Computer Assignment-4

Discrete Time Fourier Transform function:-

```
function X_w = DTFT(X_n, w, n)
    X_w = zeros(size(w));
    for k = 1:length(w)
        X_w(k) = sum(X_n .* exp(-1i * w(k) * n));
    end
end
```

Discrete Time Inverse Fourier Transform function:-

```
function X_n = IDTFT(X_w, w, n)
    X_n = zeros(size(n));
    for i = 1:length(n)
        X_n(i) = (sum(X_w .* exp(1i * w * n(i))) * 0.01)* 1/(2*pi);
    end
end
```

Continuous Time Fourier Transform function:-

```
function X_w = CTFT(X_n, w, t)
    X_w = zeros(size(w));
    for k = 1:length(w)
        X_w(k) = sum(X_n .* exp(-1i * w(k) * t));
    end
end
```

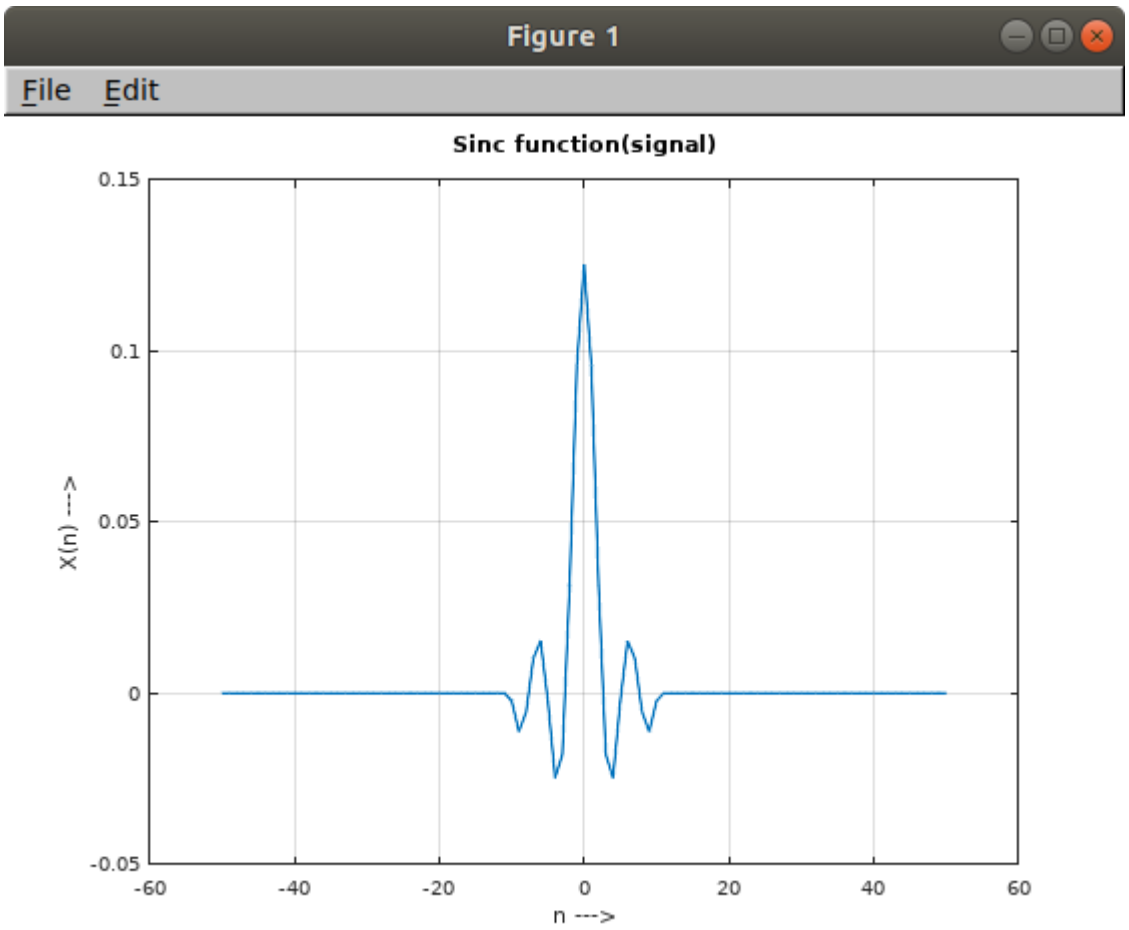
Menu driven program:-

```
clc
clear all
clear

% ============================================{ DTFT } ======================|
%Question:-1
N_init = -50;
N_end = 50;
n = N_init:N_end;

X_n = sinc(pi*n/8)/8;
X_n(abs(n) > 10) = 0;;
figure, plot(n, X_n, 'linewidth', 2), xlabel('n --->'), ylabel('X(n) --->'),
title('Sinc function(signal)');
grid on
```

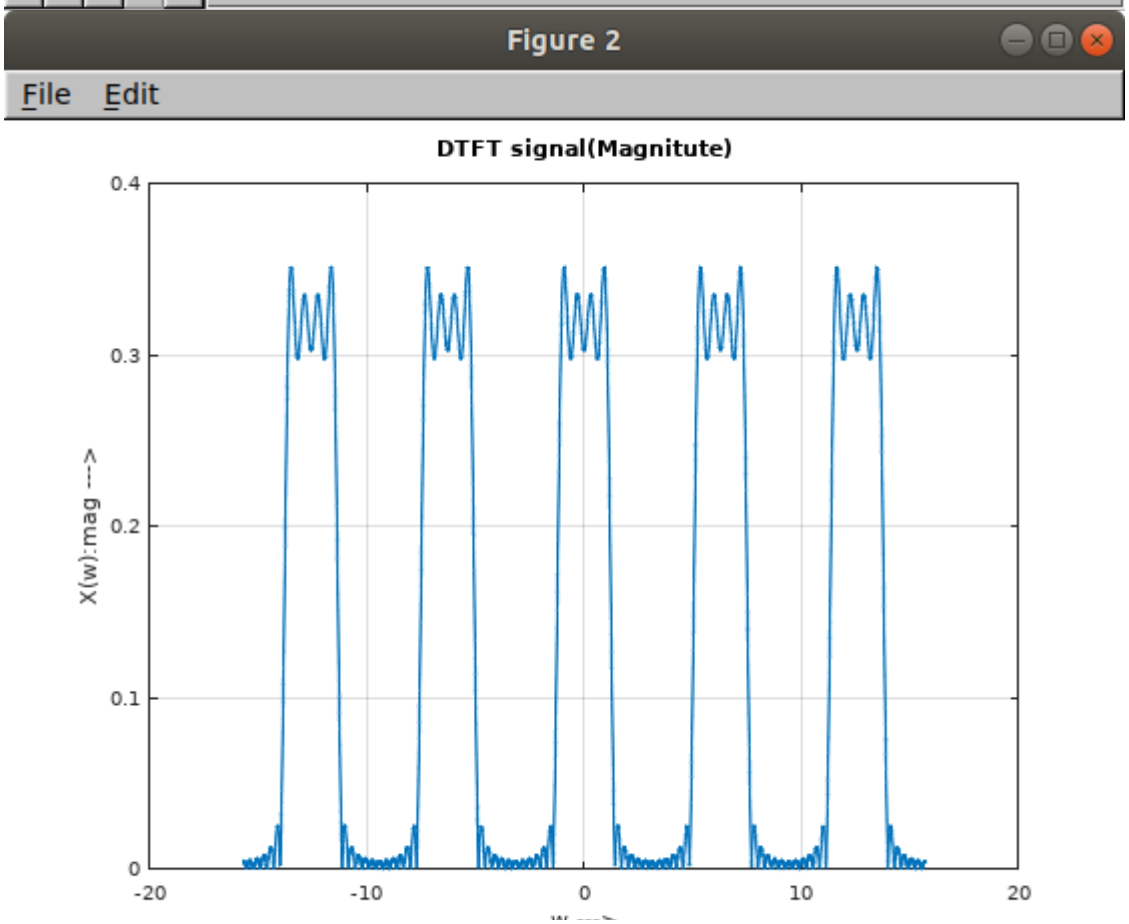
```
% Plot the DTFT X(w)
omega1 = -5*pi:0.01:5*pi;
X_w1 = DTFT(X_n, omega1, n);
X_mag1 = abs(X_w1);
X_angle1 = angle(X_w1);
figure,plot(omega1, X_mag1,'linewidth', 2), xlabel('w --->'), ylabel('X(w):mag --->'),
title('DTFT signal(Magnitute)');
grid on

figure,plot(omega1, X_angle1,'linewidth', 2), xlabel('w --->'), ylabel('X(w):angle ---
>'), title('DTFT signal(Angle)');
grid on

%--------------------------------
% Question:-2

omega2 = -pi:0.01:pi;
omega2_bounbed = (omega2 >= -pi/3 & omega2 <= pi/3);
X_w2 = zeros(size(omega2));
X_w2(omega2_bounbed) = 1 + omega2(omega2_bounbed).^2;
figure,plot(omega2, X_w2, 'linewidth',2),xlabel('w --->'),ylabel('X(w) ---
>'),title('Parabolic spectrum (signal)');
grid on

% Plot the IDTFT
X_n_reconst = IDTFT(X_w2,omega2,n);
figure,plot(n, X_n_reconst,'linewidth', 2), xlabel('n --->'), ylabel('X(n) --->'),
title('IDTFT signal');
grid on

%================================{ Sampling }================================|
% Question:-3

t_init3 = -10;
t_end3 = 10;
t3 = t_init3:0.01:t_end3;

X_t3 = zeros(size(t3));
X_t3(t3 > 0 & t3 < 5) = 1 + 0*t3(t3>0 & t3<5);
figure, plot(t3, X_t3, 'linewidth', 2), xlabel('t --->'), ylabel('X(t) --->'),
title('Rectangular signal');
grid on


% ---- CTFT ---->
omega3 = -5*pi:0.01:5*pi;
X_w3 = CTFT(X_t3, omega3, t3);
X_w3_mag = abs(X_w3)*0.01;
X_w3_angle = angle(X_w3);
figure, plot(omega3, X_w3_mag, 'linewidth', 2), xlabel('w --->'), ylabel('X(w):mag ---
>'), title('CTFT signal(Magnitute)');
grid on
```

```
figure,plot(omega3, X_w3_angle, 'linewidth', 2),xlabel('w --->'),ylabel('X(w):angle --->'), title('CTFT signal(Angle)');
grid on

%-------------------------------------
% Question:-4 (Taking same time interval for 3 and 4)

t_init4 = -10;
t_end4 = 10;
t4 = t_init4:0.01:t_end4;

X_t4 = zeros(size(t4));
X_t4(t4 >= -3 & t4 <= 3) = 1 - abs(t4(t4 >= -3 & t4 <= 3))/3;
figure, plot(t4, X_t4, 'linewidth', 2), xlabel('t --->'), ylabel('X(t) --->'),
title('Triangle signal');
grid on


% ---- CTFT ---->
omega4 = -5*pi:0.01:5*pi;
X_w4 = CTFT(X_t4, omega4, t4);
X_w4_mag = abs(X_w4)*0.01;
X_w4_angle = angle(X_w4);
figure, plot(omega4, X_w4_mag, 'linewidth', 2), xlabel('w --->'), ylabel('X(w):mag --->'), title('CTFT signal(Magnitute)');
grid on
figure,plot(omega4, X_w4_angle, 'linewidth', 2),xlabel('w --->'),ylabel('X(w):angle --->'),title('CTFT signal(Angle)');
grid on

% -------------------------------------
% 3dB bandwidth falls within the range  of...
figure, powerbw(abs(X_w3), omega3./2*pi,'linewidth', 2), xlabel('w --->'),
ylabel('X(w)--->'), title('CTFT signal');
grid on);
figure, powerbw(abs(X_w4), omega4./2*pi,'linewidth', 2), xlabel('w --->'),
ylabel('X(w)--->'), title('CTFT signal');
grid on);

%=========================================================================
```

Results:- **1. DTFT**



A G P R ? [-23.17, 0.1263]

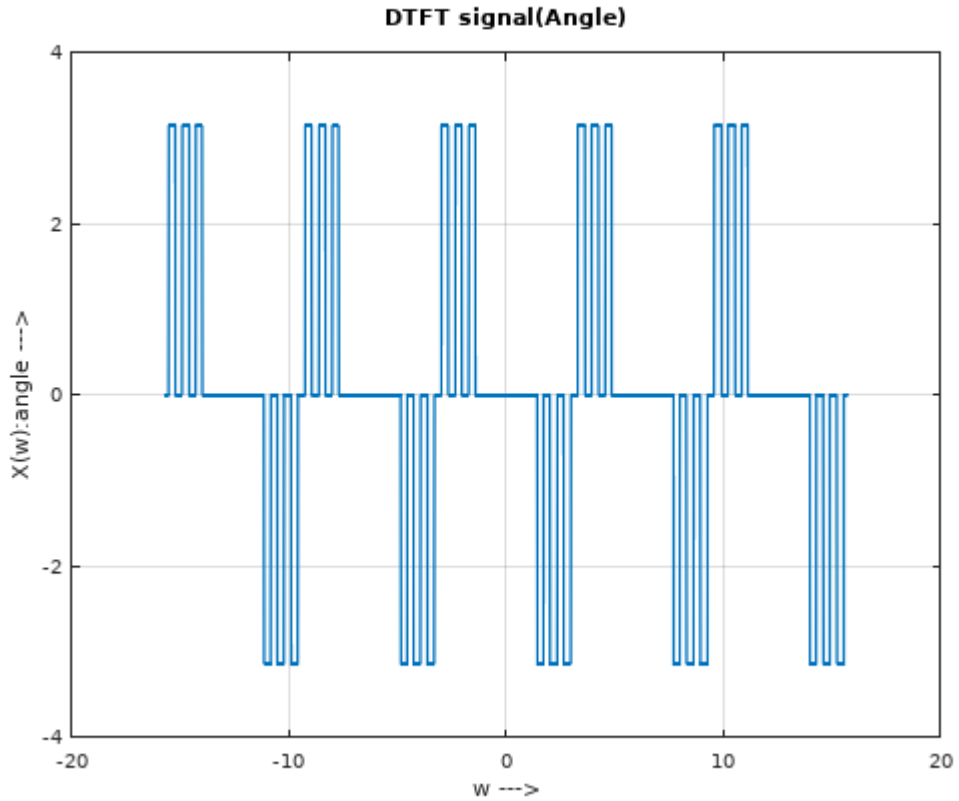


w --->

A G P R ? [6.562, 0.4029]

Figure 3

File Edit



A G P R ? [-0.6267, 0.6228]

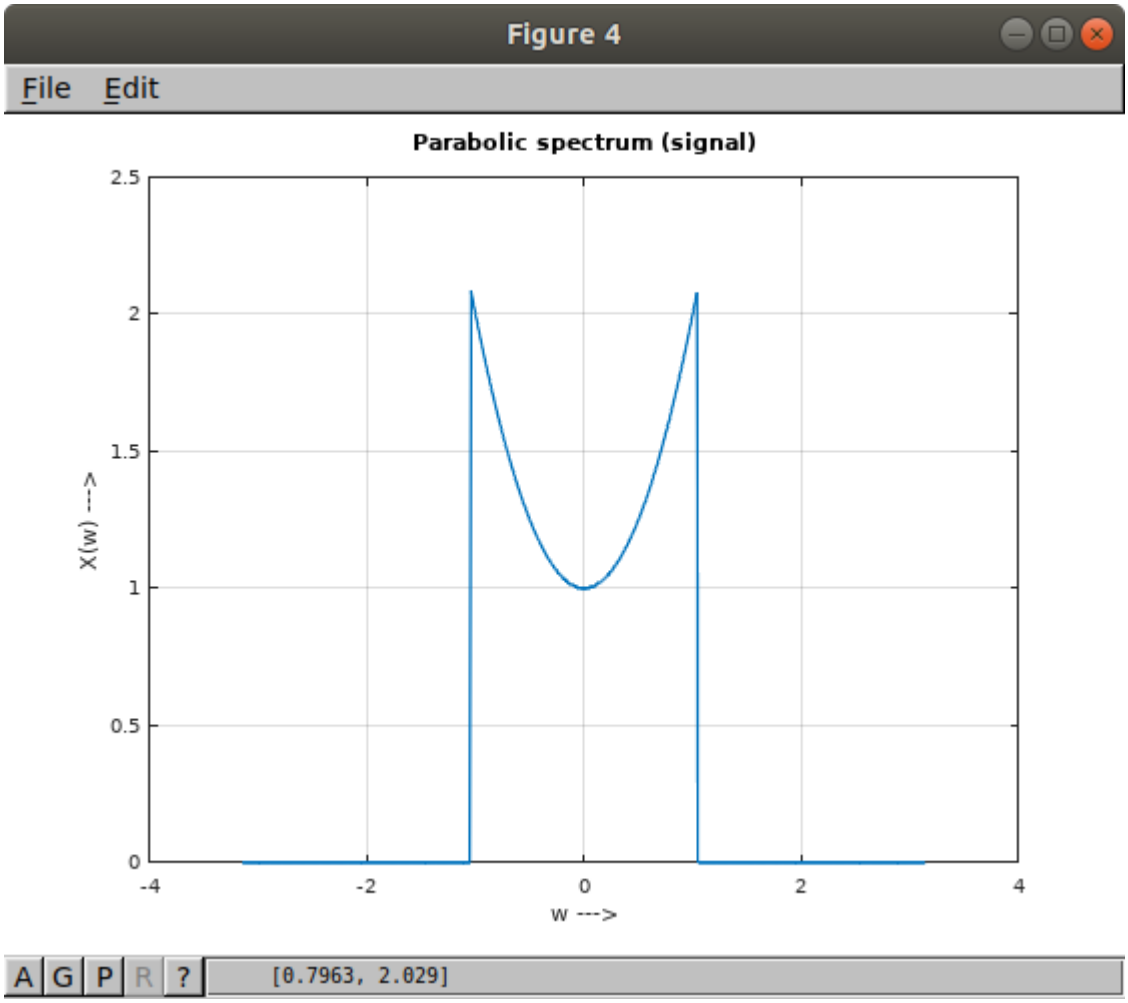


Figure 4
File Edit
Parabolic spectrum (signal)
X(w) --->
w --->
2.5
2
1.5
1
0.5
0
-4
-2
0
2
4
A G P R ?
[0.7963, 2.029]

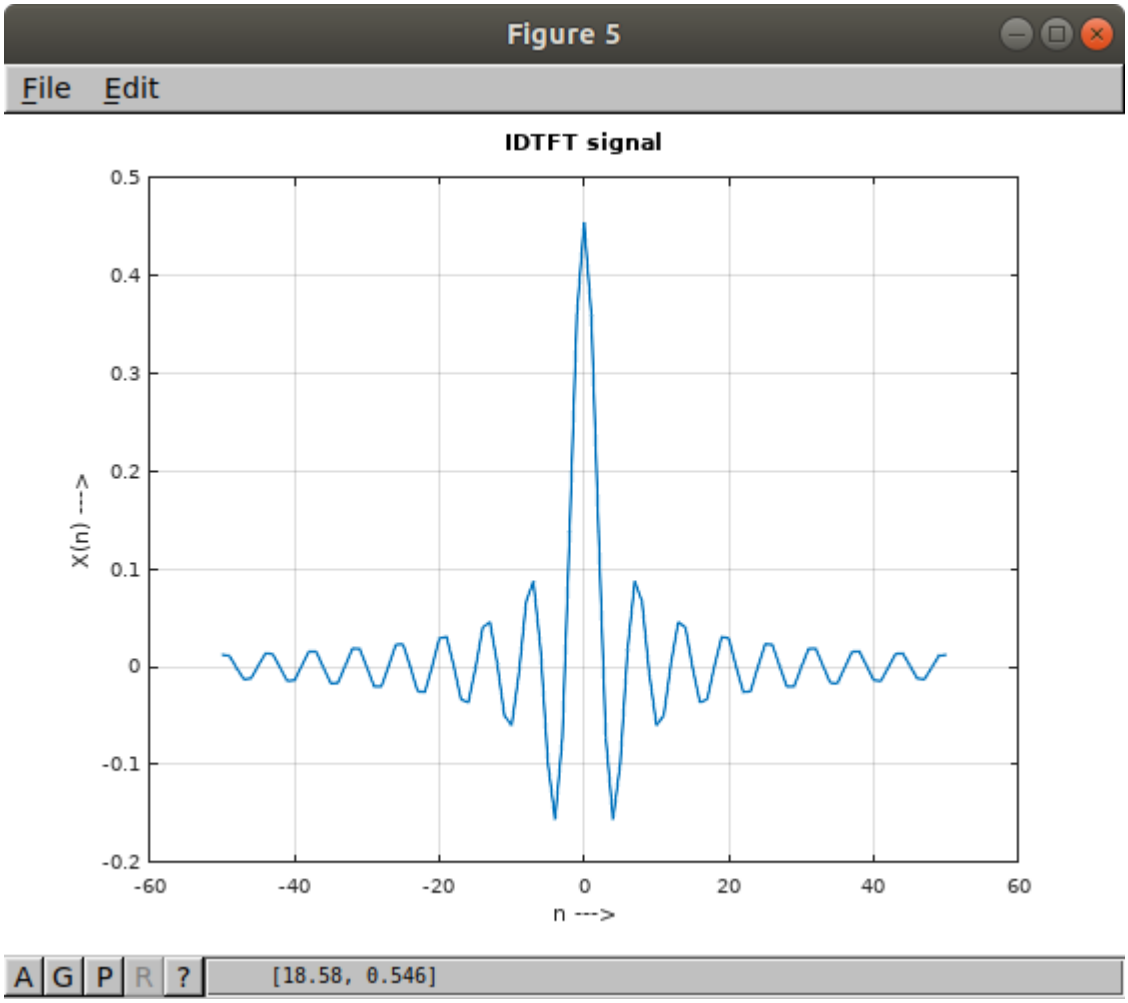


Figure 5
File Edit
IDTFT signal
X(n) --->
n --->
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-60
-40
-20
0
20
40
60
A G P R ?
[18.58, 0.546]

2. Sampling:-

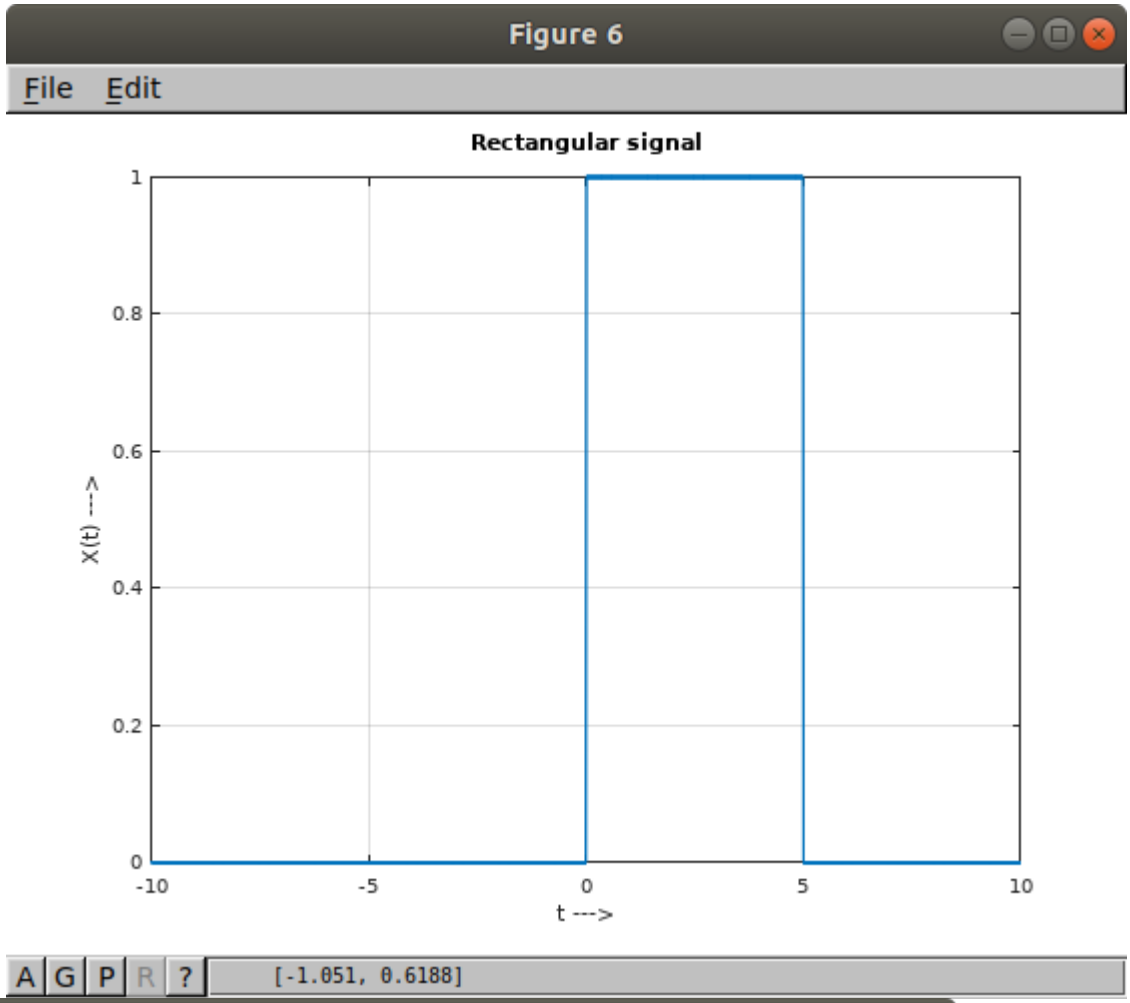


Figure 6
File Edit
Rectangular signal
X(t) --->
t --->
1
0.8
0.6
0.4
0.2
0
-10
-5
0
5
10
A G P R ?
[-1.051, 0.6188]

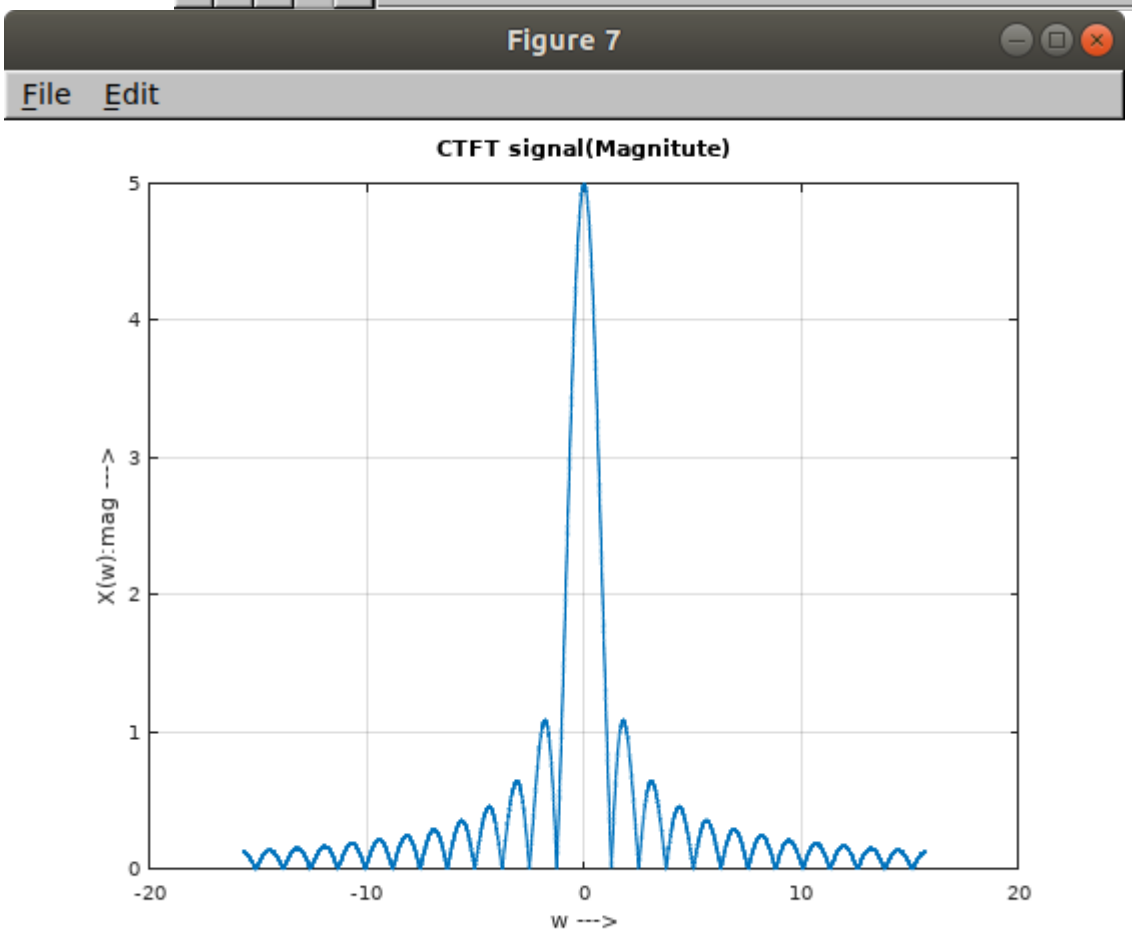
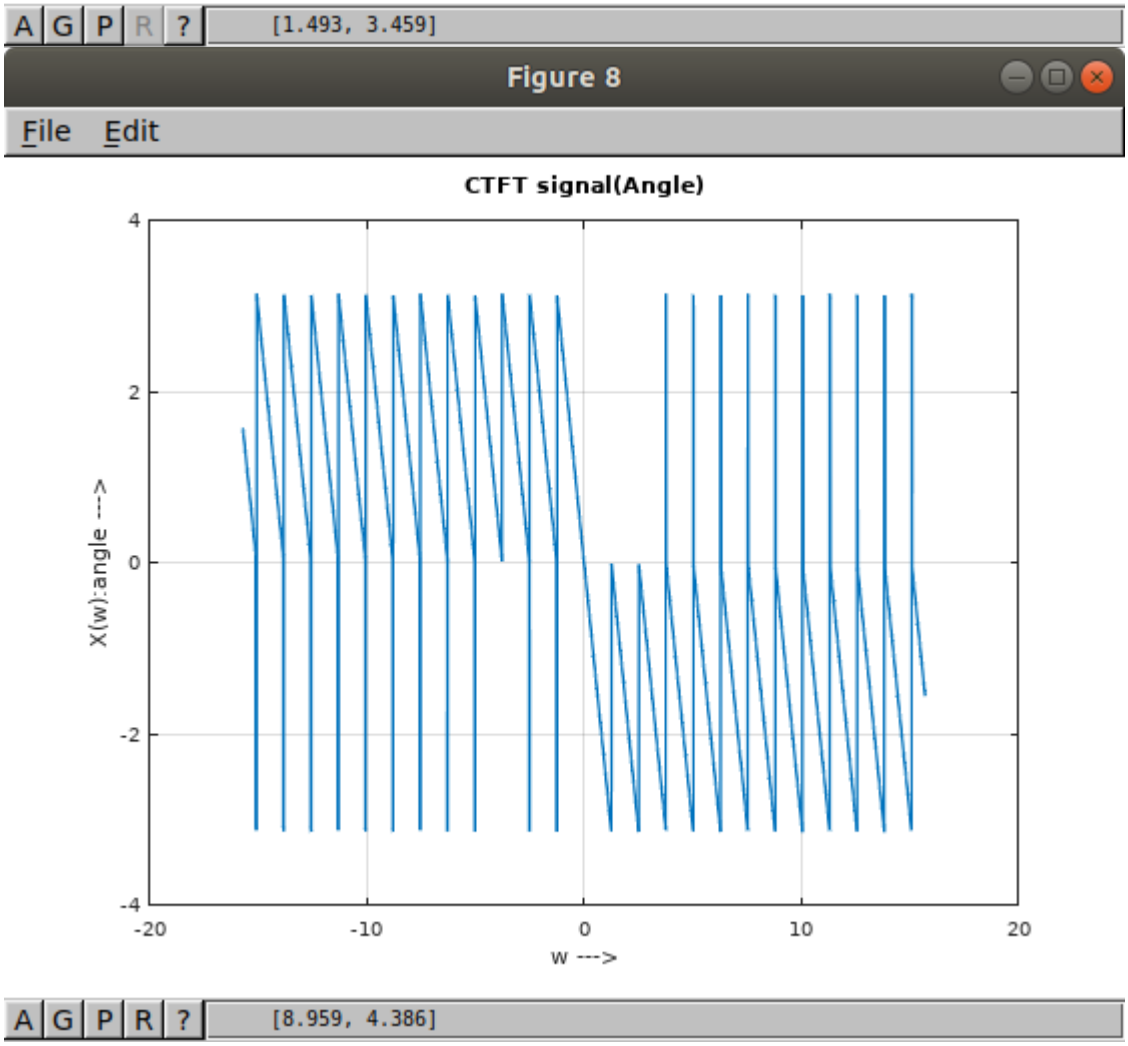
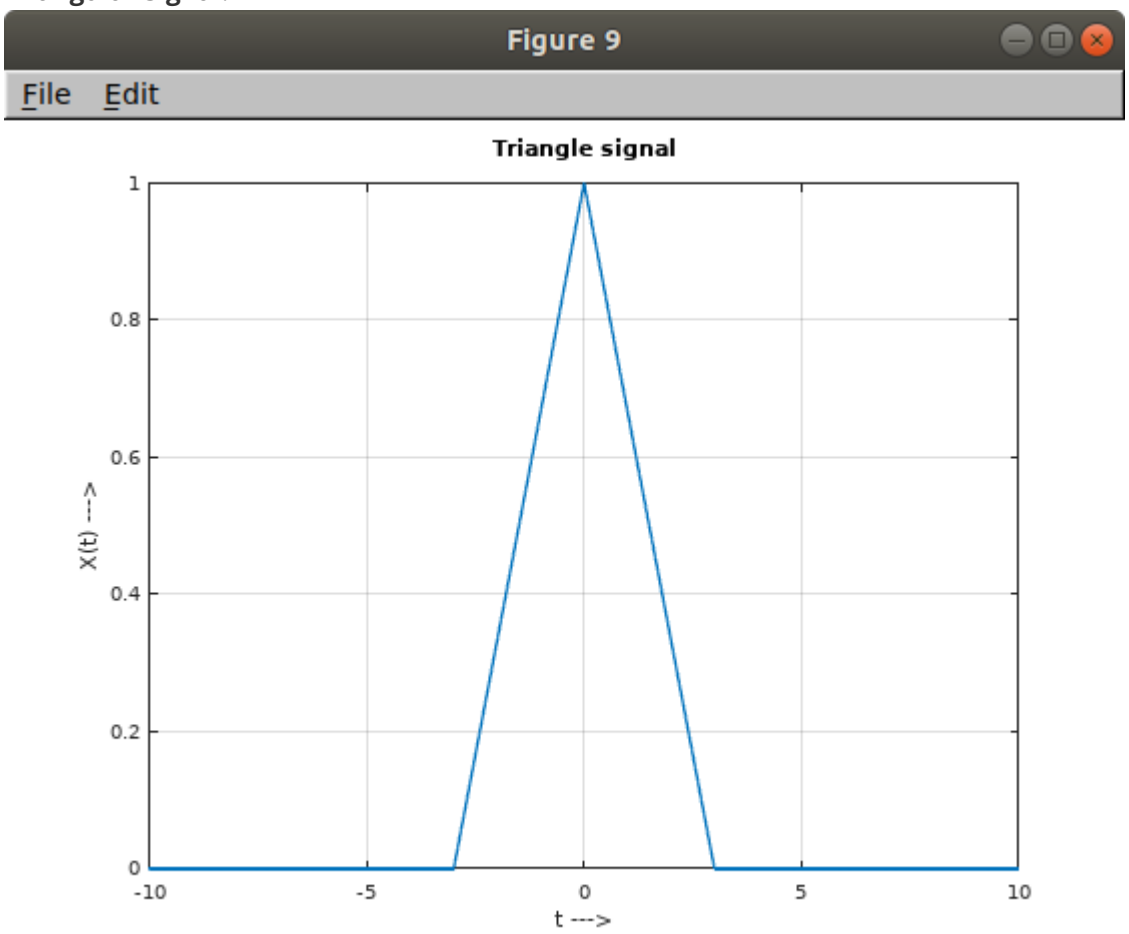
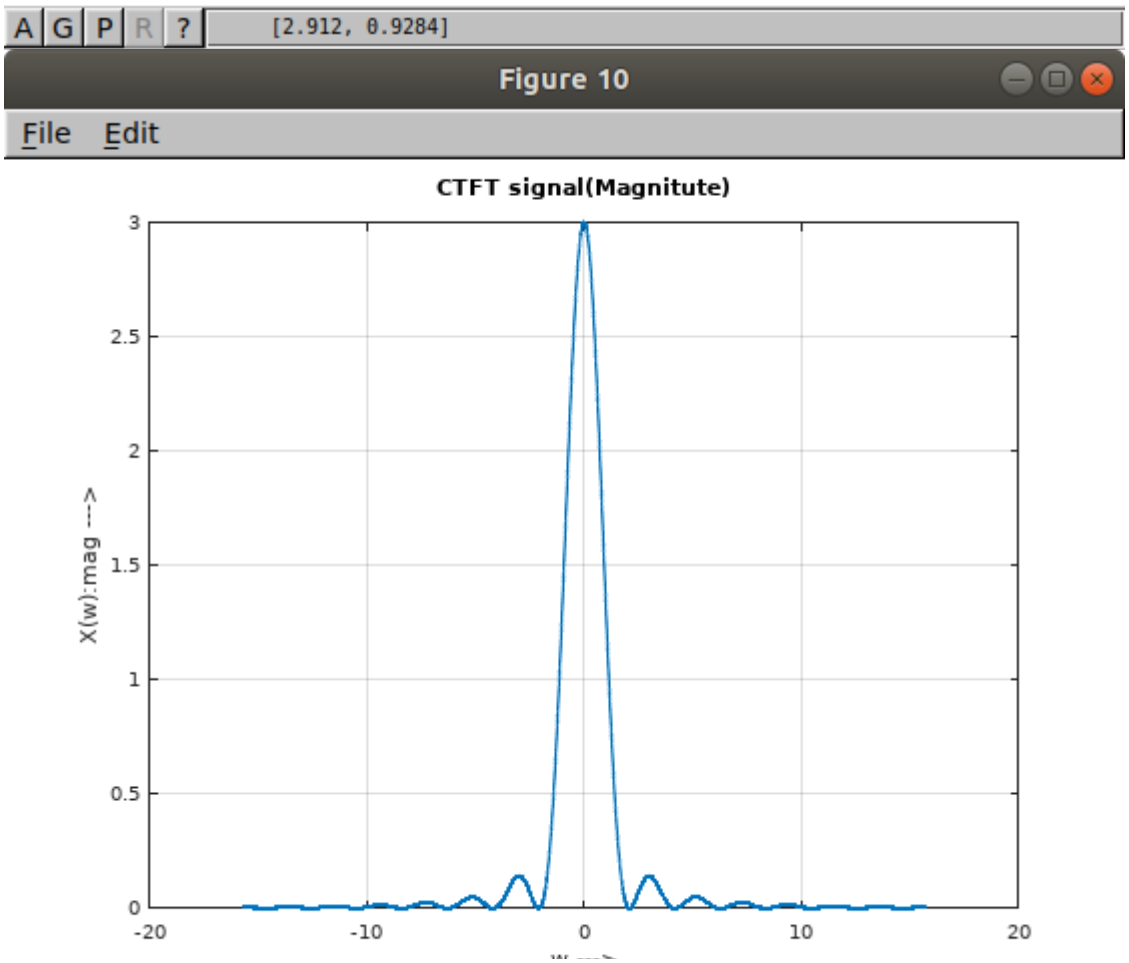


Figure 7
File Edit
CTFT signal(Magnitute)
X(w):mag --->
w --->
5
4
3
2
1
0
-20
-10
0
10
20

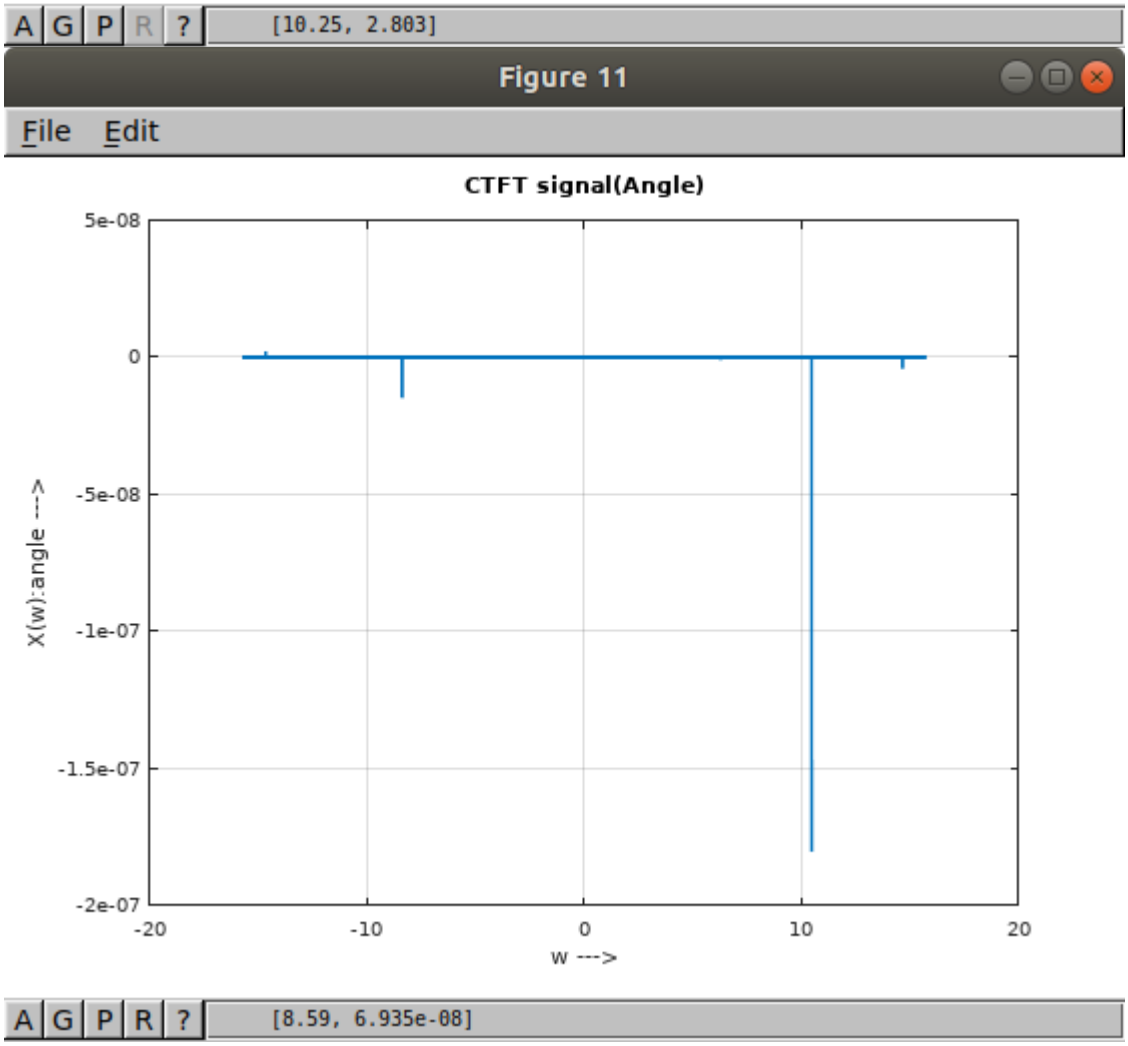

A G P R ?
[1.493, 3.459]
Figure 8
File Edit
CTFT signal(Angle)
X(w):angle --->
w --->
4
2
0
-2
-4
-20
-10
0
10
20
A G P R ?
[8.959, 4.386]

Triangular Signal:-

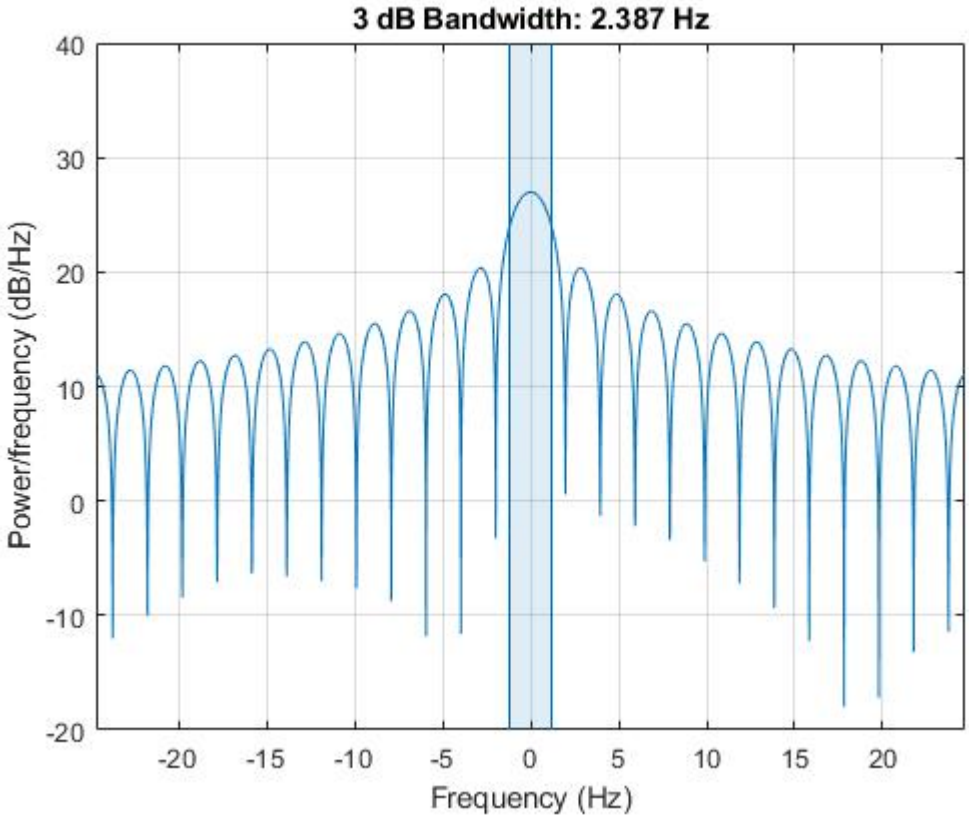




w --->


A G P R ?
[10.25, 2.803]
Figure 11
File Edit
CTFT signal(Angle)
5e-08
0
-5e-08
-1e-07
-1.5e-07
-2e-07
X(w):angle --->
-20
-10
0
10
20
w --->
A G P R ?
[8.59, 6.935e-08]

Band-width of Sampled signals:- (**Nyquist sampling rate**) **1. Rectangular pulse**:- *Nyquist sampling rate:-* 2.387*(1/(2*pi)) = 0.3799 radians



2. Triangular pulse:- Nyquist sampling rate:- 2.914*(1/(2*pi)) = 0.4638 radians