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Section-2

Lab-06

Analytical Part

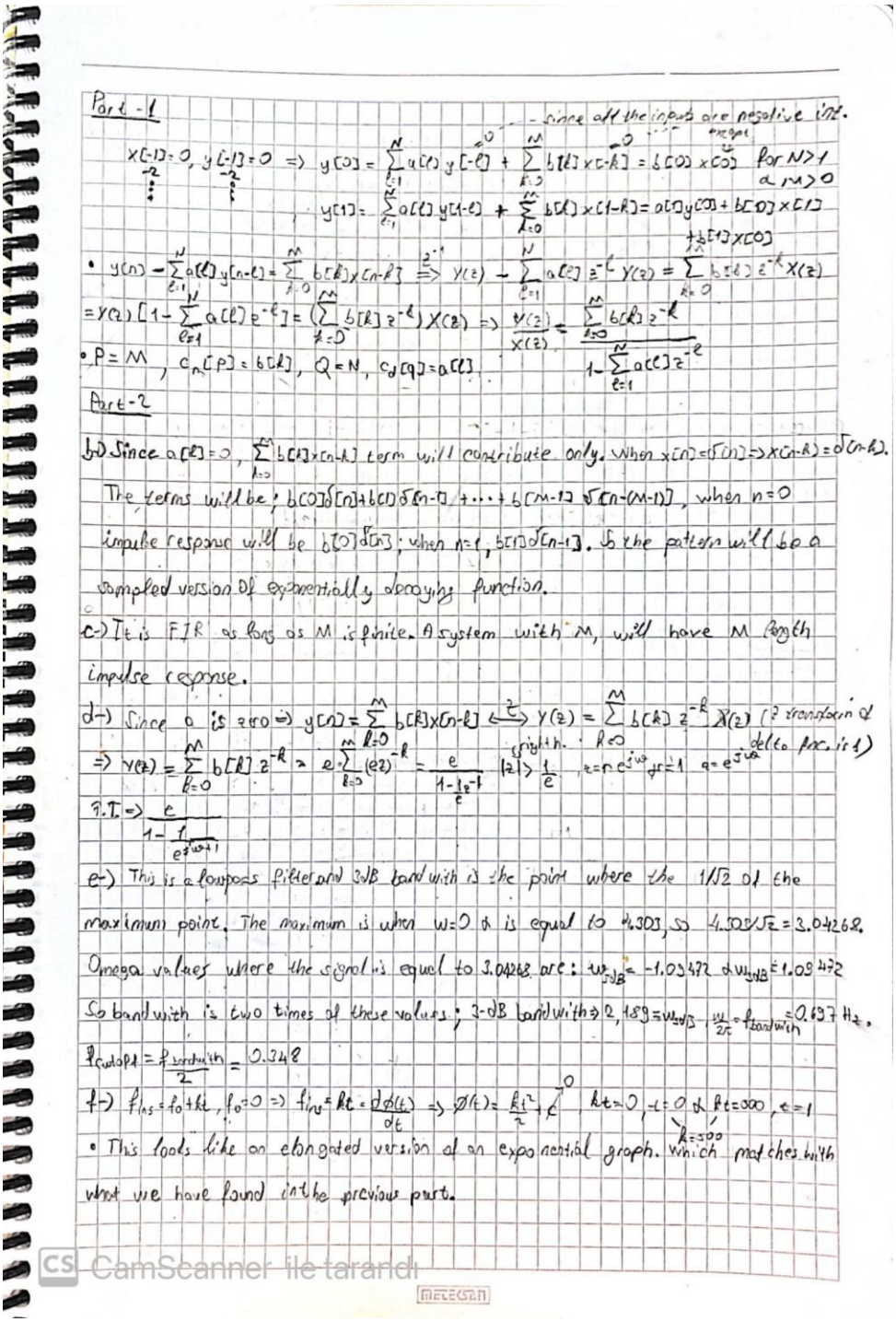


Figure 1- Analytical Part 1

Part-4

21902516 => $n_1=9$, $n_4=2$, $n_5=9$, $n_6=1$, $n_8=2$

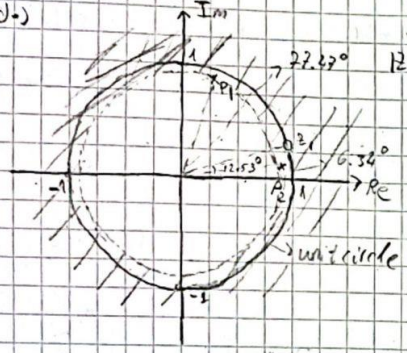
a-) $z_1=\frac{9+j2}{\sqrt{85}}$, $p_1=\frac{2+j9}{\sqrt{85}}$, $p_2=\frac{9+j1}{\sqrt{82}}$ => $H(z)=\frac{\left(z-\frac{9+2j}{\sqrt{85}}\right)}{\left(z-\frac{2+9j}{\sqrt{85}}\right)\left(z-\frac{9+j}{\sqrt{82}}\right)}=\frac{(1-z_1z^{-1})}{(1-p_1z^{-1})(1-p_2z^{-1})}$

b-) $H(z)=\frac{Y(z)}{X(z)}=\frac{(1-z_1z^{-1})}{(1-(p_1+p_2)z^{-1}+p_1p_2z^{-2})}$ => $Y(z)(1-(p_1+p_2)z^{-1}+p_1p_2z^{-2})=X(z)(1-z_1z^{-1})$

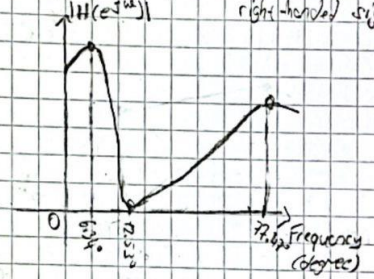
$\xrightarrow{z^{-1}}$ $y[n]-(p_1+p_2)y[n-1]+(p_1p_2)y[n-2]=x[n]-z_1x[n-1]$ => $y[n]=\sum_{l=1}^{N=2}a[l]\,y[n-l]+\sum_{k=0}^{M=1}b[k]\,x[n-k]$

where $a[1]=+(p_1+p_2)$, $a[2]=-(p_1p_2)$, $b[0]=1$, $b[1]=-z_1$

c-)



ROC: $|z|>p_1$



right-handed signal

e-) If the ROC includes the unit circle, the system is stable. Which it does in this case, so yes.

f-) When M is finite, it is FIR; when $M\to\infty$, it is IIR. Because $M=1$ (from part b) it is FIR

g-) $z=e^{j\omega}$ => $\frac{(1-z_1e^{-j\omega})}{(1-p_1e^{-j\omega})(1-p_2e^{-j\omega})}$

This filter will let signals pass at p_1 & p_2, hence why there are peak. And will suppress signals at z_1. This is why p_2 has smaller peak, is suppressed by z_1.

h-) $f_{ins}(t)=f_0+kt$, $f_0=-500$, $\frac{d\beta(t)}{dt}=f_{ins}$ => $t=0$, $f_{ins}=-500$ & $t=1$, $f_{ins}=500$ => $k=1000$

$\beta(t)=f_0t+\frac{kt^2}{2}$

- This graph also looks similar to previous part, as expected.

Figure 2- Analytical Part 2

Plots

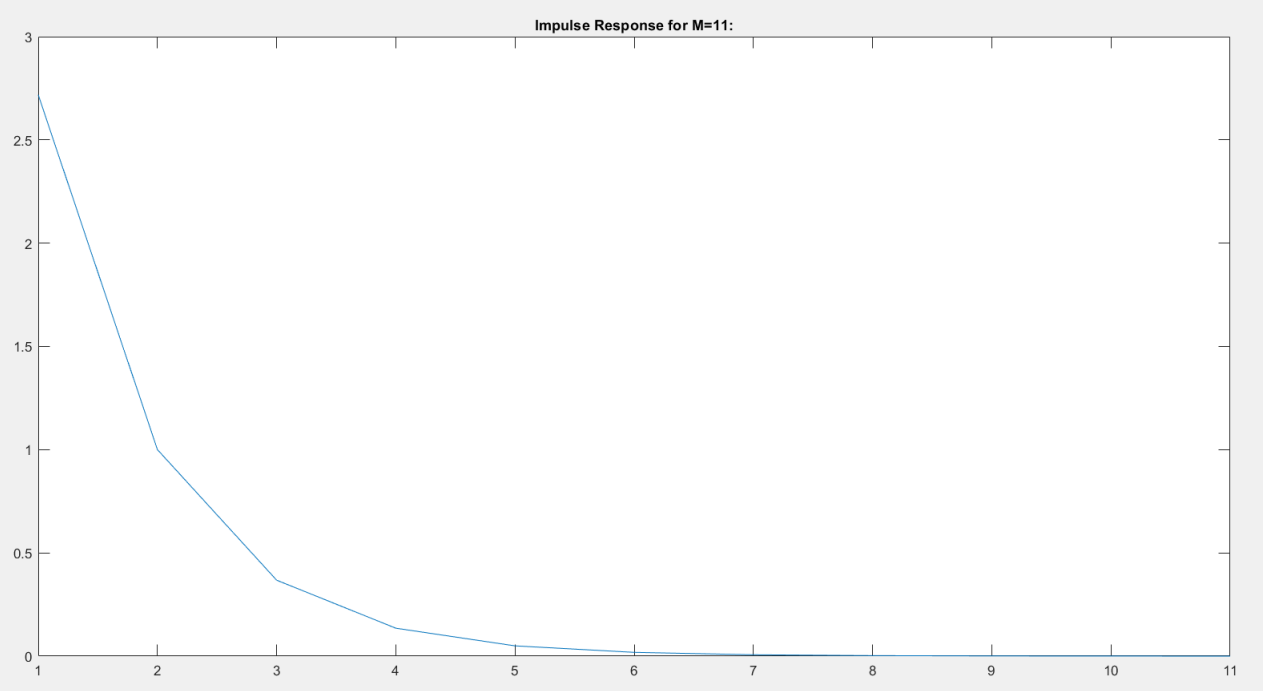


Figure 3- Impulse Response

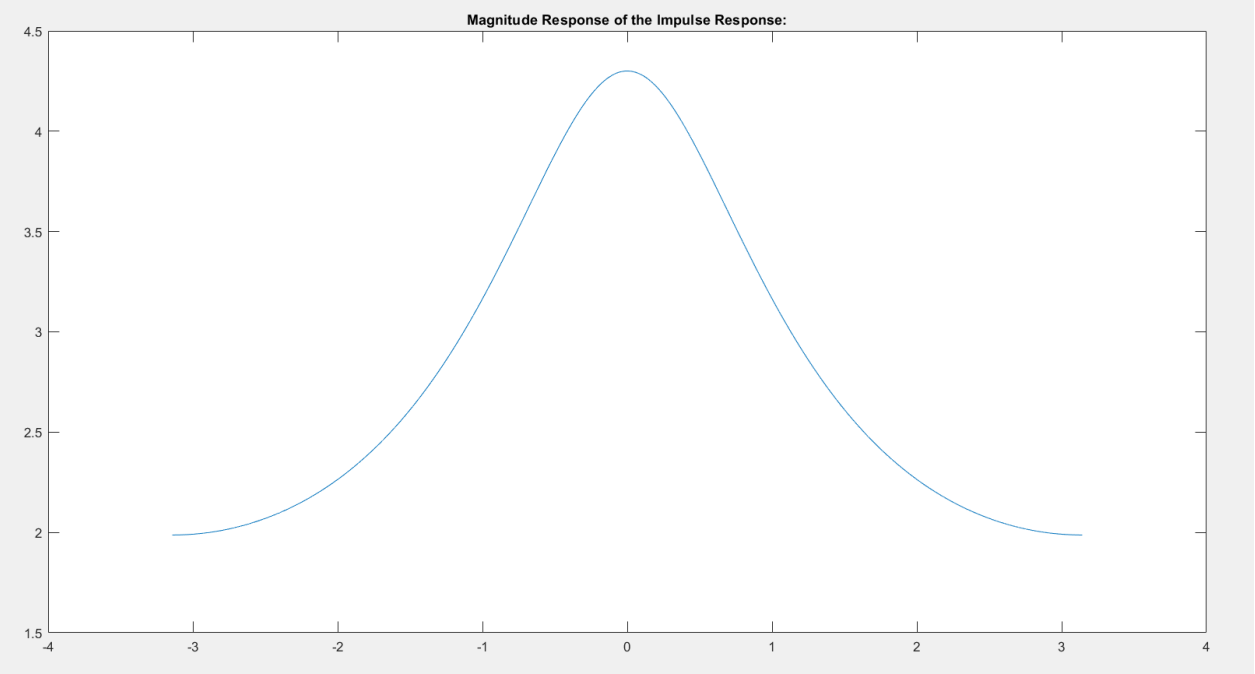


Figure 4- Magnitude Response of Impulse Response

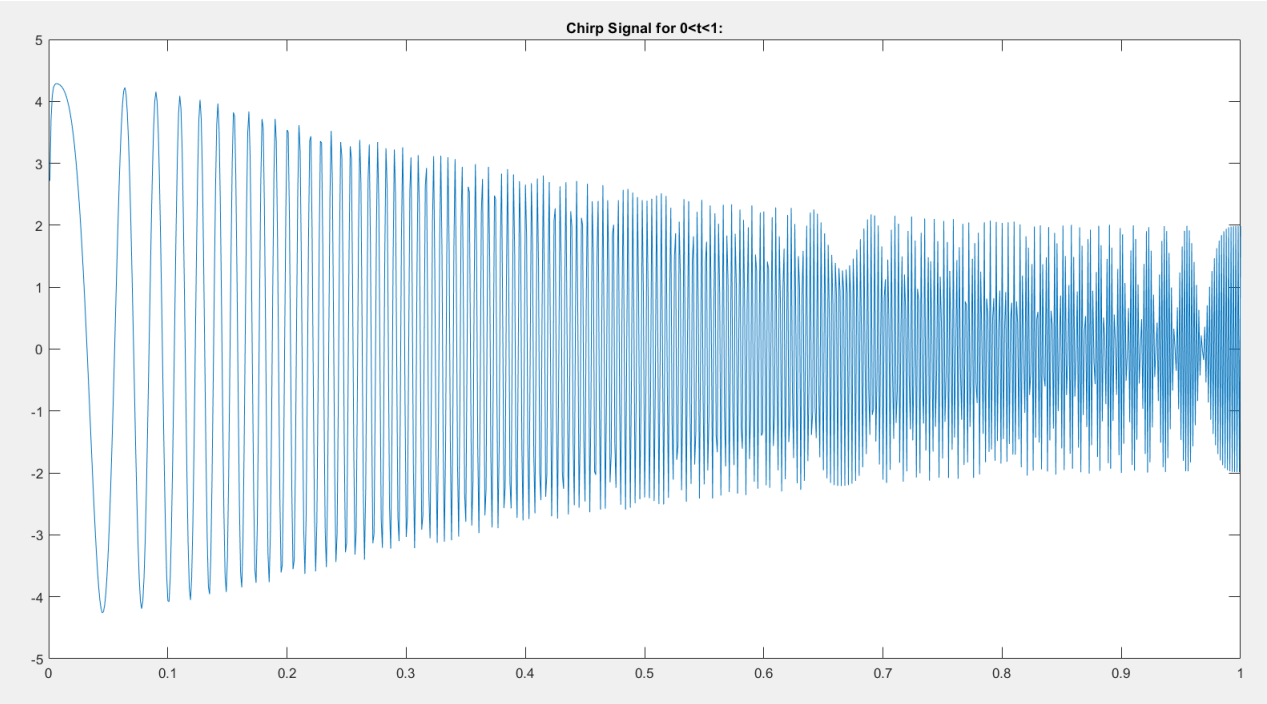


Figure 5- Chirp Signal 1

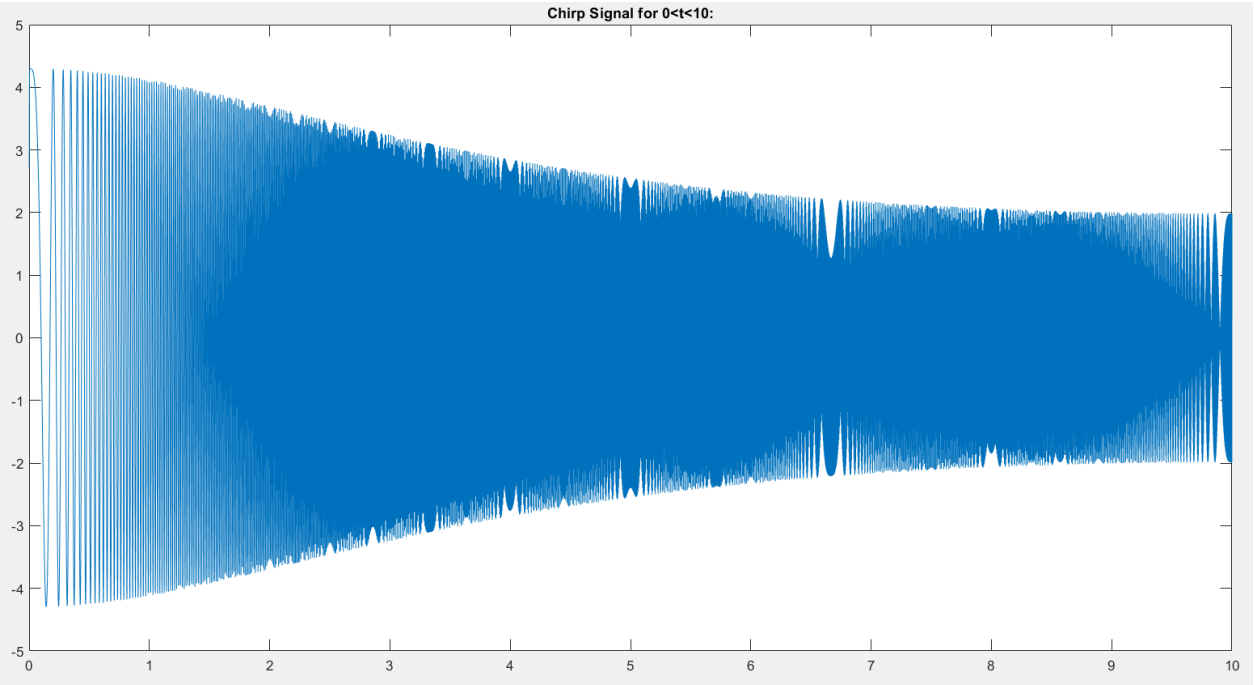


Figure 6- Chirp Signal 2

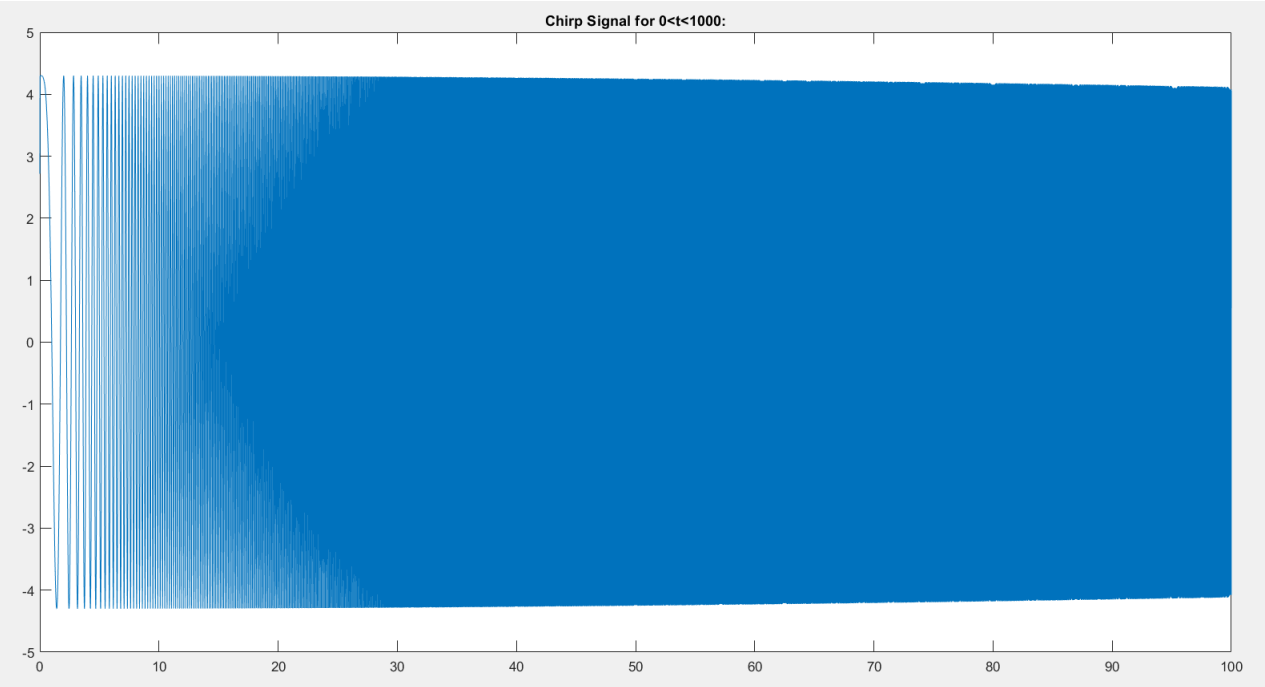


Figure 7- Chirp Signal 3

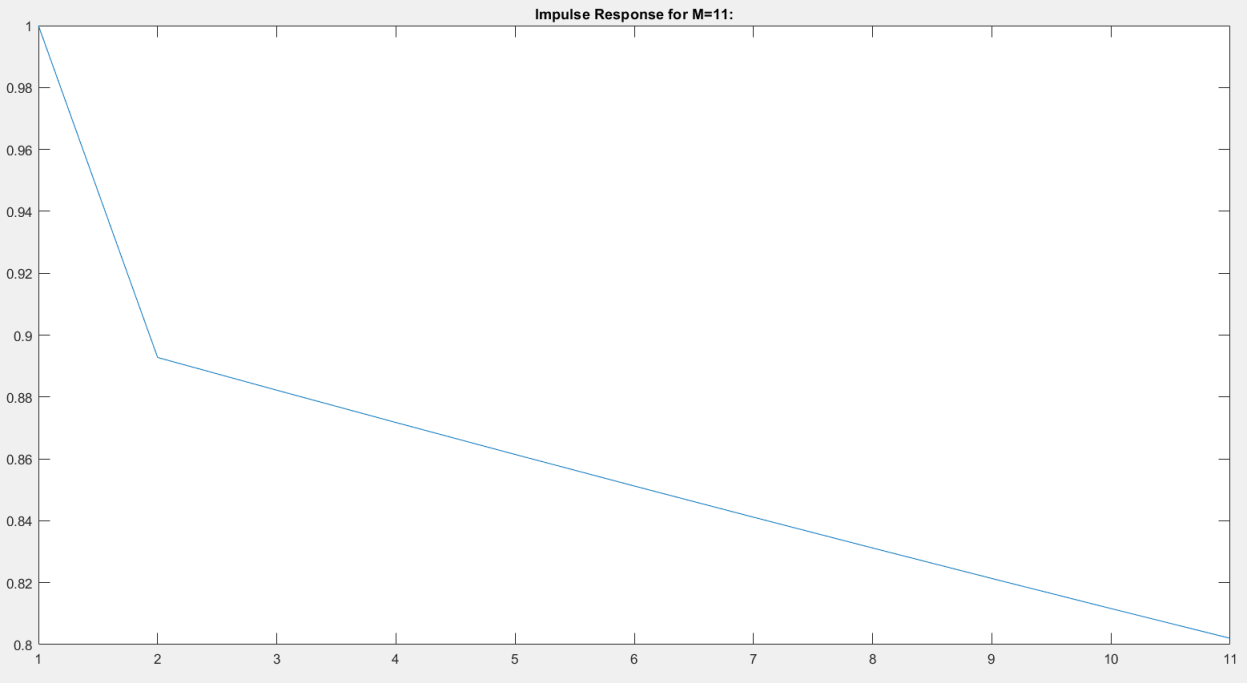


Figure 8- Impulse Response of Part 4

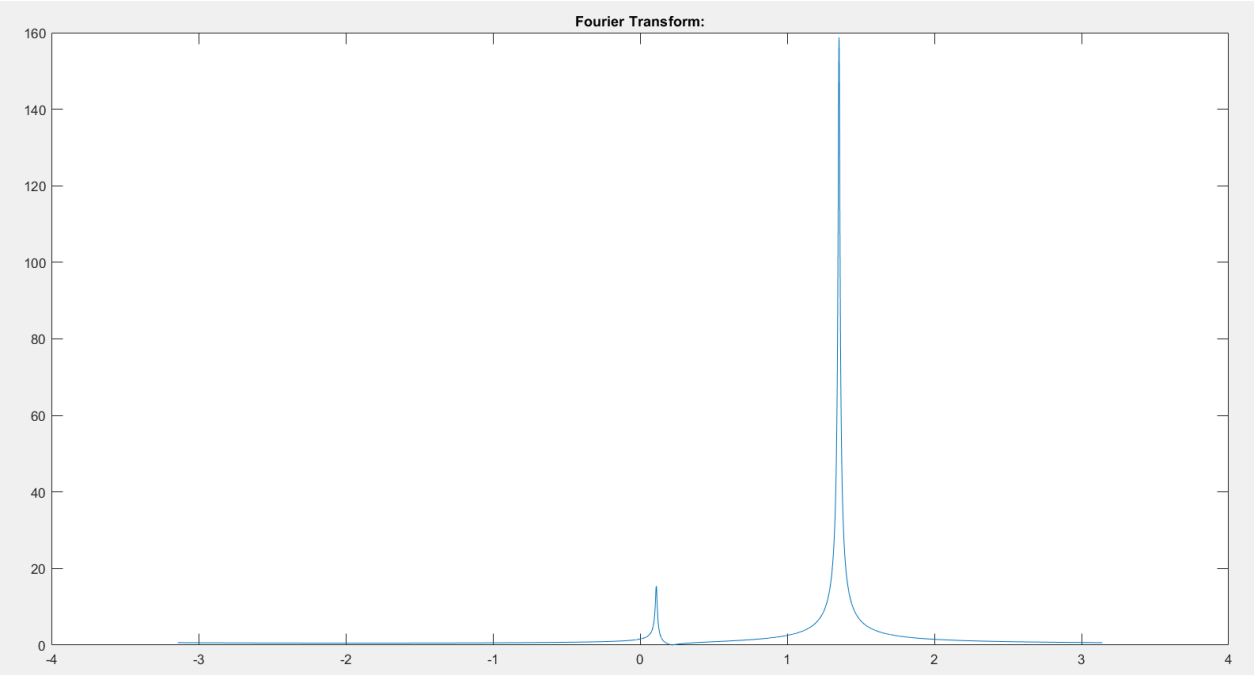


Figure 9- Fourier Transform Magnitude Plot

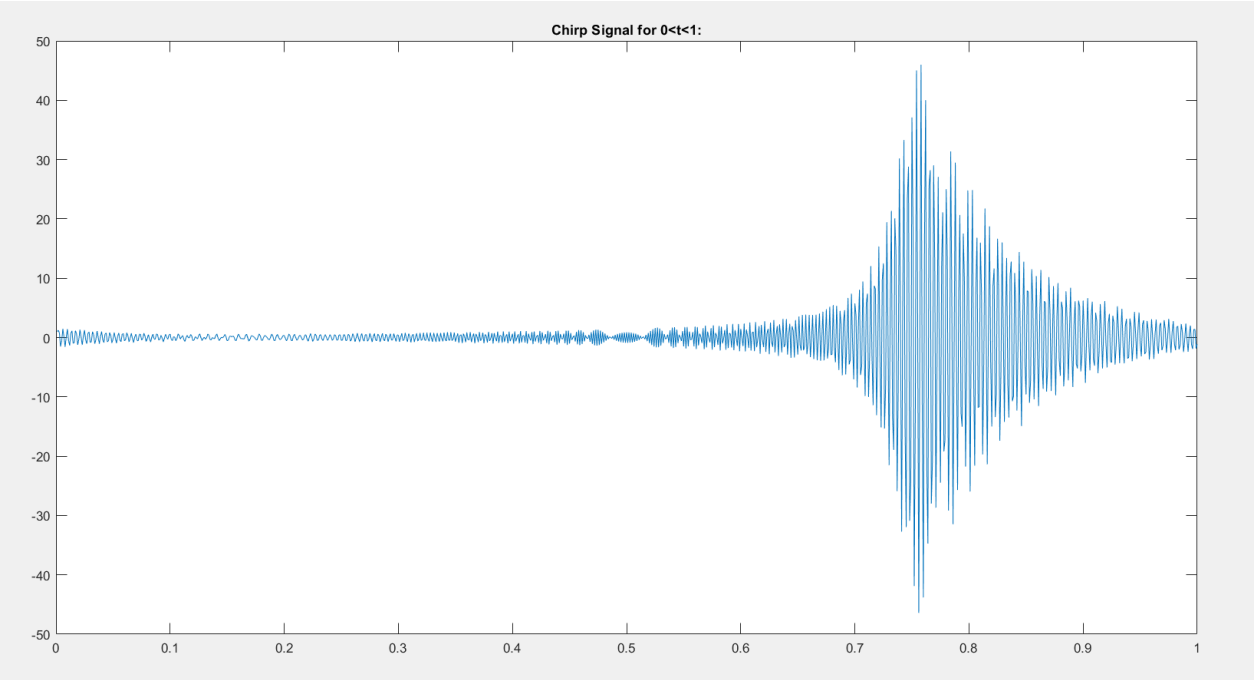


Figure 10- Chirp Signal 1

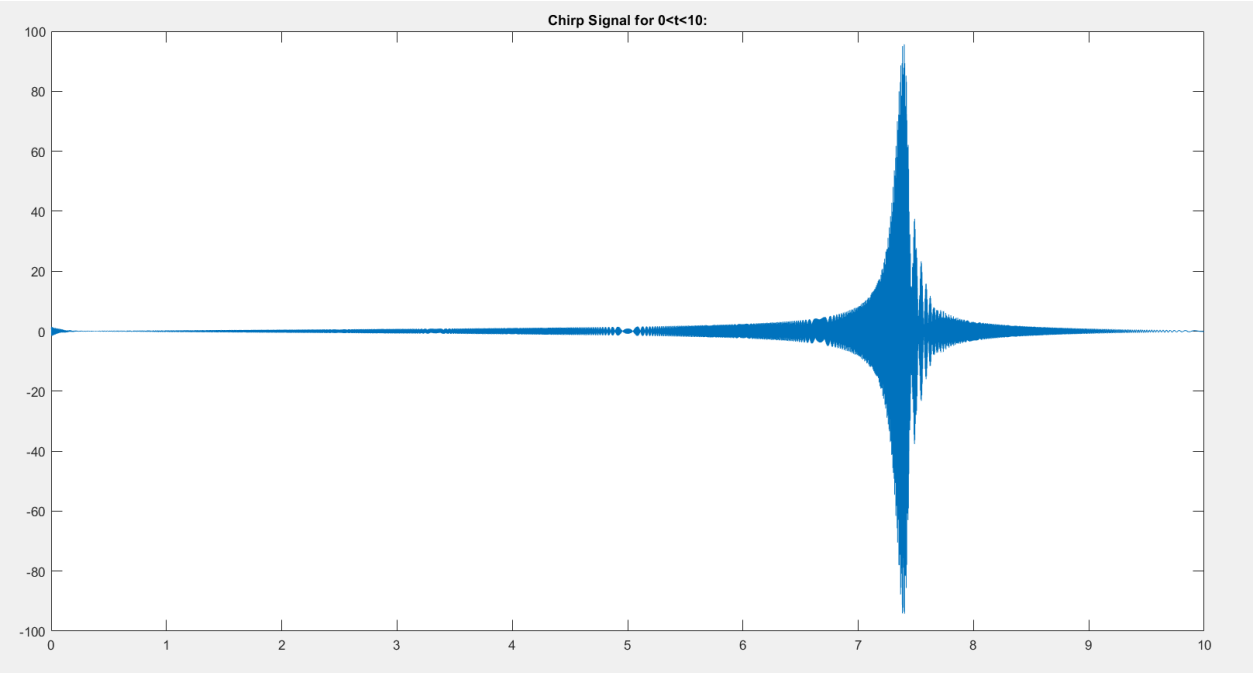


Figure 11- Chirp Signal 2

MATLAB Code

```
M=11;
a=zeros(1,11);
b=[];
for l=1:M
    newval=exp(-1*(l-1)+1);
    b(l)=newval;
end
x_init0=1:11;
y0=[];
y0=DTLTI(a,b,[1 0 0 0 0 0 0 0 0 0 0],11);

figure(1)
plot(x_init0,y0)
title('Impulse Response for M=11:')

figure(2)
omega=-1*pi:1/8192:pi;
mag_imp=exp(1)./(1-exp(-1i*omega-1));
plot(omega,abs(mag_imp))
title('Magnitude Response of the Impulse Response:')
```

```
figure(3)
x_t=0+0.001:1/1000:1;
k=500;
a=zeros(1,length(x_t));
M=length(x_t);
for l=1:M
    newval=exp(-1*(l-1)+1);
    b(l)=newval;
end
x_t0=cos(pi*k*(x_t).^2);
y_chirp=DTLTI(a,b,x_t0,length(x_t));
plot(x_t,y_chirp)
title('Chirp Signal for 0<t<1:')

figure(4)
x_t=0+0.001:1/1000:10;
k=50;
a=zeros(1,length(x_t));
M=length(x_t);
for l=1:M
    newval=exp(-1*(l-1)+1);
    b(l)=newval;
end
x_t0=cos(pi*k*(x_t).^2);
y1_chirp=DTLTI(a,b,x_t0,length(x_t));
plot(x_t,y1_chirp)
title('Chirp Signal for 0<t<10:')

figure(5)
x_t=0+0.001:1/1000:1000;
k=1/2;
a=zeros(1,length(x_t));
M=length(x_t);
for l=1:M
    newval=exp(-1*(l-1)+1);
    b(l)=newval;
end
x_t0=cos(pi*k*(x_t).^2);
y2_chirp=DTLTI(a,b,x_t0,length(x_t));
plot(x_t,y2_chirp)
title('Chirp Signal for 0<t<1000:')
```

```
figure(6)
x_init1=1:11;
a1=[((2+9i)/sqrt(86)+(9+1i)/sqrt(83)) -
((2+9i)/sqrt(86)*(9+1i)/sqrt(83)) 0 0 0 0 0 0 0 0 0];
b1=[1 -(9+2i)/sqrt(85) 0 0 0 0 0 0 0 0 0];
y1=DTLTI(a1,b1,[1 0 0 0 0 0 0 0 0 0 0],11);
plot(x_init1,abs(y1))
title('Impulse Response for M=11:')

figure(7)
mag_sec=(1-(9+2i)*exp(-1i*omega)/sqrt(85))./((1-(2+9i)*exp(-
1i*omega)/sqrt(86)).*(1-(9+1i)*exp(-1i*omega)/sqrt(83)));
plot(omega,abs(mag_sec))
title('Fourier Transform:')

figure(8)
x_t=0+0.001:1/1000:1;
k=1000;
a1=zeros(1,length(x_t));
a1(1)=((2+9i)/sqrt(86)+(9+1i)/sqrt(83));
a1(2)=-((2+9i)/sqrt(86)*(9+1i)/sqrt(83));
b1=zeros(1,length(x_t));
b1(1)=1;
b1(2)=-(9+2i)/sqrt(85);
x_t0=exp(1i*2*pi*k*(1/2*(x_t).^2+-500*x_t));
y3_chirp=DTLTI(a1,b1,x_t0,length(x_t));
plot(x_t,y3_chirp)
title('Chirp Signal for 0<t<1:')

figure(9)
x_t=0+0.001:1/1000:10;
k=100;
a1=zeros(1,length(x_t));
a1(1)=((2+9i)/sqrt(86)+(9+1i)/sqrt(83));
a1(2)=-((2+9i)/sqrt(86)*(9+1i)/sqrt(83));
b1=zeros(1,length(x_t));
b1(1)=1;
b1(2)=-(9+2i)/sqrt(85);
x_t0=exp(1i*2*pi*k*(1/2*(x_t).^2+-500*x_t));
y4_chirp=DTLTI(a1,b1,x_t0,length(x_t));
plot(x_t,y4_chirp)
title('Chirp Signal for 0<t<10:')

figure(10)
```

```
x_t=0+0.001:1/1000:1000;
k=1;
a1=zeros(1,length(x_t));
a1(1)=((2+9i)/sqrt(86)+(9+1i)/sqrt(83));
a1(2)=-((2+9i)/sqrt(86)*(9+1i)/sqrt(83));
b1=zeros(1,length(x_t));
b1(1)=1;
b1(2)=-(9+2i)/sqrt(85);
x_t0=exp(1i*2*pi*k*(1/2*(x_t).^2+-500*x_t));
y5_chirp=DTLTI(a1,b1,x_t0,length(x_t));
plot(x_t,y5_chirp)
title('Chirp Signal for 0<t<1000:')


function y=DTLTI(a,b,x,Ny)
    y=zeros(1,Ny);
    N=1:Ny;
    T0=(1==N);
    T=(2<=N & N<=Ny);
    y(T0)=b(T0).*x(T0);
    if Ny> 1
        for Ny=1:Ny
            n=Ny-1;
            x_holder=0;
            y_holder=0;
            for initializer=[1:Ny]
                initializer0=n-initializer+2;

x_holder=x_holder+b(initializer).*x(initializer0);
            end
            if n==1
                y_holder=a(1).*y(1);
            else
                for initializer=[1:Ny-1]
                    initializer0=n-initializer+2;

y_holder=y_holder+a(initializer).*y(initializer0);
                end
            end
            y(N==n+1)=x_holder+y_holder;
        end
    end
end
```