Computer and Communication Engineering Program

Faculty of Engineering

Alexandria University

Course Title: Signals and Systems

Course Code: EEC 276

Final Project

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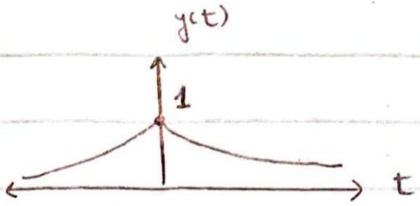
Part One

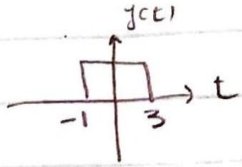
Handwritten Solutions

Final project

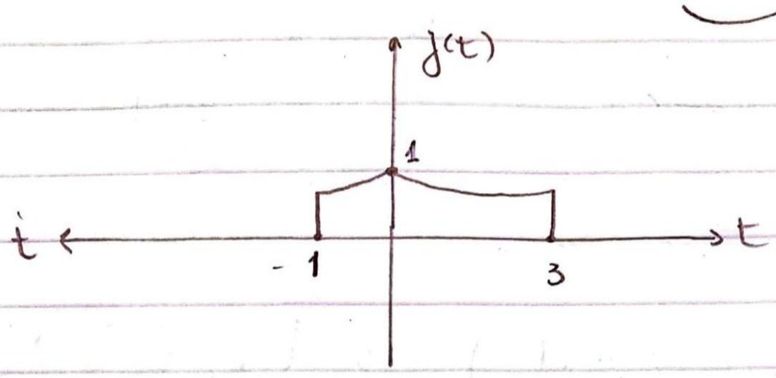
(1) * For: $y(t) = e^{-\frac{|t|}{5}}$



(a) $y(t) = e^{-\frac{|t|}{5}}\left[u(t+1) - u(t-3)\right]$



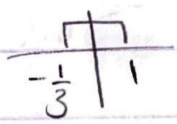
$[-1, 3]$

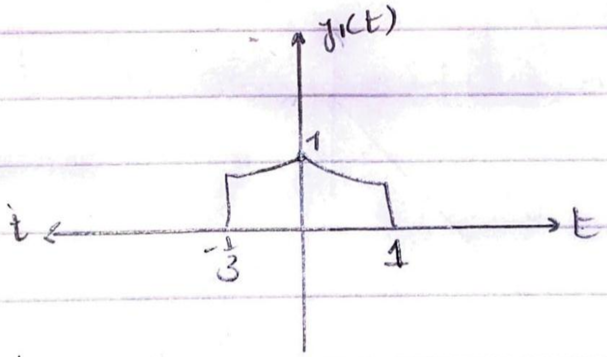


(b) * $y_1(t) = y(3t)$

$-\frac{1}{3}$ $\quad -1$

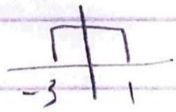
$y_1(t) = e^{-\frac{|3t|}{5}}\left[u(3t+1) - u(3t-3)\right]$

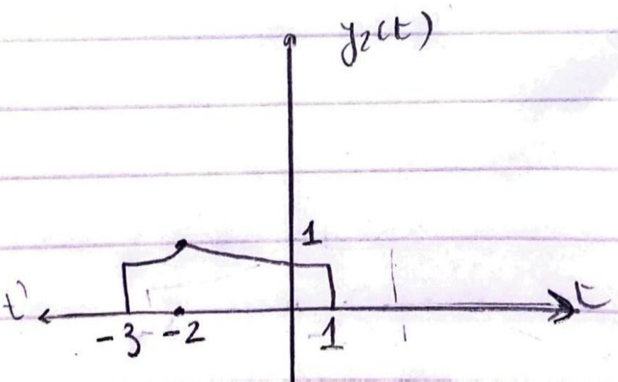




* $y_2(t) = y(t+2)$

$y_2(t) = e^{-\frac{|t+2|}{5}}\left[u(t+3) - u(t-1)\right]$

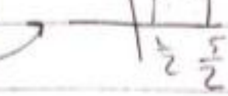


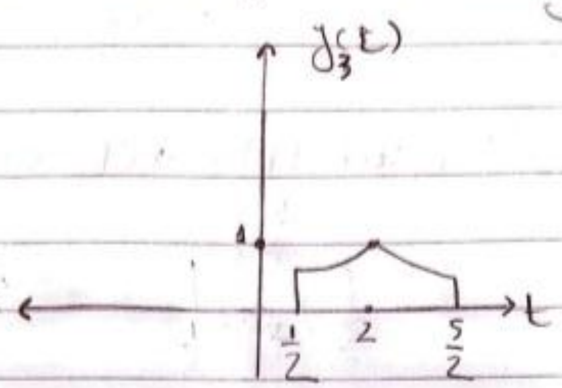


$u(4-2t+1) = u(5-2t) \rightarrow -\frac{5}{2}$
$u(4-2t-3) = u(1-2t) \rightarrow -\frac{1}{2}$

$* \; y_3(t) = y(4-2t)$

$y_3(t) = e^{-\frac{|4-2t|}{5}} [u(5-2t) - u(1-2t)]$





(c) //

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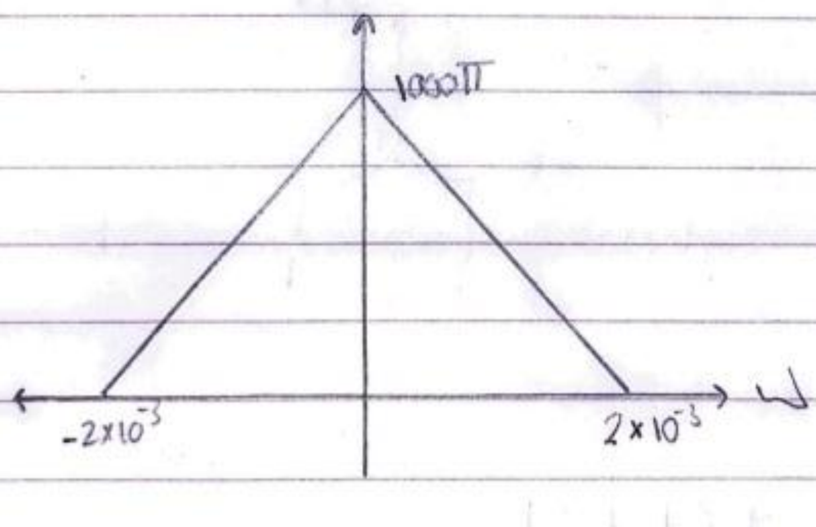
(2) (a) $\frac{W}{2\pi} \operatorname{Sinc}^2\left(\frac{Wt}{2}\right) \rightarrow \operatorname{tri}\left(\frac{\omega}{2W}\right)$

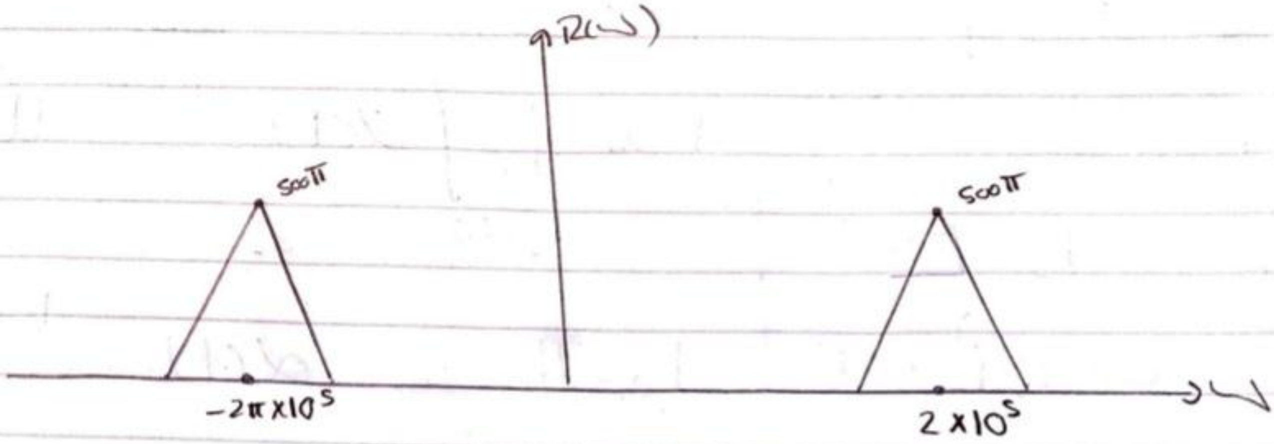
$\frac{W}{2} = 10^{-3} \qquad W = 2 * 10^{-3}$

$\operatorname{Sinc}^2(10^{-3} t) \rightarrow \frac{2\pi}{W} \operatorname{tri}\left(\frac{\omega}{2W}\right)$



(b) $x(t)\cos(\omega_o t) \rightarrow \frac{1}{2}[X[\omega-\omega_o]+X[\omega+\omega_o]]$

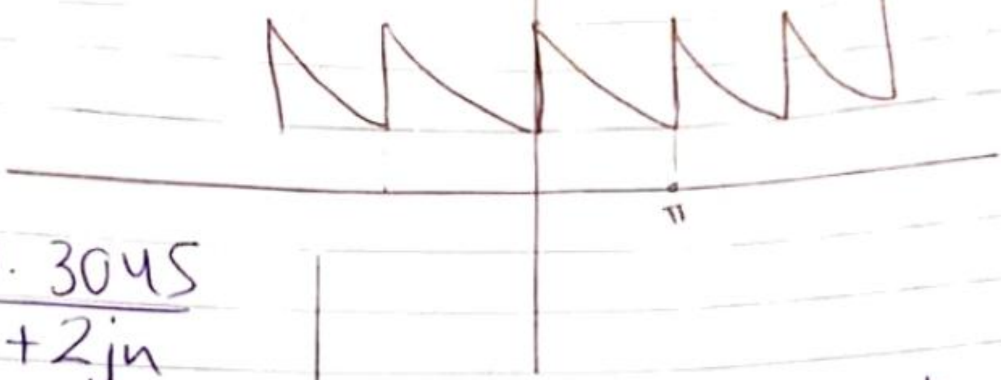
$\omega_o = 2\pi \times 10^{+5}$



(c) * the frequency response was shifted by "ω_o" to right and left sides

* and magnitude decreased to half

③ ⓐ



$D_n = \dfrac{0.3045}{1+2jn}$

$D_0 = 0.3045$

$D_1 = 0.136 \angle -63.4$

$D_2 = 0.073 \angle -75.96$

$D_3 = 0.05 \angle -80$

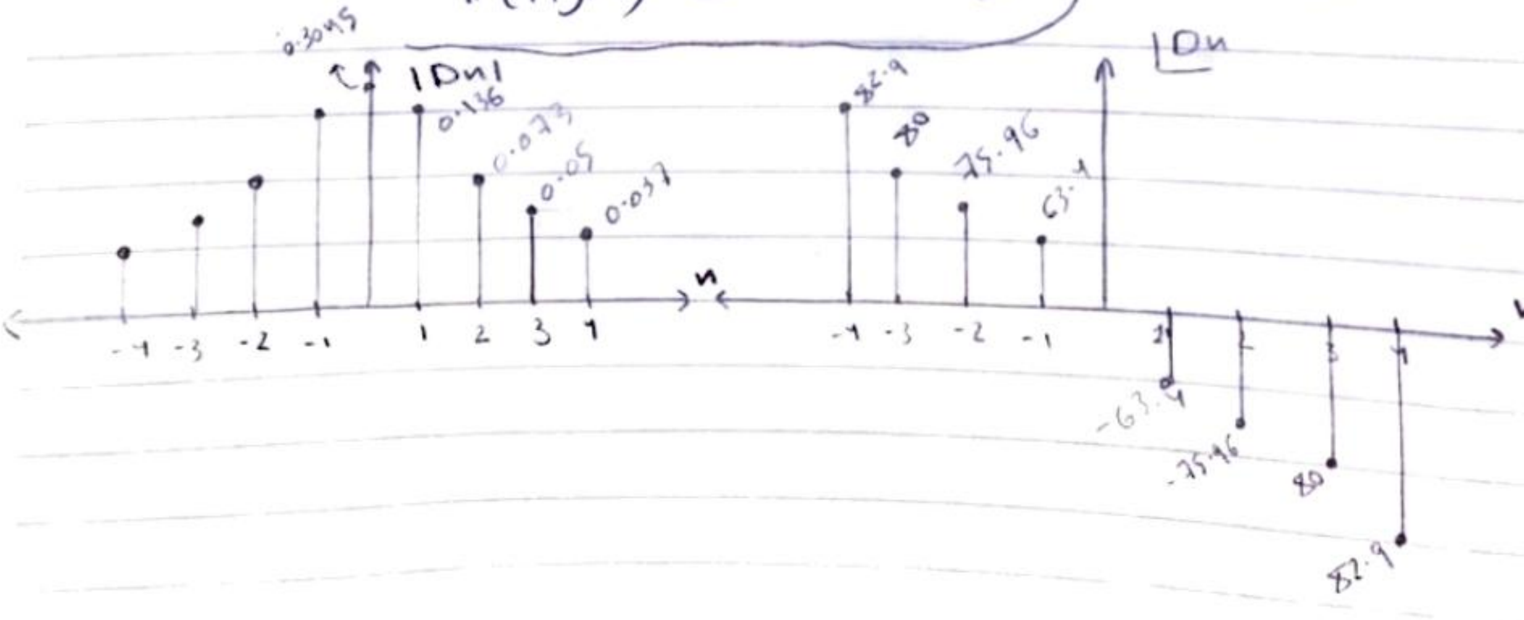
$D_4 = 0.037 \angle -82.9$

$D_n = \dfrac{1}{T_0} \displaystyle\int_{\langle T_0 \rangle} x(t) e^{-jn\omega_0 t} \, dt$

$T_0 = \pi \qquad x(t) = e^{-t}$

$* \ \dfrac{1}{\pi} \displaystyle\int_0^{\pi} e^{-t(1+j2n)} \, dt = \dfrac{-1}{\pi(1+2jn)} \left[e^{-t(1+j2n)} \right]_0^{\pi}$ $\times -1$

$$\boxed{= \frac{1}{\pi(1+j2n)} \left[1 - e^{-\pi} \right]}$$



MatLab Simulations

Question One

Code:

```
fs = 100;
t= linspace(-5, 5, 10*fs);
y=exp(-abs(t)./5).*(heaviside(t+1)-heaviside(t-3));
subplot(2,2,1);
plot(t,y);
title("y(t)");
y1=exp(-abs(3*t)./5).*(heaviside((3*t)+1)-heaviside((3*t)-3));
subplot(2,2,2);
plot(t,y1);
title("y1(t)");
y2=exp(-abs(t+2)./5).*(heaviside((t+2)+1)-heaviside((t+2)-3));
subplot(2,2,3);
plot(t,y2);
title("y2(t)");
y3=exp(-abs(4-2*t)./5).*(heaviside((4-2*t)+1)-heaviside((4-2*t)-3));
subplot(2,2,4);
plot(t,y3);
title("y3(t)");
```

Simulation:

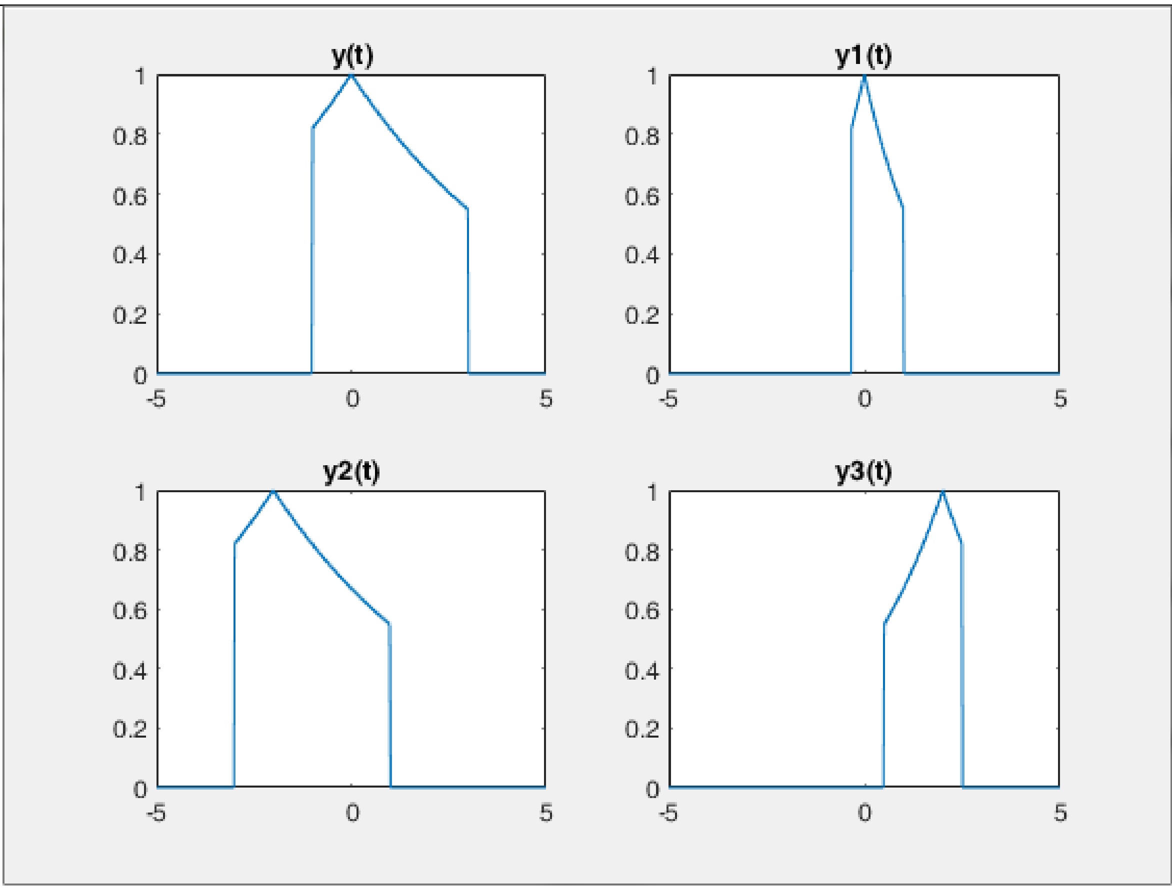


Fig. 01: Simulation of y(t), y(3t), y(t+2) and y(4-2t)
Part One Question One

Question Two

A)

Code:

```
fs=2;
Ts=1/fs;
t=linspace(-100000,100000,200000*fs);
x=(10^(-3)).*t;
m=(sin(x)./x).^2;
M=Ts.*fftshift(fft(m));
n=length(m);
f=(-n/2:n/2-1)*(fs/n);
w=2*pi*f;
subplot(3, 1, 3);
plot(w,angle(M));
title("phase of M(s)");
w=2*pi*f;
subplot(3, 1, 2);
plot(w,abs(M));
title("magnitude of M(s)");
xlim([-0.004,0.004]);
subplot(3, 1, 1);
plot(t,m);
title("m(t)");
```

Simulation:

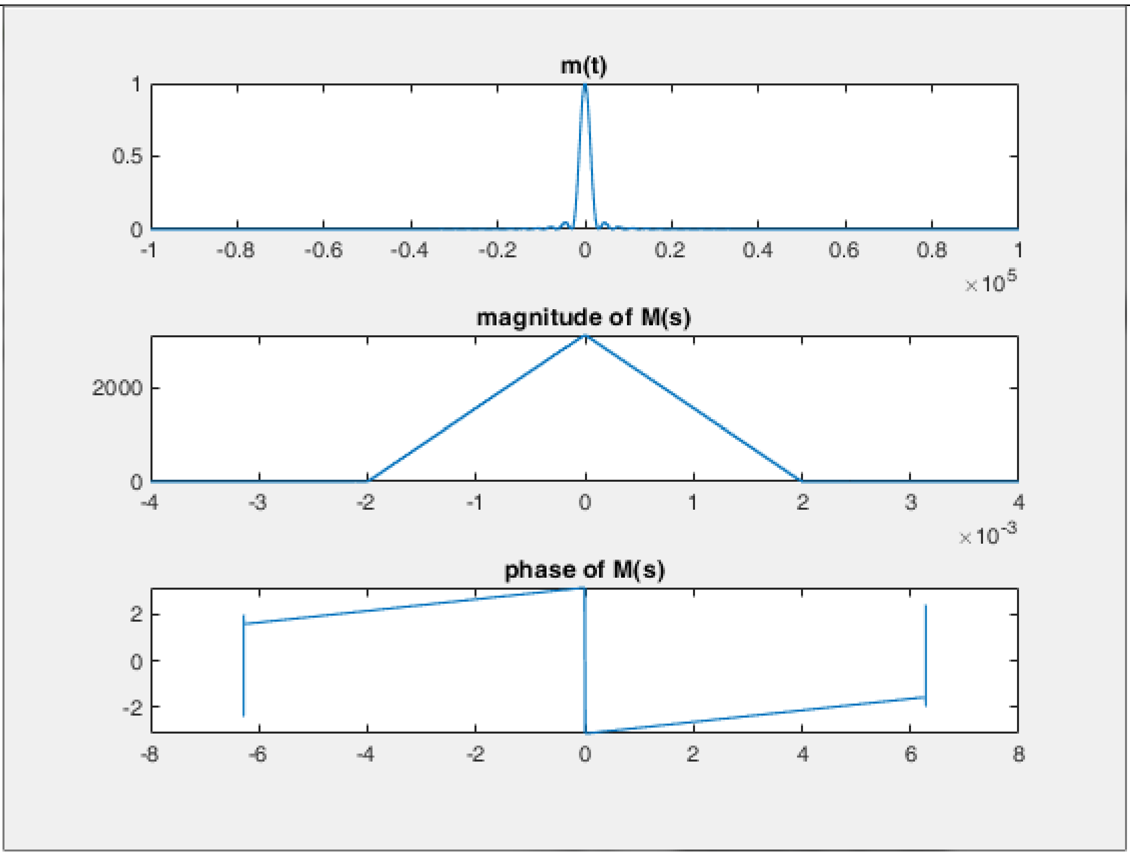


Fig. 02: Simulation of m(t), magnitude of M(s) and phase of M(s)
Part One Question Two A

B)

Code:

```
fs=5;
Ts=1/fs;
t=linspace(-100000,100000,200000*fs);
x=(10^(-3)).*t;
m=(sin(x)./x).^2;
y= 2.* pi .*(10.^5).*t;
r=m.*cos(y);
R=Ts.*fftshift(fft(r));
n=length(r);
f=(-n/2:n/2-1)*(fs/n);
w=2*pi*f.*(10.^6);
subplot(3, 1, 2);
plot(w,abs(R));
title("magnitude of R(s)");
subplot(3, 1, 3);
plot(w,angle(R));
title("phase of R(s)");
subplot(3, 1, 1);
plot(t,r);
title("r(t)");
```

Simulation:

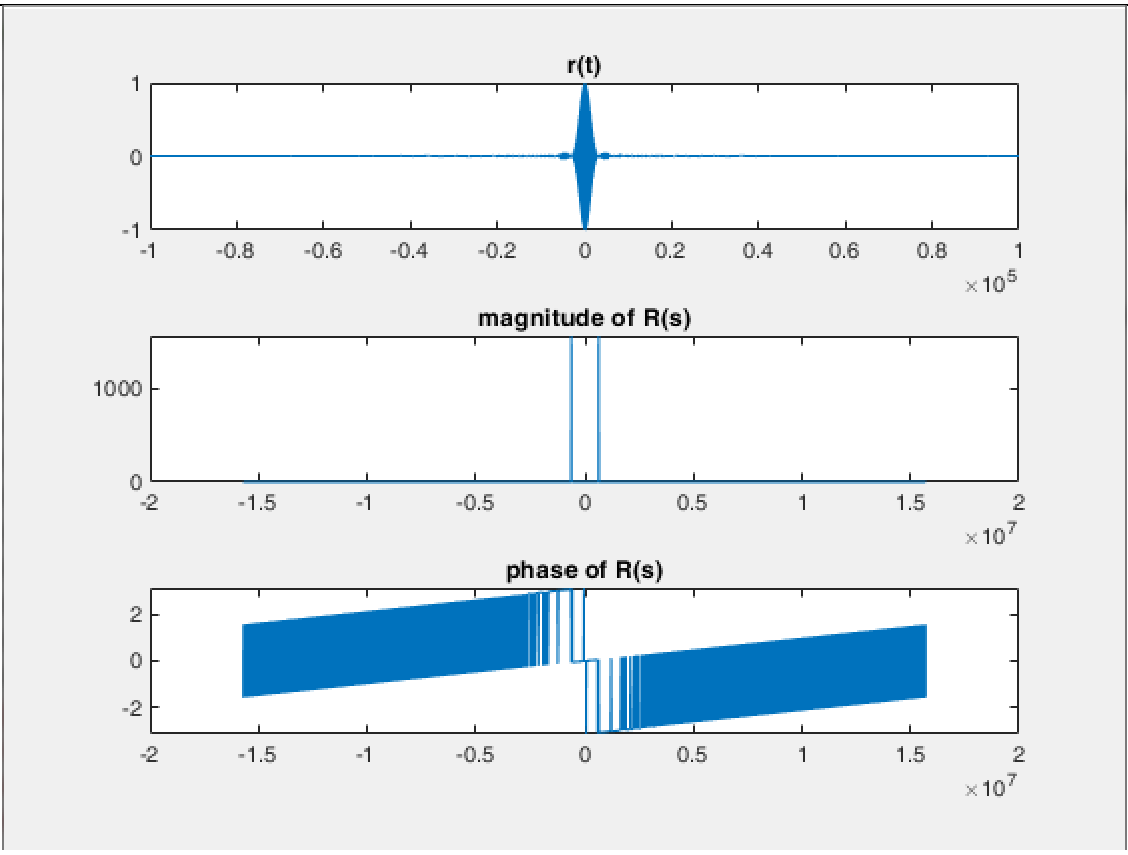


Fig. 03: Simulation of r(t), magnitude of R(s) and phase of R(s)
Part One Question Two B

Question Three

Code:

```
syms o n s
o= exp(-n);
D = (1/pi).* int(o.* exp(-2.*s.*n.*1i),n ,0 , pi);
s= -10:10;
DV= double(subs(D,s));
subplot(2, 1, 1);
stem(s,abs(DV));
title("Magnitude Spectrum");
subplot(2, 1, 2);
stem(s,angle(DV));
title("Phase Spectrum");
```

Simulation:

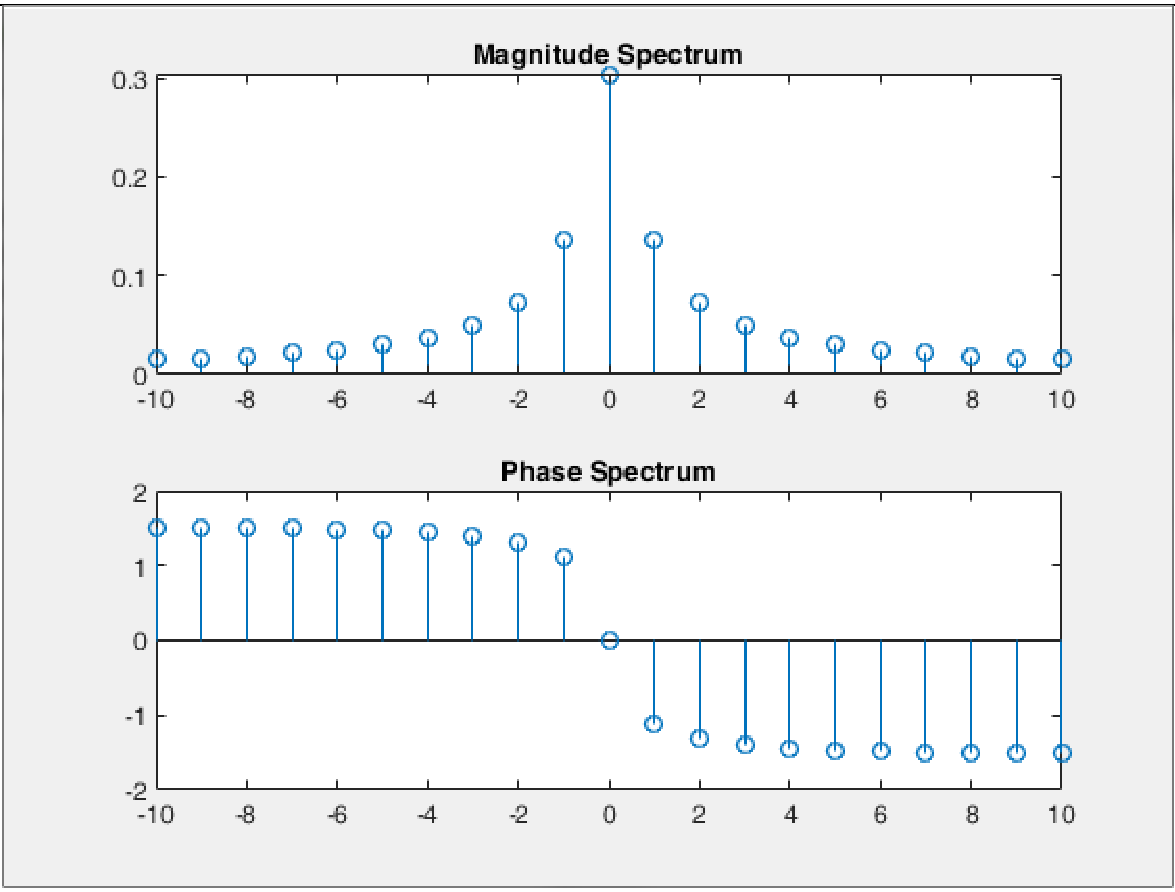


Fig. 04: Simulation of magnitude of X(s) and phase of X(s)
Part One Question Three

Part Two

Code:

```
fs = input("Enter sampling frequency: ");
fprintf("fs = %d\n", fs);
t1 = input("Enter start of time scale: ");
fprintf("t1 = %d\n", t1);
t2 = input("Enter end of time scale: ");
fprintf("t2 = %d\n", t2);
n = input("Enter number of break points: ");
t = linspace(t1, t2, (t2-t1)*fs);
z = zeros(1, n+1);
z(1) = t1;
for i=1:1:n
    z(i+1) = input("Position of break point: ");
end
x = [];
z = [z t2];
for i=1:1:n+1
    fprintf("1. DC Signal\n2. Ramp Signal\n3. General Order
Polynomial\n4. Exponential Signal\n5. Sinusoidal Signal\n");
    j = input("Enter number corresponding to your choice: ");
    switch j
        case 1
            h = input("Amplitude: ");
            y = h.*ones(1, (z(i+1)-z(i))*fs);
            x =[x y];
        case 2
            s = input("Slope: ");
            c = input("Intercept: ");
            ty = linspace(z(i), z(i+1), (z(i+1)-z(i))*fs);
            y = s*ty + c;
            x = [x y];
        case 3
            a = input("Amplitude: ");
            p = input("Power: ");
            c = input("Intercept: ");
            ty = linspace(z(i), z(i+1), (z(i+1)-z(i))*fs);
            y = a*(ty.^p) + c;
            x = [x y];
        case 4
            a = input("Amplitude: ");
            e = input("Exponent: ");
            ty = linspace(z(i), z(i+1), (z(i+1)-z(i))*fs);
            y = a*(exp(e*ty));
            x = [x y];
        case 5
            a = input("Amplitude: ");
            f = input("Frequency: ");
            p = input("Phase: ");
            ty = linspace(z(i), z(i+1), (z(i+1)-z(i))*fs);
            y = a*sin(f*pi*ty + p*pi/180);
            x = [x y];
    end
end
subplot(2, 1, 1);
plot(t, x);
title("Main Signal");
```

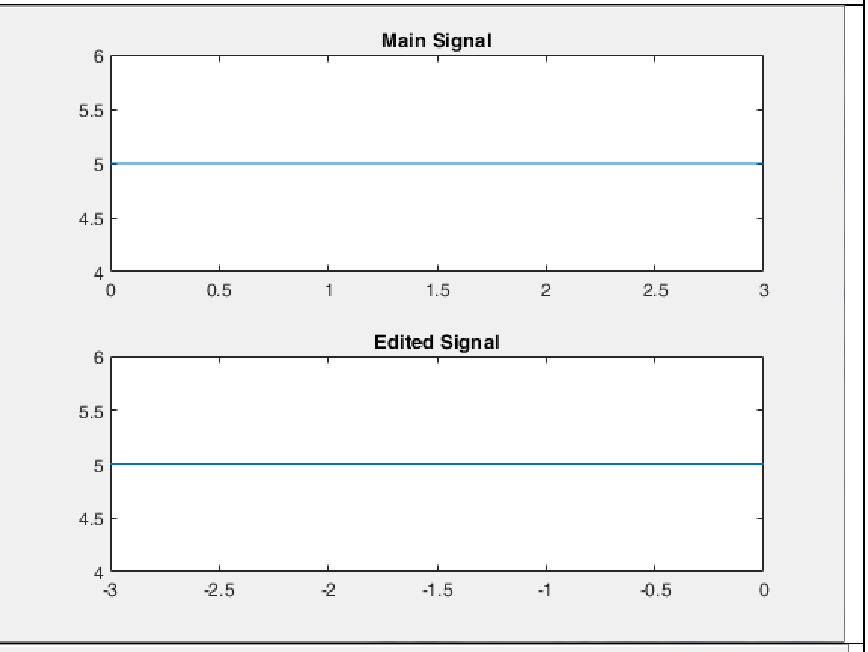
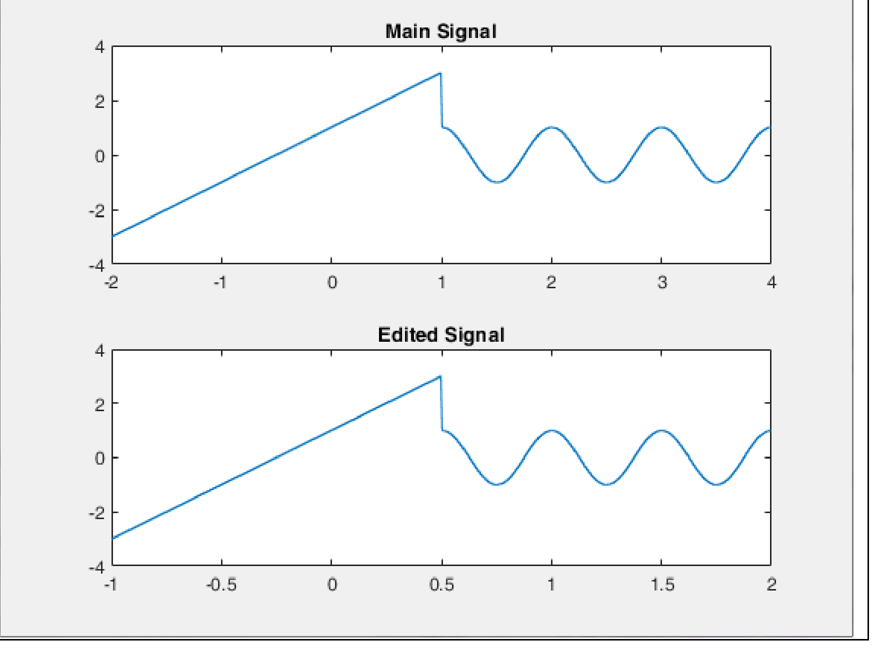
```
fprintf("1. Amplitude Scaling\n2. Time Reversal\n3. Time Shift\n4.
Expanding The Signal\n5. Compressing The Signal\n6. None\n");
j = input("Enter number corresponding to your choice: ");
switch j
   case 1
      a = input("Scale value: ");
      x = a*x;
   case 2
      t = linspace(-t1, -t2, abs(t2-t1)*fs);
   case 3
      ts = input("Shift value: ");
      t = linspace(t1, t2, abs(t2-t1)*fs);
   case 4
      ex = input("Expanding value: ");
      t = linspace(ex.*t1, ex.*t2, (t2-t1)*fs);
   case 5
      co = input("Compressing value: ");
      t = linspace(t1/co, t2/co, (t2-t1)*fs);
   case 6
end
subplot(2, 1, 2);
plot(t, x);
title("Edited Signal");
```

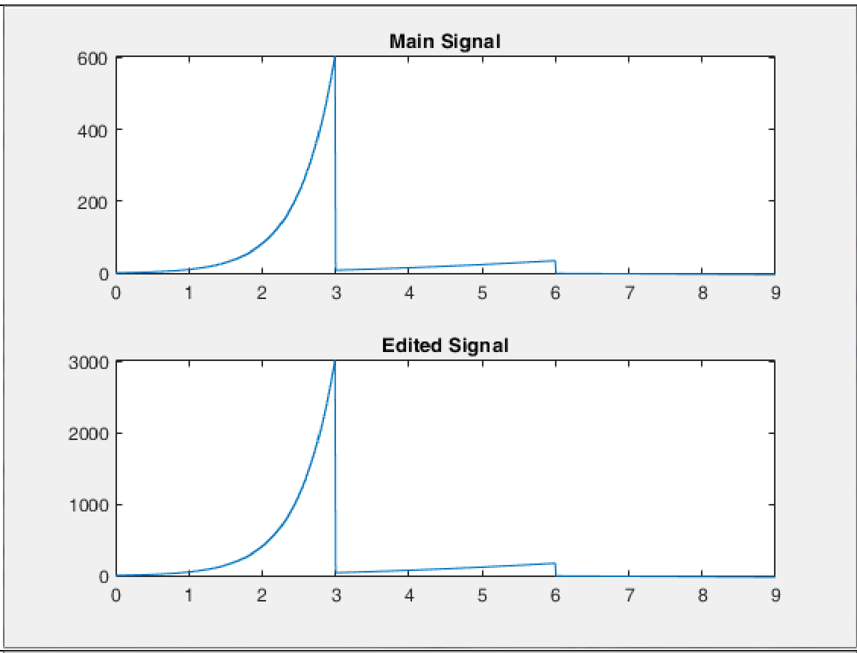
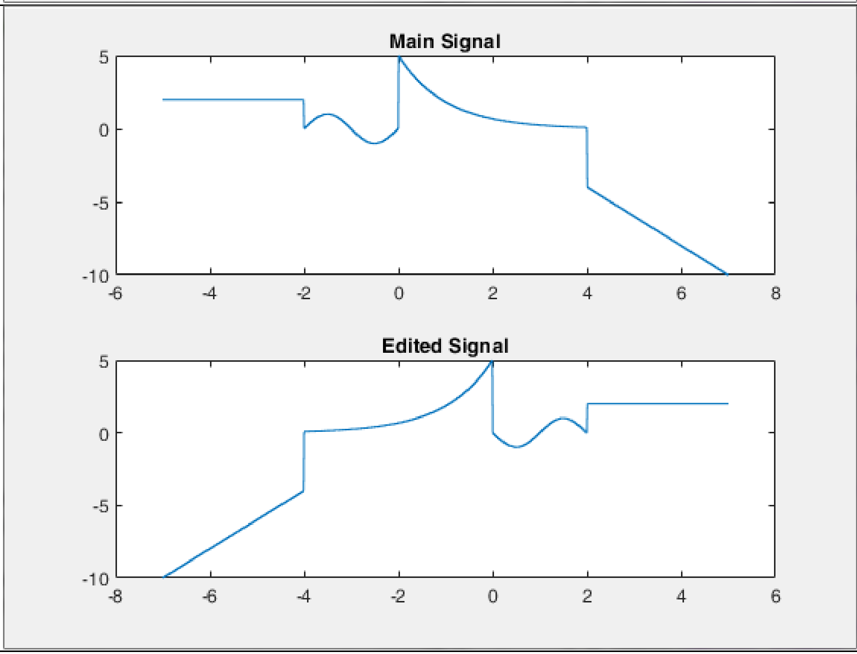
Simulations:

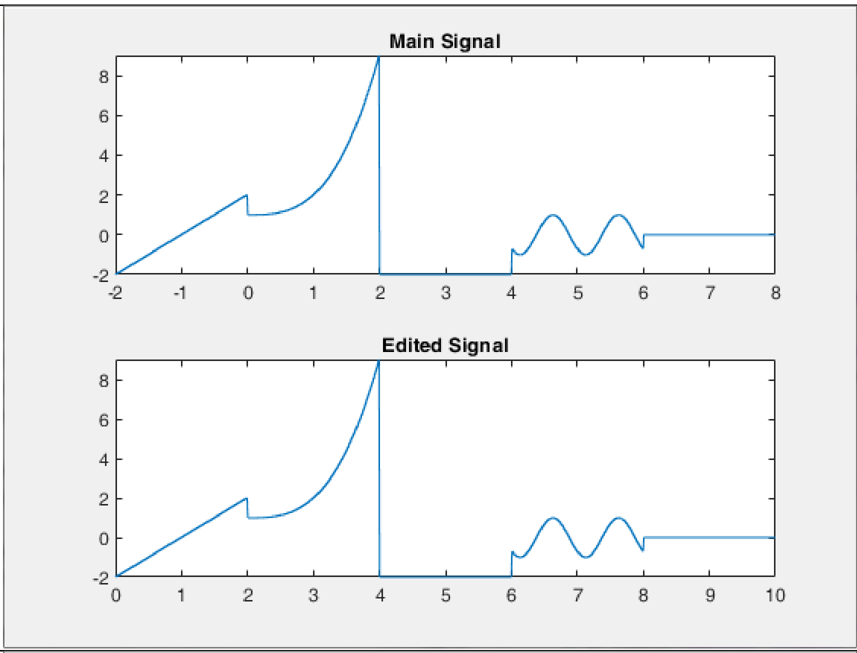
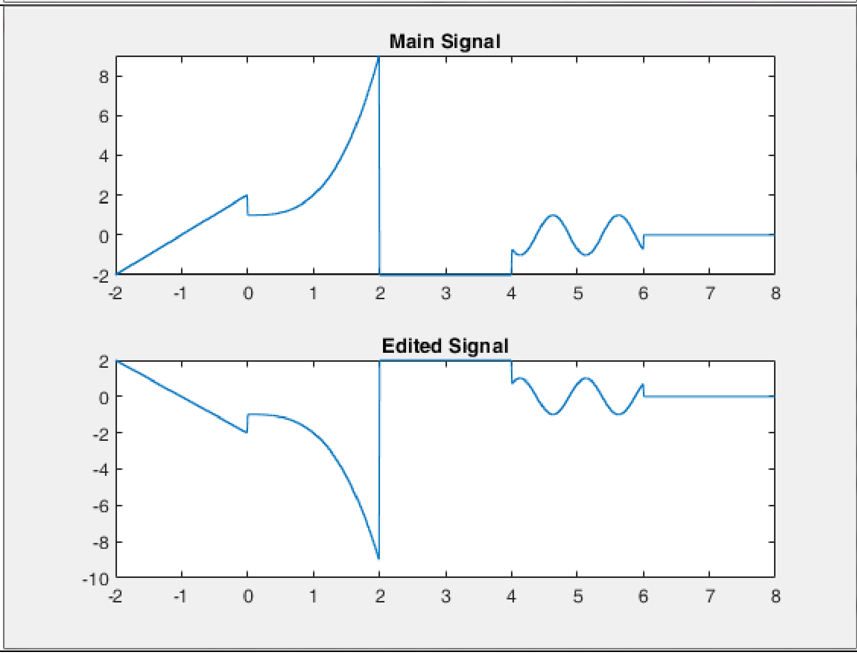
Ten signals (samples) are entered to the program with a sampling frequency of 100 for all of them and the following results where produced corresponding to each sample:

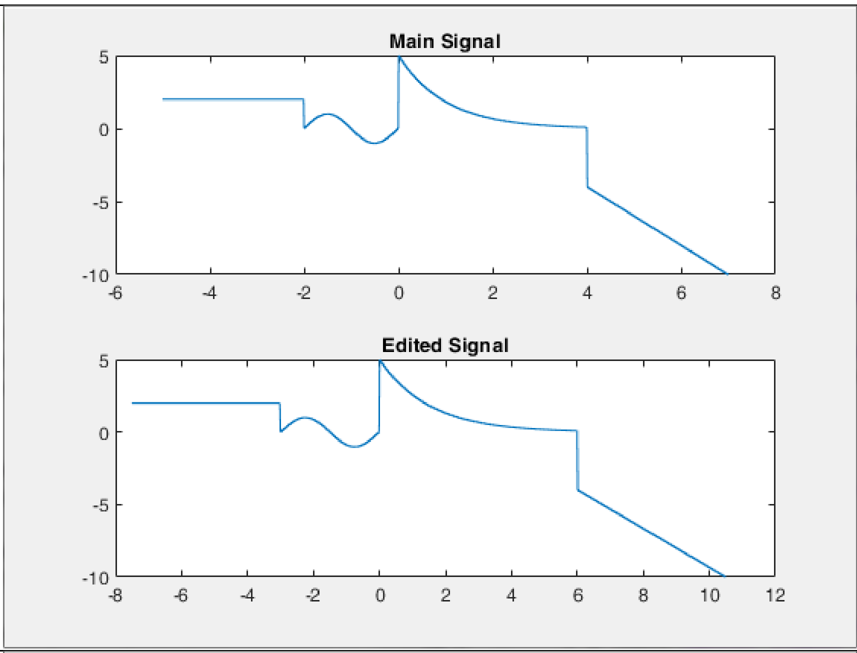
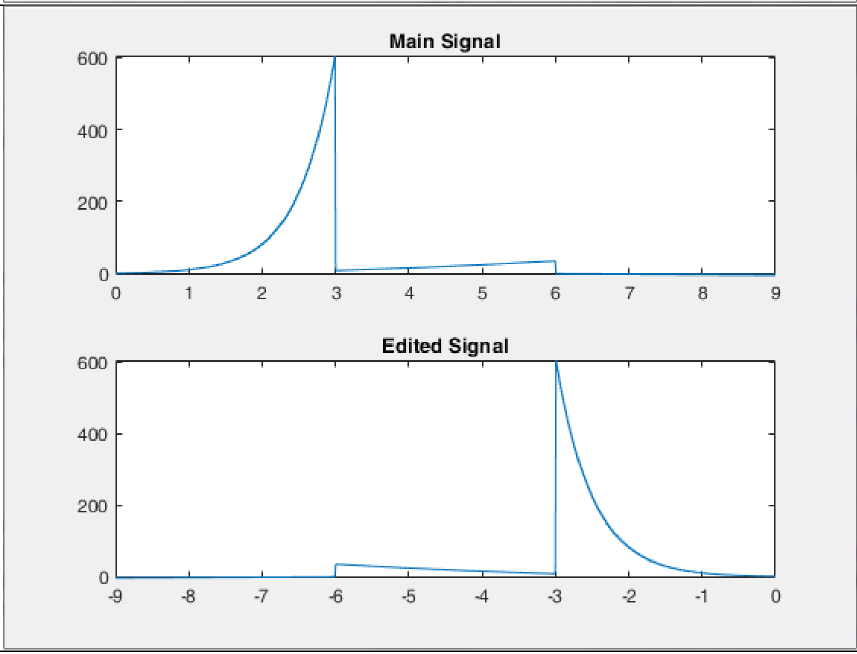
1. DC Signal with amplitude 5 from 0 to 3. Then time reversing.
2. Ramp Signal with amplitude 2 and intercept 1 from -2 to 1 and Sinusoidal Signal with amplitude 1, frequency 2 and phase 90 from 1 to 4. Then compressing by 2.
3. Exponential Signal with amplitude 1.5 and exponent 2 from 0 to 3, 2nd Order Polynomial Signal with amplitude 1 and intercept 0 from 3 to 6 and Ramp Signal with amplitude -1 and intercept 6 from 6 to 9. Then amplitude scaling by 5.
4. DC Signal with amplitude 2 from -5 to -2, Sinusoidal Signal with amplitude 1, frequency 1 and phase 0 from -2 to 0, Exponential Signal with amplitude 5 and exponent -1 from 0 to 4 and Ramp Signal with amplitude -2 and intercept 4 from 4 to 7. Then time reversing.
5. Ramp Signal with amplitude 2 and intercept 2 from -2 to 0, 3rd Order Polynomial Signal with amplitude 1 and intercept 1 from 0 to 2, DC Signal with amplitude -2 from 2 to 4, Sinusoidal Signal with amplitude -1, frequency 2 and phase 45 from 4 to 6, DC Signal with amplitude 0 from 6 to 8. Then shifting by 2.
6. Ramp Signal with amplitude 2 and intercept 2 from -2 to 0, 3rd Order Polynomial Signal with amplitude 1 and intercept 1 from 0 to 2, DC Signal with amplitude -2 from 2 to 4, Sinusoidal Signal with amplitude -1, frequency 2 and phase 45 from 4 to 6, DC Signal with amplitude 0 from 6 to 8. Then amplitude scaling by -1.
7. DC Signal with amplitude 2 from -5 to -2, Sinusoidal Signal with amplitude 1, frequency 1 and phase 0 from -2 to 0, Exponential Signal with amplitude 5 and exponent -1 from 0 to 4 and Ramp Signal with amplitude -2 and intercept 4 from 4 to 7. Then expanding by 1.5.

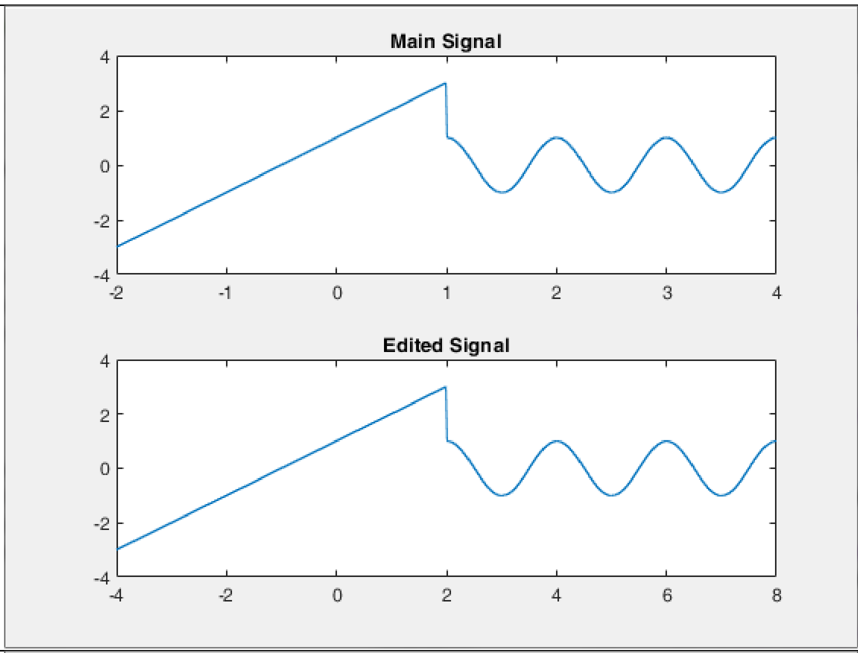
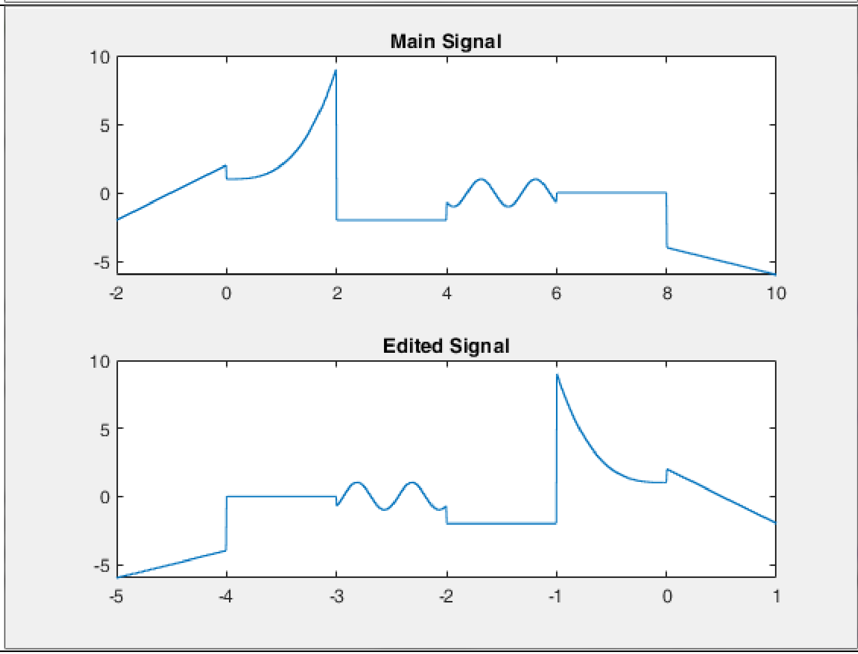
8. Exponential Signal with amplitude 1.5 and exponent 2 from 0 to 3, 2nd Order Polynomial Signal with amplitude 1 and intercept 0 from 3 to 6 and Ramp Signal with amplitude -1 and intercept 6 from 6 to 9. Then time reversing.
9. Ramp Signal with amplitude 2 and intercept 1 from -2 to 1 and Sinusoidal Signal with amplitude 1, frequency 2 and phase 90 from 1 to 4. Then expanding by 2.
10. Ramp Signal with amplitude 2 and intercept 2 from -2 to 0, 3rd Order Polynomial Signal with amplitude 1 and intercept 1 from 0 to 2, DC Signal with amplitude -2 from 2 to 4, Sinusoidal Signal with amplitude -1, frequency 2 and phase 45 from 4 to 6, DC Signal with amplitude 0 from 6 to 8 and Ramp Signal with amplitude -1 and intercept 4 from 8 to 10. Then compressing by -2.

Number of Sample	Figure of Sample
1	
2	

3	Main Signal 600 400 200 0 0 1 2 3 4 5 6 7 8 9 Edited Signal 3000 2000 1000 0 0 1 2 3 4 5 6 7 8 9
4	Main Signal 5 0 -5 -10 -6 -4 -2 0 2 4 6 8 Edited Signal 5 0 -5 -10 -8 -6 -4 -2 0 2 4 6

5	Main Signal 8 6 4 2 0 -2 -2 -1 0 1 2 3 4 5 6 7 8 Edited Signal 8 6 4 2 0 -2 0 1 2 3 4 5 6 7 8 9 10
6	Main Signal 8 6 4 2 0 -2 -2 -1 0 1 2 3 4 5 6 7 8 Edited Signal 2 0 -2 -4 -6 -8 -10 -2 -1 0 1 2 3 4 5 6 7 8

7	
8	

9	 Main Signal 4 2 0 -2 -4 -2 -1 0 1 2 3 4 Edited Signal 4 2 0 -2 -4 -4 -2 0 2 4 6 8
10	 Main Signal 10 5 0 -5 -2 0 2 4 6 8 10 Edited Signal 10 5 0 -5 -5 -4 -3 -2 -1 0 1