

MGM's
Jawaharlal Nehru Engineering College

Electrical Engineering Department

Laboratory Manual

Digital Signal Processing

For

Final Year (EEP) Students

Manual made by

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FOREWORD

It is my great pleasure to present this laboratory manual for final year **ELECTRICAL ELECTRONIC & POWER** engineering students for the subject of Digital Signal Processing. Keeping in view the vast coverage required for visualization of concepts of Digital Signal Processing with simple language.

As a student, many of you may be wondering with some of the questions in your mind regarding the subject and exactly what has been tried is to answer through this manual.

Faculty members are also advised that covering these aspects in initial stage itself, will greatly relieve them in future as much of the load will be taken care by the enthusiasm energies of the students once they are conceptually clear.

Dr.H.H.Shinde
Principal

LABORATORY MANUAL CONTENTS

This manual is intended for the final year students of **ELECTRICAL ELECTRONIC & POWER** engineering branch in the subject of Digital Signal Processing. This manual typically contains practical/Lab Sessions related to Digital Signal Processing covering various aspects related to the subject to enhance understanding.

Although, as per the syllabus, only descriptive treatment is prescribed, we have made the efforts to cover various aspects of DSP subject covering types of different Digital Signal Processing techniques, Transforms and applications will be complete in it to make it meaningful, elaborative understandable concepts and conceptual visualization.

Students are advised to thoroughly go through this manual rather than only topics mentioned in the syllabus as practical aspects are the key to understanding and conceptual visualization of theoretical aspects covered in the books.

Good Luck for your Enjoyable Laboratory Sessions

Mr. J.R.Rana



MAHATMA GANDHI MISSION'S

JAWAHARLAL NEHRU ENGINEERING COLLEGE

AURANGABAD.

Department of Electrical Electronics and Power

Vision of JNEC

To create self-reliant, continuous learner and competent technocrats imbued with human values.

Mission of JNEC

1. Imparting quality technical education to the students through participative teaching – learning process.
2. Developing competence amongst the students through academic learning and practical experimentation.
3. Inculcating social mindset and human values amongst the students.

JNEC Environmental Policy

1. The environmental control during its activities, product and services.
2. That applicable , legal and statutory requirements are met according to environmental needs.
3. To reduce waste generation and resource depletion.
4. To increase awareness of environmental responsibility amongst its students and staff.
5. For continual improvement and prevention of pollution.

JNEC Quality Policy:

Institute is committed to:

- To provide technical education as per guidelines of competent authority.
- To continually improve quality management system by providing additional resources required. Initiating corrective & preventive action & conducting management review meeting at periodical intervals.
- To satisfy needs & expectations of students, parents, society at large.

EEP Department

VISION:

- To Develop competent Electrical Engineers with human values.

MISSION:

- To Provide Quality Technical Education To The Students Through Effective Teaching-learning Process.
- To Develop Student's Competency Through Academic Learning, Practicals And Skill Development Programs.
- To Encourage Students For Social Activities & Develop Professional Attitude Along With Ethical Values.

SUBJECT INDEX

1. Do's and Don'ts

2. Lab exercise:

- 1) Introduction to the Functions of MATLAB.
- 2) To represent basic signals (Unit Step, Unit Impulse, Ramp)
- 3) To represent basic signals (Exponential, Sine and Cosine).
- 4) To verify sampling theorem.
- 5) To verify stability test.
- 6) To develop the program for discrete convolution
- 7) To develop the program for discrete correlation.
- 8) To design a program for computing z transforms.
- 9) To design a program for computing inverse z transforms.
- 10) To design FIR Filter.
- 11) To design Digital IIR filter.
- 12) Application of Digital Signal Processing.

3. Conduction of Viva-Voce Examination

4. Evaluation and Marking Systems

1. DOs and DON'Ts:

1. Make entry in the Log Book as soon as you enter and exit the Laboratory.
2. All the students should sit according to their roll numbers starting from their left to right.
3. All the students are supposed to enter the terminal number in the log book.
4. Do not change the terminal on which you are working.
5. Do not remove/change LAN cable, Mouse, Keyboard etc.
6. Strictly follow the instructions given by the teacher/Lab Instructor.
7. Do not make noise during Lab sessions.
8. Do not enter the lab without College Uniform and I Card.
9. Use Internet facility appropriately downloading without permission is strictly prohibited.
10. Submission related work should be completed immediately during the next lab session.
11. Arrange the chairs and drawers shut down computer at the end of lab session.

Instructions for Laboratory Teachers:

1. Submission related to whatever lab work has been completed should be done during the next lab session. The immediate arrangements for printouts related to submission on the day of practical assignments.
2. Students should be taught for taking the observations /readings of Simulation output/script debugs under the observation of lab teacher.
3. The promptness of submission should be encouraged by way of marking and evaluation patterns that will benefit the sincere students.

Practical 1 : (2 Hours):

TO STUDY MATLAB FUNCTIONS USED FOR DIGITAL SIGNAL PROCESSING.

Study following Function using MATLAB help.

1. CLC
2. CLEAR
3. CLOSE
4. SUBPLOT
5. STEM
6. XLABEL
7. YLABEL
8. PLOT
9. CONV
10. DISP
11. XCORR
12. FLIPLR
13. FIR
14. ABS
15. TITLE
16. BOXCAR
17. ANGLE
18. FREQS
19. ZEROS
20. REAL
21. ZTRANS
22. IZTRANS

Conclusion: Mention functions applications are understood and are used for execution of digital signal processing programming.

Practical 2 : (2 Hours):

TO REPRESENT BASIC SIGNALS (UNIT STEP, UNIT IMPULSE, RAMP).

AIM: To simulate basic signals (Unit Step, Unit Impulse, Ramp, Exponential, Sine and Cosine).

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:

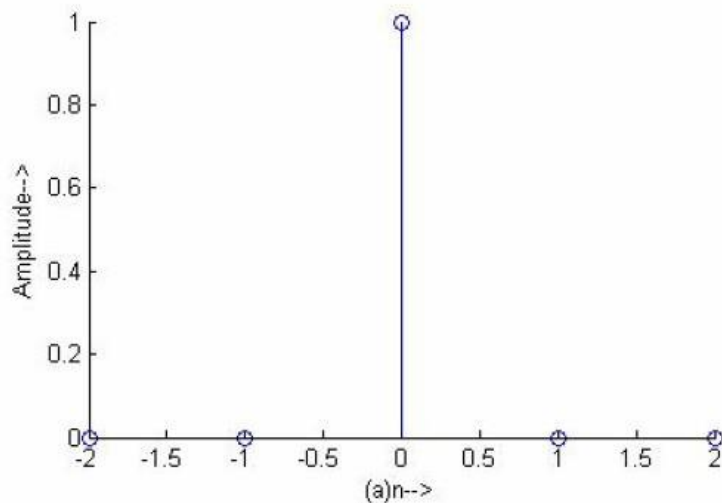
1. What are the basic signals in DSP and how they are mathematically represented?

MATLAB SCRIPTS FOR THE BASIC SEQUENCES:

Unit Impulse: -

```
% Program for the generation of unit impulse signal
clc;
clear all;
close all;
t = -2:1:2;
y=[zeros(1,2),ones(1,1),zeros(1,2)];
subplot (2,2,1);
stem (t,y);
ylabel ('Amplitude-->');
xlabel ('(a)n-->');
```

Output: -

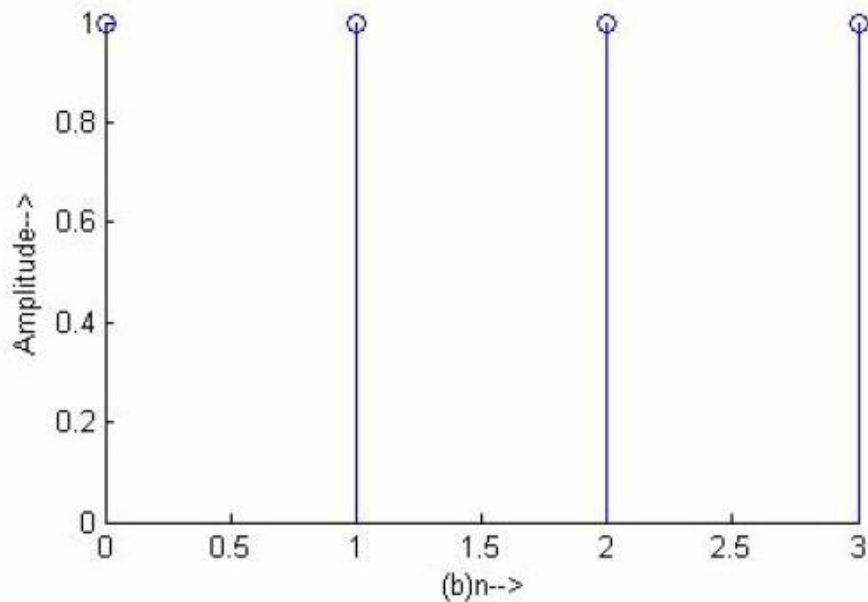


Unit Step Sequence: -

```
% Program for the generation of unit step sequence [u(n)-u(n-N)]
n=input('Enter the N value');
t=0:1:n-1;
y1=ones(1,n);
subplot(2,2,2);
stem(t,y1);
ylabel('Amplitude-->');
xlabel('(b)n-->');
```

Output: -

Enter the N value4

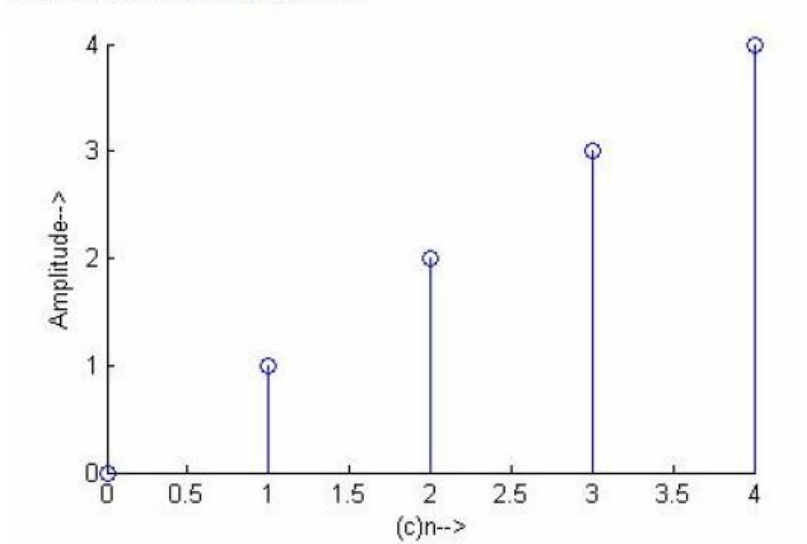


Ramp Sequence: -

```
% Program for the generation of ramp sequence
n1=input('Enter the length of ramp sequence');
t=0:n1;
subplot(2,2,3);
stem(t,t);
ylabel('Amplitude-->');
xlabel('(c)n-->');
```

Output: -

Enter the length of rampsequence4



CONCLUSION:

Any type of the complex waveform can be represented in Digital Signal Processing mathematically as the combination of these basic signals, which helps for understanding the signal behavior for the analysis.

Practical 3 : (2 Hours):

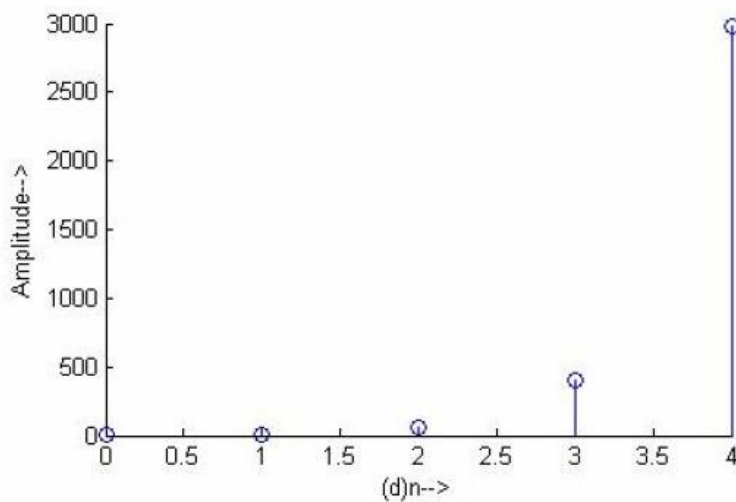
TO REPRESENT BASIC SIGNALS (EXPONENTIAL, SINE AND COSINE).

Exponential Sequence: -

```
% Program for the generation of exponential sequence
n2=input('Enter the length of exponential sequence');
t=0:n2;
a=input('Enter the (a) value');
y2=exp(a*t);
subplot(2,2,4);
stem(t,y2);
ylabel('Amplitude-->');
xlabel('(d)n-->');
```

Output: -

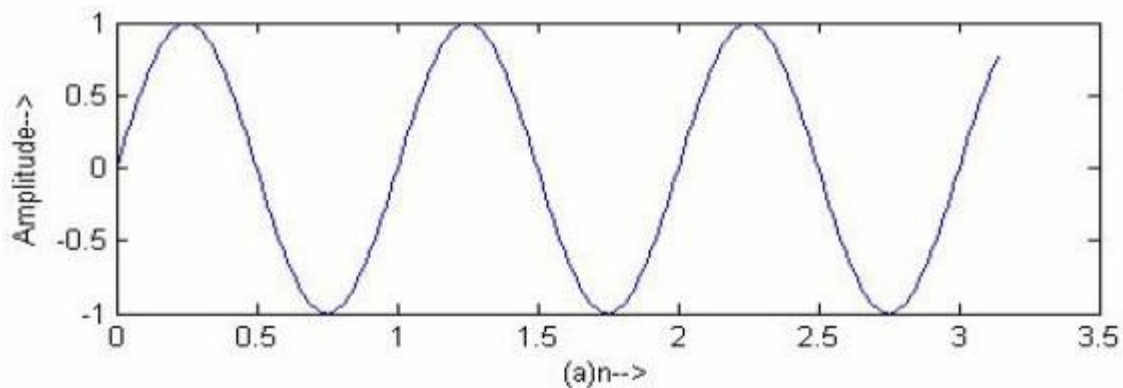
Enter the length of exponential sequence4
Enter the (a) value2



Sine Sequence: -

```
% Program for the generation of sine sequence  
t=0:.01:pi;  
y=sin(2*pi*t);  
figure(2);  
subplot(2,1,1);  
plot(t,y);  
ylabel('Amplitude-->');  
xlabel('(a)n-->');
```

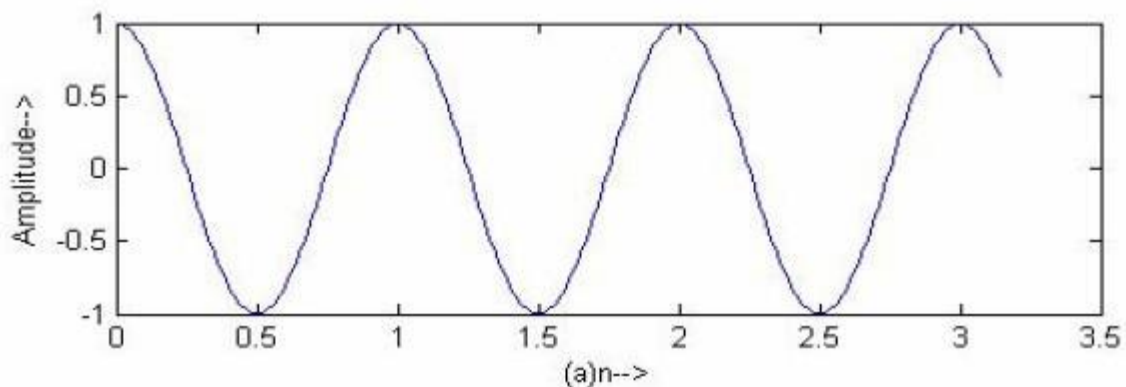
Output: -



Cosine Sequence: -

```
% Program for the generation of cosine sequence  
t=0:.01:pi;  
y=cos(2*pi*t);  
figure(2);  
subplot(2,1,1);  
plot(t,y);  
ylabel('Amplitude-->');  
xlabel('(a)n-->');
```

Output: -



CONCLUSION:

Any type of the complex waveform can be represented in Digital Signal Processing mathematically as the combination of these basic signals, which helps for understanding the signal behavior for the analysis.

Practical 4 : (2 Hours):

TO VERIFY SAMPLING THEOREM

Aim:- To verify sampling theorem

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

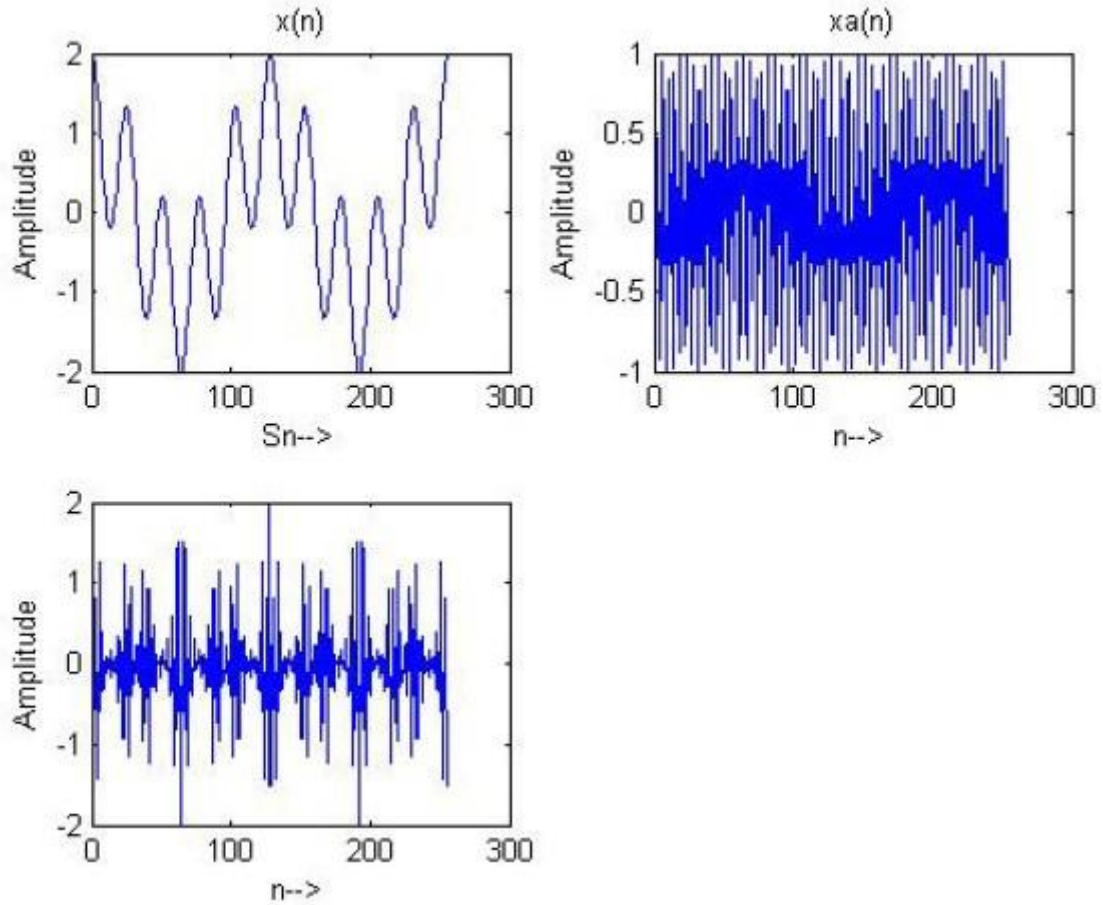
THEORY:-

1. What is sampling theorem?
2. Where it is applied?

MATLAB CODE:

```
%Program to understand sampling theorem
f1=1/128;
f2=5/128;
n=0:255;
fc=50/128;
x=cos(2*pi*f1*n)+cos(2*pi*f2*n);
xa=cos(2*pi*fc*n);
xamp=x.*xa;
subplot(2,2,1);
plot(n,x);
title('x(n)');
xlabel('Sn-->');
ylabel('Amplitude');
subplot(2,2,2);
plot(n,xa);
title('xa(n)');
xlabel('n-->');
ylabel('Amplitude');
subplot(2,2,3);
plot(n,xamp);
xlabel('n-->');
ylabel('Amplitude');
```

Output: -



CONCLUSION:-

We conclude that frequency of sampling must be greater than twice the highest frequency component of the signal otherwise the signal becomes unequally spaced.

Practical 5 : (2 Hours):

TO VERIFY STABILITY TEST

AIM: To verify Stability test in MATLAB.

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:

1. What is stability test?
2. What are the important constraints?
3. What are different conditions for system stability?

MATLAB SCRIPT:

```
%Program for stability test
clc;
clear all;
close all;
b=input('enter the denominator coefficients of the filter');
k=poly(b);
knew=fliplr(k);
s=all(abs(knew));
if(s==1)
disp('stable system');
else
disp('Non-stable System');
end
```

Output: -

```
enter the denominator coefficients of the filter[1 -1 .5]
'stable system'
```

CONCLUSION:-

Stability test is used to verify the stability of the system by putting the condition that a bounded input system remains stable and produces a bounded output (BIBO).

Practical 6 : (2 Hours):

TO DEVELOP THE PROGRAM FOR DISCRETE CONVOLUTION

AIM: To develop MATLAB program for evaluation of discrete convolution.

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:

1. What is convolution of signals?
2. How convolutions are represented?
2. Is it equivalent to the multiplication of two sequences?

MATLAB SCRIPT:

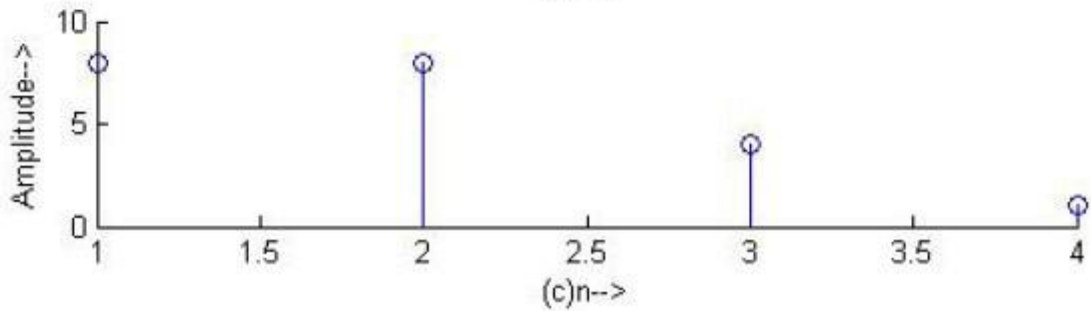
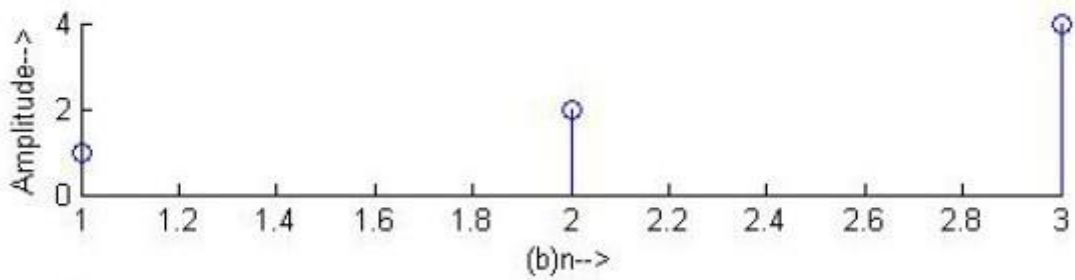
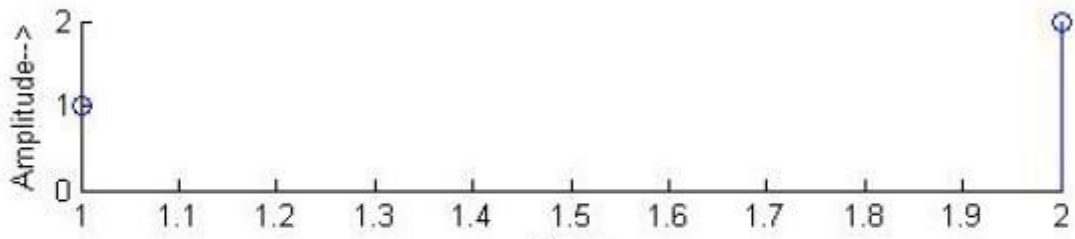
```
%Program for linear convolution of the sequence x= [1,2] and h= [1,2,4]
clc;
clear all;
close all;
x=input('enter the 1st sequence');
h=input('enter the 2nd sequence');
y=conv(x,h);
figure;
subplot(3,1,1);
stem(x);
ylabel('Amplitude-->');
xlabel('(a)n-->');
subplot(3,1,2);
stem(h);
ylabel('Amplitude-->');
xlabel('(b)n-->');
subplot(3,1,3);
stem(fliplr(y));
ylabel('Amplitude-->');
xlabel('(c)n-->');
disp('The resultant signal is');y
```

Output: -

enter the 1st sequence[1 2]
enter the 2nd sequence[1 2 4]
The resultant signal is

y =

1 4 8 8



CONCLUSION:-

Discrete convolution of two sequences gives the product of two sequences. This property of signals is used in designing the DSP based filters.

Practical 7 : (2 Hours):

TO DEVELOP THE PROGRAM FOR DISCRETE CORRELATION

AIM: - To develop MATLAB program for evaluating discrete correlation.

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:-

- 1) What is discrete correlation?
- 2) What are the applications of Discrete Correlation?
- 3) How it can be implemented in the time domain analysis?

MATLAB SCRIPT:

```
%Program for computing cross correlation of the sequences x=[1,2,3,4] and h=[4,3,2,1]
clc;
clear all;
close all;
x=input('enter the 1st sequence');
h=input('enter the 2nd sequence');
y=xcorr(x,h);
figure;
subplot(3,1,1);
stem(x);
ylabel('Amplitude-->');
xlabel('(a)n-->');
subplot(3,1,2);
stem(h);
ylabel('Amplitude-->');
xlabel('(b)n-->');
subplot(3,1,3);
stem(fliplr(y));
ylabel('Amplitude');
xlabel('(c)n-->');
disp('The resultant signal is');
fliplr(y)
```

OUTPUT:-

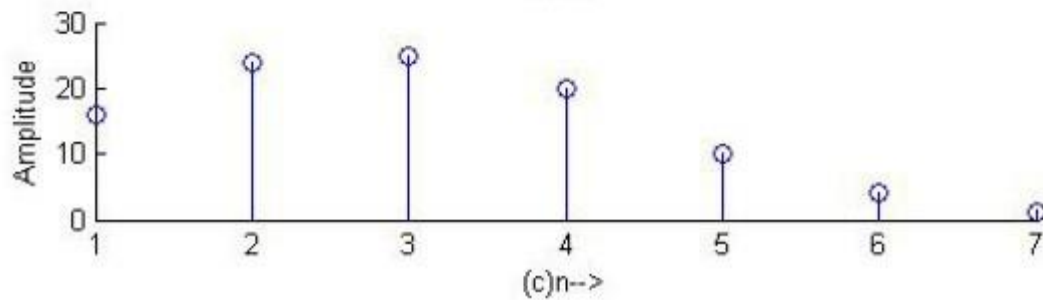
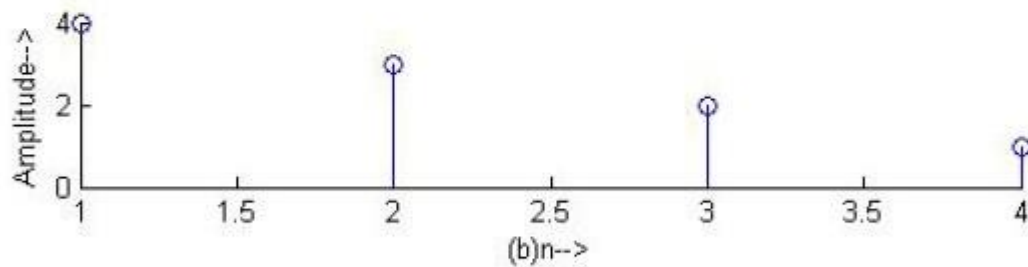
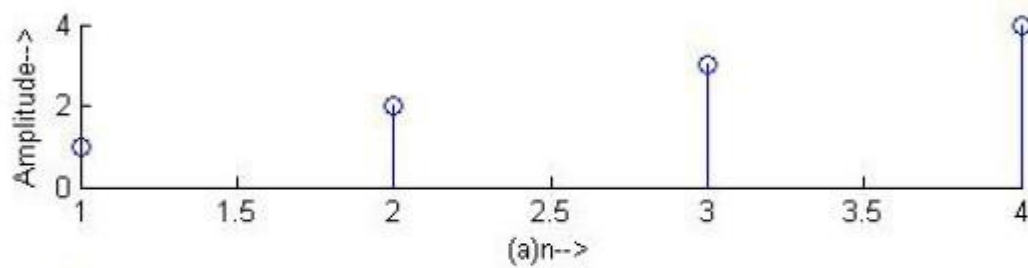
enter the 1st sequence[1 2 3 4]

enter the 2nd sequence[4 3 2 1]

The resultant signal is

ans =

16.0000 24.0000 25.0000 20.0000 10.0000 4.0000 1.0000



CONCLUSION:

Cross correlation is the important property of DSP and it is a measure of similarity of two waveforms as a function of a time-lag applied to one of them.

Practical 8 & 9 : (2 Hours):

TO DESIGN A PROGRAM FOR COMPUTING Z TRANSFORM and INVERSE Z TRANSFORMS

AIM:- To design a program for computing Z transform and inverse z transforms

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:-

- 1) What are the methods of obtaining inverse Z transform?

MATLAB SCRIPT:

Z Transform

```
>> syms z n
>> ztrans(1/4^n)
```

Ans = $4^z/(4^z-1)$

```
>> syms z n
>> iztrans(2^z/(2^z-1))
```

Ans = $(1/2)^n$

```
>> syms z n
>> iztrans((4^z/(4^z-1)-z^-1+5)/(6-5*z^-1+z^-2))
```

Ans = $1/2*(1/4)^n+5/2*(1/2)^n-2*(1/3)^n$

Inverse Z Transform

```
>> b=[1 2 1];
>> a=[1 -2 4];
>> n=5;
>> b=[b zeros(1,n-1)];
>> [x,r]=deconv(b,a);
>> disp(x)
```

Ans=1 4 5 -6 -32

```
>> [r,p,k]=residuez([1,2,1],[1,-2,4])
```

Ans

r = 0.3750 - 0.9382i 0.3750 + 0.9382i p = 1.0000 + 1.7321i 1.0000 - 1.7321i k = 0.2500

CONCLUSION:

We conclude that Inverse Z transform for a rational transfer function can be computed from the coefficients of polynomials of numerator and denominator of a transfer function.

Practical 10: (2 Hours):

To design FIR Filter .

Aim:- To design FIR Filter using window technique.

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

Theory:-

- 1) What is FIR filter?
- 2) State and Explain Structures of FIR Filter.

MATLAB SCRIPT:-

```
%Program for the design of FIR low pass, high pass, band pass, band stop using
%rectangular window
clc;
clear all;
close all;
rp=input('enter the passband ripple');
rs=input('enter the stopband ripple');
fp=input('enter the passband freq');
fs=input('enter the stopband freq');
f=input('enter the sampling freq');
wp=2*fp/f;
ws=2*fs/f;
num=-20*log10(sqrt(rp*rs))-13;
dem=14.6*(fs-fp)/f;
n=ceil(num/dem);
n1=n+1;
if (rem(n,2)~=0)
    n1=n;
    n=n-1;
end
y=boxcar(n1);
%low pass filter
b=fir1(n,wp,y);
[h,o]=freqz(b,1,256);
m=20*log10(abs(h));
subplot(2,2,1);
plot(o/pi,m);
```

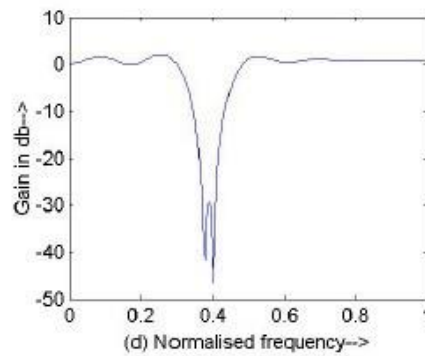
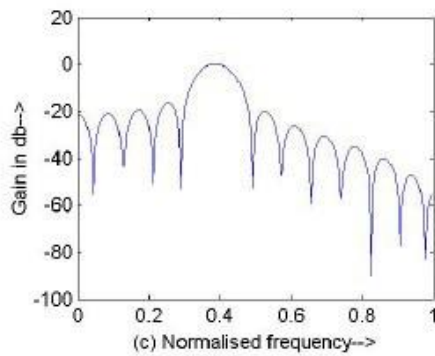
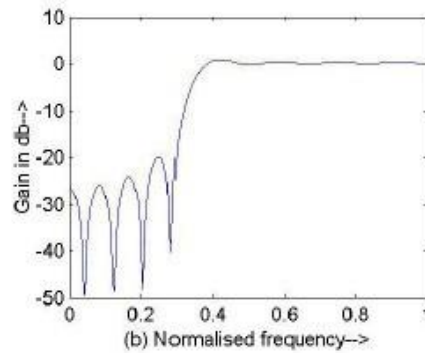
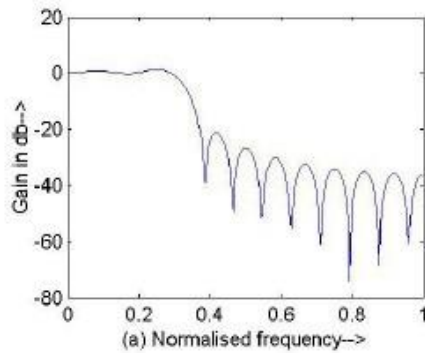
```

ylabel('Gain in db-->');
xlabel('(a) Normalised frequency-->');
%high pass filter
b=fir1(n,wp,'high',y);
[h,o]=freqz(b,1,256);
m=20*log10(abs(h));
subplot(2,2,2);
plot(o/pi,m);
ylabel('Gain in db-->');
xlabel('(b) Normalised frequency-->');
%band pass filter
wn=[wp ws];
b=fir1(n,wn,y);
[h,o]=freqz(b,1,256);
m=20*log10(abs(h));
subplot(2,2,3);
plot(o/pi,m);
ylabel('Gain in db-->');
xlabel('(c) Normalised frequency-->');
%band stop filter
b=fir1(n,wn,'stop',y);
[h,o]=freqz(b,1,256);
m=20*log10(abs(h));
subplot(2,2,4);
plot(o/pi,m);
ylabel('Gain in db-->');
xlabel('(d) Normalised frequency-->');

```


Output: -

enter the passband ripple 0.04
enter the stopband ripple 0.02
enter the passband freq 1500
enter the stopband freq 2000
enter the sampling freq 9000



Conclusion:-

We conclude that, window technique helps in designing the filters.

Practical 11 : (2 Hours):

TO DESIGN DIGITAL IIR FILTER

AIM:- To design Digital IIR filter using MATLAB.

APPARATUS:

- 1) MATLAB Software
- 2) Digital Signal Processing Toolbox

THEORY:-

- 1) What is IIR filter?
- 2) State and Explain Structures of FIR Filter.

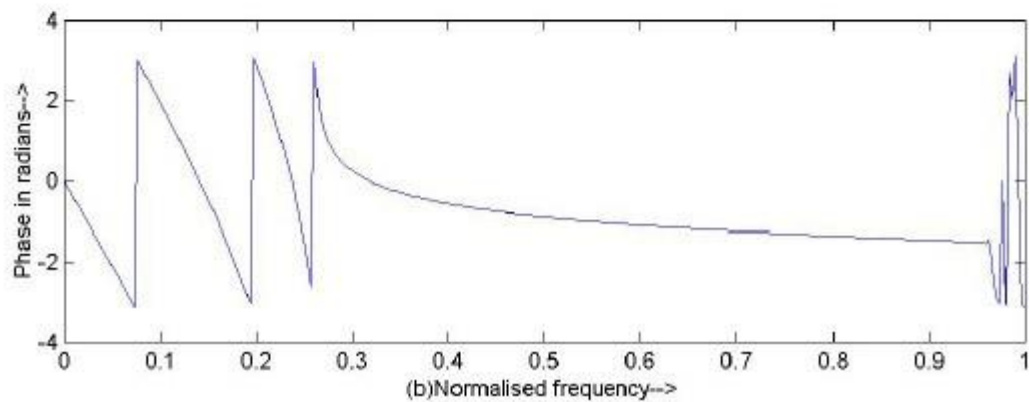
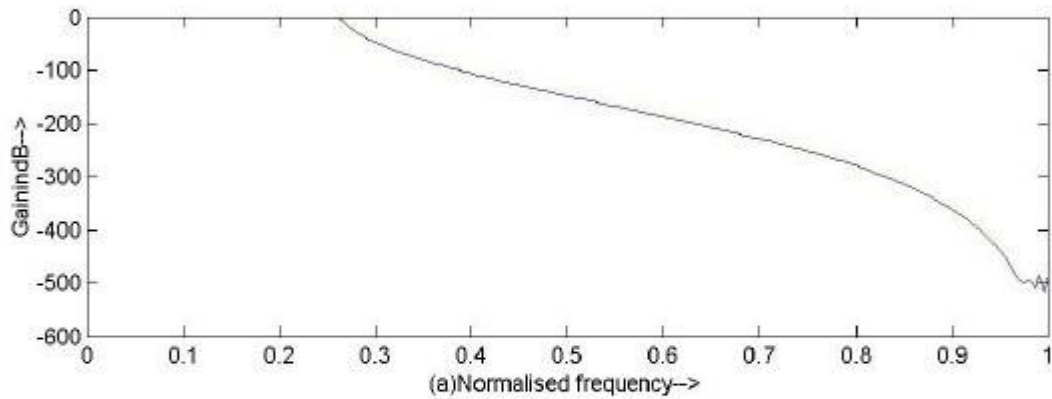
MATLAB SCRIPT:

Low Pass: -

```
%program for the design of chebyshev lowpass filter
clc;
close all;
clear all;
format long
rs=input('enter the stopband ripple...');
rp=input('enter the passband ripple...');
ws=input('enter the stopband freq...');
wp=input('enter the passband freq...');
fs=input('enter the sampling freq...');
w1=2*wp/fs;
w2=2*ws/fs;
[n,wn]=cheblord(w1,w2,rp,rs);
[b,a]=cheby1(n,rp,wn);
w=0:0.01:pi;
[h,om]=freqz(b,a,w);
m=20*log10(abs(h));
an=angle(h);
subplot(2,1,1);
plot(om/pi,m);
ylabel('GainindB-->');
xlabel('(a)Normalised frequency-->');
subplot(2,1,2);
plot(om/pi,an)
xlabel('(b)Normalised frequency-->');
ylabel('Phase in radians-->');
```

Output :-

enter the stopband ripple...45
enter the passband ripple...0.2
enter the stopband freq...1500
enter the passband freq...1300
enter the sampling freq...10000



Conclusion:-

We conclude that Digital IIR filters play important role in DSP technology.

Practical 12: (2 Hours):

APPLICATIONS OF DIGITAL SIGNAL PROCESSING.

Aim:- To study a practical digital signal processing system.

Contents:

Study report of digital system.

Conclusion:-

Thus we have studied digital signal processing system.

1. *Conduction of Viva-Voce Examinations:*

Teacher should oral exams of the students with full preparation. Normally, the objective questions with guess are to be avoided. To make it meaningful, the questions should be such that depth of the students in the subject is tested Oral examinations are to be conducted in co-cordial environment amongst the teachers taking the examination. Teachers taking such examinations should not have ill thoughts about each other and courtesies should be offered to each other in case of difference of opinion, which should be critically suppressed in front of the students.

2. *Evaluation and marking system:*

Basic honesty in the evaluation and marking system is absolutely essential and in the process impartial nature of the evaluator is required in the examination system to become popular amongst the students. It is a primary responsibility of the teacher that right students who are really putting up lot of hard work with right kind of intelligence are correctly awarded.

The marking patterns should be justifiable to the students without any ambiguity and teacher should see that students are faced with unjust circumstances.