width of the amplifier is calculated from the graph using the expression,

Bandwidth, $BW=f_2-f_1$

Where f_1 lower cut-off frequency of CE amplifier, and
Where f_2 upper cut-off frequency of CE amplifier

11. The bandwidth product of the amplifier is calculated using the Expression

Gain Bandwidth product=3-dBmidband gain X Bandwidth

RESULT:

VIVA QUESTIONS:

1. What is phase difference between input and output waveforms of CE amplifier?
2. What type of biasing is used in the given circuit?
3. If the given transistor is replaced by a p-n-p, can we get output or not?
4. What is effect of emitter-bypass capacitor on frequency response?
5. What is the effect of coupling capacitor?
6. What is region of the transistor so that it is operated as an amplifier?
7. How does transistor acts as an amplifier?
8. Draw the h-parameter model of CE amplifier?
9. What type of transistor configuration is used in intermediate stages of a multistage amplifier?
10. What is early effect?

10. FREQUENCY RESPONSE OF CC AMPLIFIER

AIM: 1. To measure the voltage gain of a CC amplifier
2. To draw the frequency response of the CC amplifier

APPRATUS:

Transistor BC 107		-1No.
Regulated Power Supply (0-30V)		-1No.
Function Generator		-1No.
CRO		-1No.
Resistors 33KΩ, 3.3KΩ, 330Ω, 1.5KΩ, 1KΩ, 2.2KΩ & 4.7KΩ		-1No.Each
Capacitors	10µF	-2Nos
	100µF	-1No.
Breadboard		
Connecting wires		

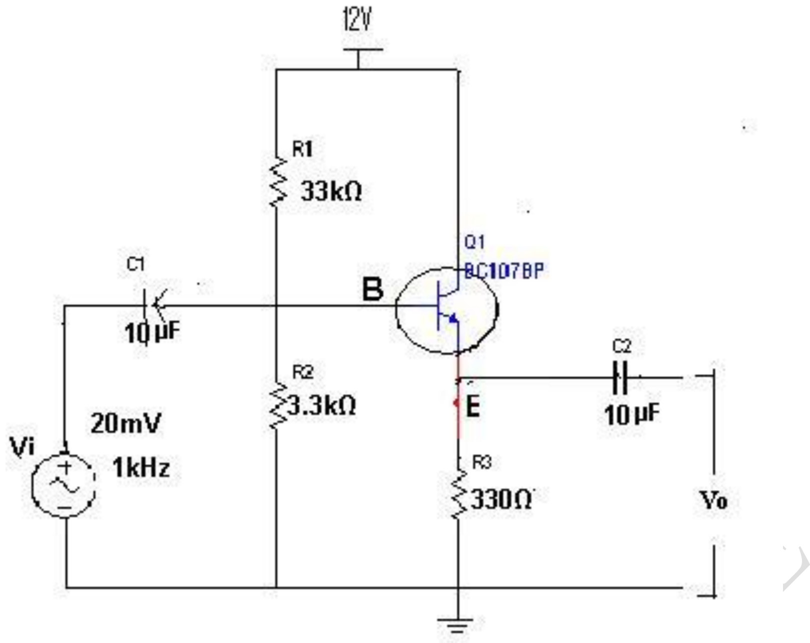
THEORY:

In common-collector amplifier the input is given at the base and the output is taken at the emitter. In this amplifier, there is no phase inversion between input and output. The input impedance of the CC amplifier is very high and output impedance is low. The voltage gain is less than unity. Here the collector is at ac ground and the capacitors used must have a negligible reactance at the frequency of operation.

This amplifier is used for impedance matching and as a buffer amplifier. This circuit is also known as emitter follower.

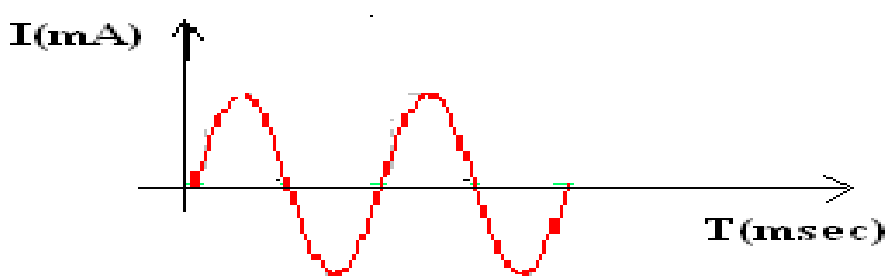
The most common use of the emitter follower is as a circuit, which performs the function of impedance transformation over a wide range of frequencies.

CIRCUIT DIAGRAM:

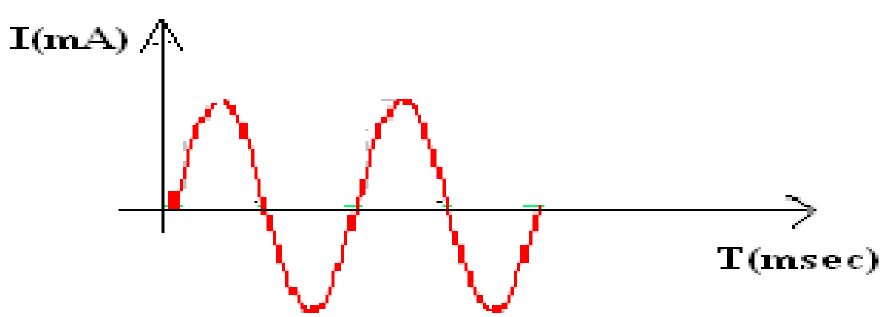


MODEL WAVEFORM:

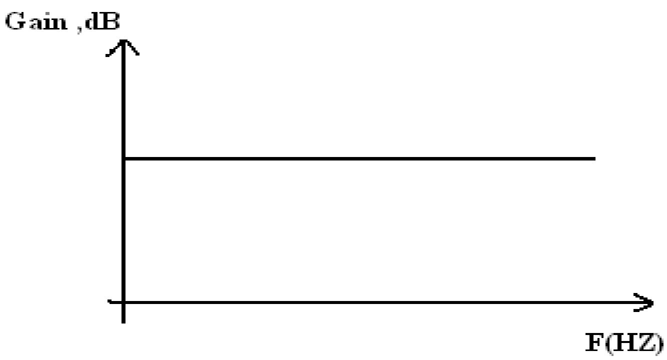
A) INPUT WAVEFORM



B) OUTPUT WAVEFORM:



FREQUENCY RESPONSE PLOT:



OBSERVATIONS:

B) FREQUENCY RESPONSE, V_i=20mV

Frequency(HZ)	Output Voltage(Vo)	Gain in dB A_v=20log 10(V0/V_i)

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The voltage gain calculated by using the expression, $A_v=V_0/V_i$
3. For plotting the frequency response the input voltage is kept constant a 20mV peak-to- peak and the frequency is varied from 100Hzto 1MHz.
4. Note down the values of output voltage for each frequency.

5. The voltage gain in dB is calculated by using the expression,
A_v=20log 10(V0/V_i)
6. A graph is drawn by taking frequency on X-axis and gain in dB on y-axis on Semi-log graph sheet.
7. The Bandwidth of the amplifier is calculated from the graph using the Expression,

Bandwidth BW=f_2-f_1

Where f_1 is lower cut-off frequency of CE amplifier
f_2 is upper cut-off frequency of CE amplifier

8. The gain Bandwidth product of the amplifier is calculated using the Expression,

Gain -Bandwidth product=3-dB midband gain X Bandwidth

PRECAUTIONS:

1. The input voltage must be kept constant while taking frequency response.
2. Proper biasing voltages should be applied.

RESULT:

VIVA QUESTIONS:

1. What are the applications of CC amplifier?
2. What is the voltage gain of CC amplifier?
3. What are the values of input and output impedances of the CC amplifier?
4. To which ground the collector terminal is connected in the circuit?
5. Identify the type of biasing used in the circuit?
6. Give the relation between α, β and γ.
7. Write the other name of CC amplifier?
8. What are the differences between CE, CB and CC?
9. When compared to CE, CC is not used for amplification. Justify your answer?
10. What is the phase relationship between input and output in CC?

11. FREQUENCY RESPONSE OF COMMON SOURCE FET AMPLIFIER

AIM: 1. To obtain the frequency response of the common source FET Amplifier

2. To find the Bandwidth.

APPRATUS:

N-channel FET (BFW11)	-1No.
Resistors (6.8KΩ, 1MΩ, 1.5KΩ)	-1No.Each
Capacitors 0.1µF,	-2Nos
47µF	-1No.
Regulated power Supply (0-30V)	-1No.
Function generator	-1No.
CRO	-1No.
CRO probes	-1pair
Bread board	
Connecting wires	

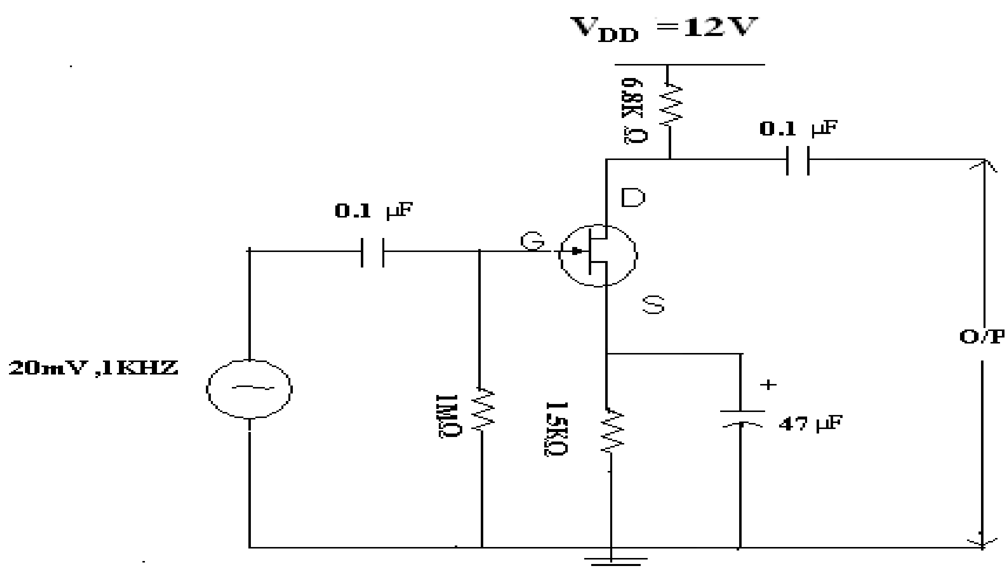
THEORY:

A field-effect transistor (FET) is a type of transistor commonly used for weak-signal amplification (for example, for amplifying wireless (signals). The device can amplify analog or digital signals. It can also switch DC or function as an oscillator. In the FET, current flows along a semiconductor path called the channel. At one end of the channel, there is an electrode called the source. At the other end of the channel, there is an electrode called the drain. The physical diameter of the channel is fixed, but its effective electrical diameter can be varied by the application of a voltage to a control electrode called the gate. Field-effect transistors exist in two major classifications. These are known as the junction FET (JFET) and the metal-oxide- semiconductor FET (MOSFET). The junction FET has a channel consisting of N-type semiconductor (N-channel) or P-type semiconductor (P-channel) material; the gate is made of the opposite semiconductor type. In P-type material, electric charges are carried mainly in the form of electron deficiencies called holes. In N-type material, the charge carriers are primarily electrons. In a JFET, the junction is the boundary between the channel and the gate. Normally, this P-N junction is reverse-biased (a DC voltage is applied to it) so that no current flows between the channel and the gate. However, under some conditions there is a small current through the junction during part of the input signal cycle. The FET has some advantages and some disadvantages relative to the bipolar transistor. Field-effect transistors are preferred for weak-signal work, for example in wireless, communications and broadcast receivers. They are also preferred in circuits and systems requiring high impedance. The FET is not, in general, used for high-power amplification, such as is required in large wireless communications and broadcast transmitters.

Field-effect transistors are fabricated onto silicon integrated circuit (IC) chips. A single IC can contain many thousands of FETs, along with other components such as resistors, capacitors, and diodes.

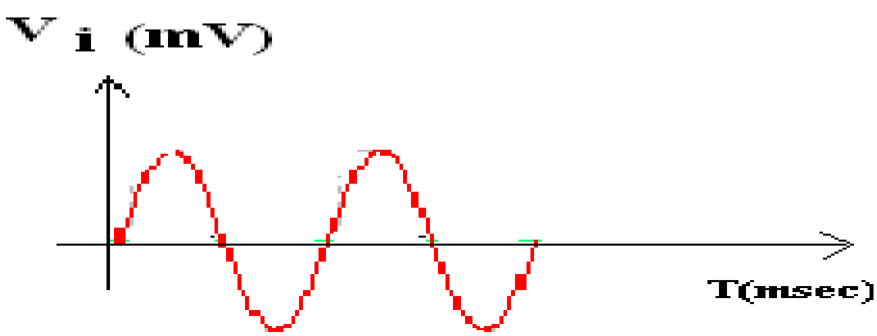
A comman source amplifier FET amplifier has high input impedance and a moderate voltage gain. Also, the input and output voltages are 180 degrees out of Phase.

CIRCUIT DIAGRAM:

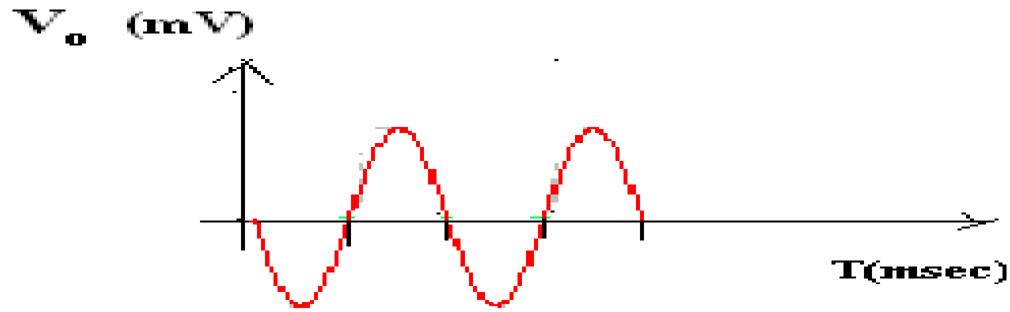


MODEL GRAPH:

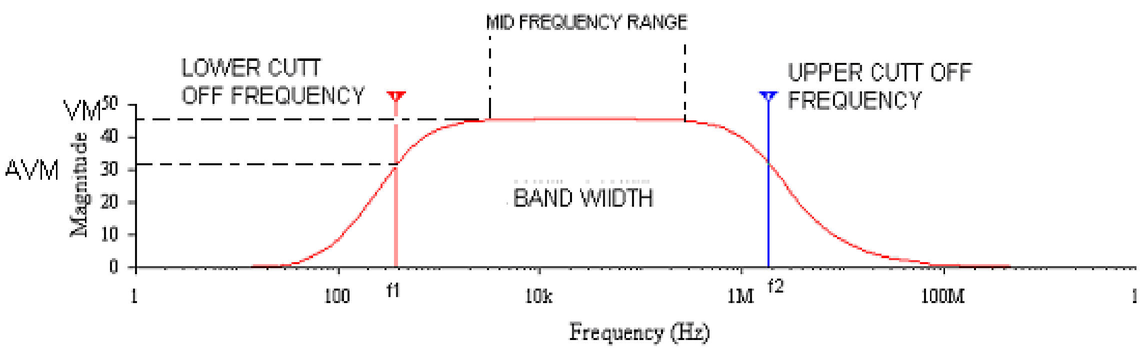
A) INPUT WAVEFORM



B) OUTPUT WAVEFORM



FREQUENCY RESPONSE PLOT:



OBSERVATIONS:

INPUT VOLTAGE (V_i) =20mA

S.NO	Output Voltage(Vo)	Voltage gain=V0/Vin	Gain in dB=$20\log_{10}$(V0/Vin)

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. A signal of 1 KHz frequency and 20mV peak-to-peak is applied at the Input of amplifier.
3. Output is taken at drain and gain is calculated by using the expression,

$$A_v = V_0 / V_i$$

4. Voltage gain in dB is calculated by using the expression,

$$A_v = 20\log 10(V0/V_i)$$

5. Repeat the above steps for various input voltages.
6. Plot A_v in dB Versus Frequency
7. The Bandwidth of the amplifier is calculated from the graph using the Expression,

$$\textbf{Bandwidth } BW = f_2 - f_1$$

Where f_1 is lower 3 dB frequency
f_2 is upper 3 dB frequency

PRECAUTIONS:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

RESULT:

VIVA QUESTIONS:

1. What is the difference between FET and BJT?
2. FET is unipolar or bipolar?
3. Draw the symbol of FET?
4. What are the applications of FET?
5. FET is voltage controlled or current controlled?
6. Draw the equivalent circuit of common source FET amplifier?
7. What is the voltage gain of the FET amplifier?
8. What is the input impedance of FET amplifier?
9. What is the output impedance of FET amplifier?
10. What are the FET parameters?
11. What are the FET applications

12. SILICON-CONTROLLED RECTIFIER (SCR) CHARACTERISTICS

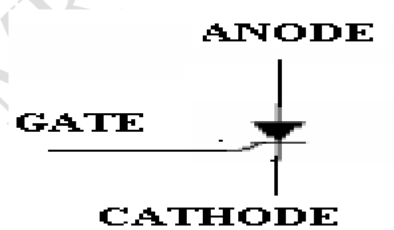
AIM: To draw the V-I Characteristics of SCR

APPARATUS:

SCR (TYN616)	-1No.
Regulated Power Supply (0-30V)	-2No.
Resistors 10kΩ, 1kΩ	-1No.Each one
Ammeter (0-50) µA	-1No.
Voltmeter (0-10V)	-1No.
Breadboard	-1No.
Connecting Wires.	

THEORY:

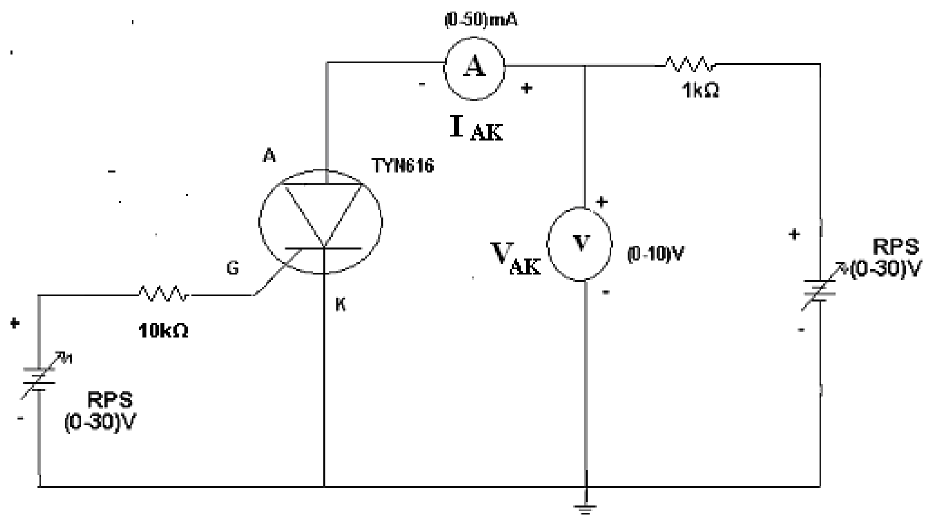
It is a four layer semiconductor device being alternate of P-type and N-type silicon. It consists of 3 junctions J_1, J_2, J_3 the J_1 and J_3 operate in forward direction and J_2 operates in reverse direction and three terminals called anode A, cathode K , and a gate G. The operation of SCR can be studied when the gate is open and when the gate is positive with respect to cathode. When gate is open, no voltage is applied at the gate due to reverse bias of the junction J_2 no current flows through R_2 and hence SCR is at cut off. When anode voltage is increased J_2 tends to breakdown. When the gate positive, with respect to cathode J_3 junction is forward biased and J_2 is reverse biased .Electrons from N-type material move across junction J_3 towards gate while holes from P-type material moves across junction J_3 towards cathode. So gate current starts flowing, anode current increase is in extremely small current junction J_2 break down and SCR conducts heavily.



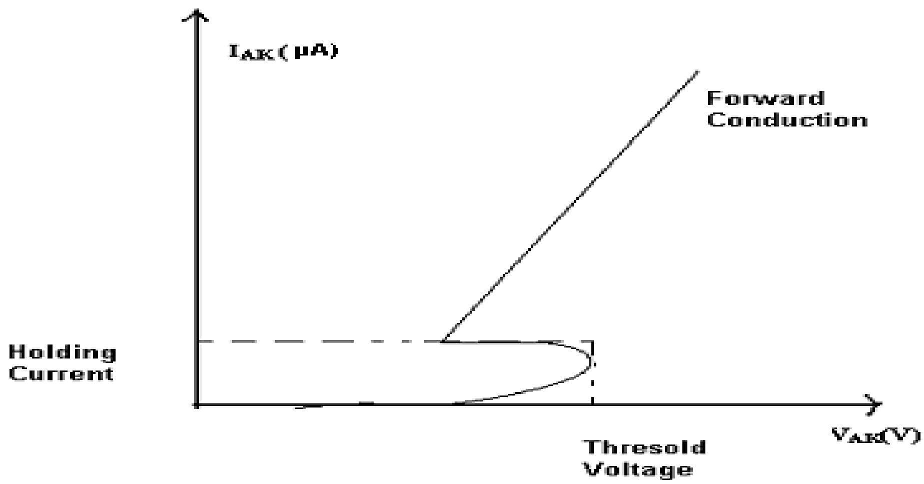
SCR SYMBOL

When gate is open thee break over voltage is determined on the minimum forward voltage at which SCR conducts heavily. Now most of the supply voltage appears across the load resistance. The holding current is the maximum anode current gate being open, when break over occurs.

CIRCUIT DIAGRAM:



MODEL WAVEFORM:



OBSERVATION:

V_{AK}(V)	I_{AK} (μA)

PROCEDURE:

1. Connections are made as per circuit diagram.
2. Keep the gate supply voltage at some constant value
3. Vary the anode to cathode supply voltage and note down the readings of voltmeter and ammeter. Keep the gate voltage at standard value.
4. A graph is drawn between V_{AK} and I_{AK}.
5. From the graph note down the threshold voltage and Holding current values.

CALCULATIONS:

Threshold Voltage =

Holding Current =

RESULT:

VIVA QUESTIONS:

1. What the symbol of SCR?
2. In which state SCR turns of conducting state to blocking state?
3. What are the applications of SCR?
4. What is holding current?
5. What are the important type's thyristors?
6. How many numbers of junctions are involved in SCR?
7. What is the function of gate in SCR?
8. When gate is open, what happens when anode voltage is increased?
9. What is the value of forward resistance offered by SCR?
10. What is the condition for making from conducting state to non conducting state?

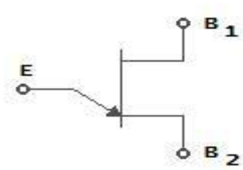
13. UJT CHARACTERISTICS

AIM: To observe the characteristics of UJT and to calculate the Intrinsic Stand-Off Ratio (η).

APPARATUS:

UJT (2N2646)	- 1 No.
Regulated power supply (0-30V)	-2Nos
0-20V (DMM)	-2Nos
0-20mA (DMM)	-1No.
Resistors 1Kohm	-2Nos
Resistor 470 ohm	-1No.
Breadboard	
Connecting wires	

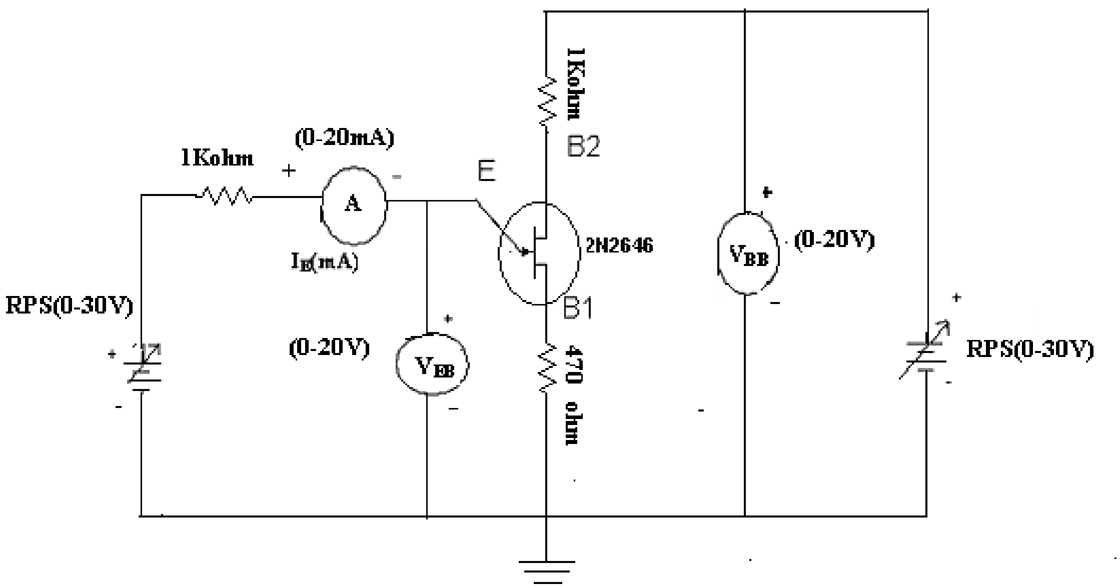
THEORY: A Unijunction Transistor (UJT) is an electronic semiconductor device that has only one junction. The UJT Unijunction Transistor (UJT) has three terminals an emitter (E) and two bases (B1 and B2). The base is formed by lightly doped n-type bar of silicon. Two ohmic contacts B1 and B2 are attached at its ends. The emitter is of p-type and it is heavily doped. The resistance between B1 and B2, when the emitter is open-circuit is called interbase resistance. The original Unijunction transistor, or UJT, is a simple device that is essentially a bar of N type semiconductor material into which P type material has been diffused somewhere along its length. The 2N2646 is the most commonly used version of the UJT.



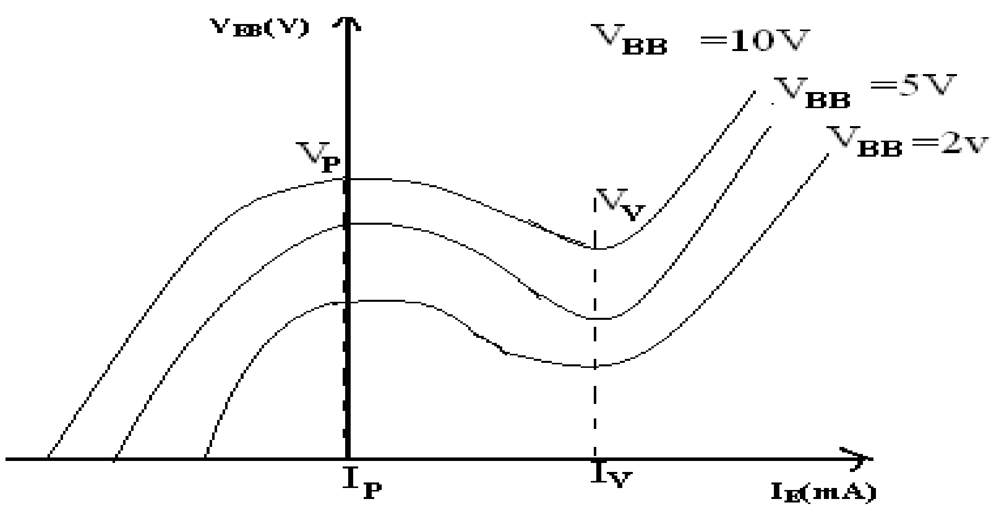
Circuit symbol

The UJT is biased with a positive voltage between the two bases. This causes a potential drop along the length of the device. When the emitter voltage is driven approximately one diode voltage above the voltage at the point where the P diffusion (emitter) is, current will begin to flow from the emitter into the base region. Because the base region is very lightly doped, the additional current (actually charges in the base region) causes (conductivity modulation) which reduces the resistance of the portion of the base between the emitter junction and the B2 terminal. This reduction in resistance means that the emitter junction is more forward biased, and so even more current is injected. Overall, the effect is a negative resistance at the emitter terminal. This is what makes the UJT useful, especially in simple oscillator circuits. hen the emitter voltage reaches V_p, the current starts o increase and the emitter voltage starts to decrease. This is represented by negative slope of the characteristics which is referred to as the negative resistance region, beyond the valley point, RB1 reaches minimum value and this region, V_{EB} proportional to $I_{E.}$

CIRCUIT DIAGRAM:



MODEL GRAPH:



PROCEDURE:

1. Connection is made as per circuit diagram.
2. Output voltage is fixed at a constant level and by varying input voltage corresponding emitter current values are noted down.
3. This procedure is repeated for different values of output voltages.
4. All the readings are tabulated and Intrinsic Stand-Off ratio is calculated using $\eta = (V_p - V_D) / V_{BB}$
5. A graph is plotted between V_{EE} and I_E for different values of $V_{BE.}$

CALCULATIONS:

$$V_P = \eta V_{BB} + V_D$$

$$\eta = (V_P - V_D) / V_{BB}$$

$$\eta = (\eta_1 + \eta_2 + \eta_3) / 3$$

OBSEVATIONS:

V_{BB}=10		V_{BB}=5		V_{BB}=2	
V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)	V_{EB}(V)	I_E(mA)

RESULT:

VIVA QUESTIONS:

1. What is the symbol of UJT?
2. Draw the equivalent circuit of UJT?
3. What are the applications of UJT?
4. Formula for the intrinsic stand off ratio?
5. What does it indicates the direction of arrow in the UJT?
6. What is the difference between FET and UJT?
7. Is UJT is used an oscillator? Why?
8. What is the Resistance between B_1 and B_2 is called as?
9. What is its value of resistance between B_1 and $B_{2?}$

10. Draw the characteristics of UJT?