Faculty of Engineering & Technology

Electrical & Computer Engineering Department

DIGITAL SIGNAL PROCESSING (DSP) - ENCS 4310

Assignment1

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Section: 2

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Part A

Consider the following continuous time signal: x (t) = cos (2pi .2.t) + 0.5cos (2pi.50.t) + 0.25cos (2pi .80.t). Let Fs= 160 samples/sec.

a) Plot x[n] for 1 sec (i.e., 160 samples)

```
q1f.m
%Mohammad Abu Shams.
%1200549.
%Sec2.
F1=2;%First Frequency.
F2=50;%Second Frequency.
F3=80;%Third Frequency.
Fs=160;%160 Samples.
n=0:1/Fs:1;
x1=cos(2*pi*F1*n);
x2=cos(2*pi*F2*n);
x3=cos(2*pi*F3*n);
x=x1+(0.5*x2)+(0.25*x3);
%plot(n,x);%Continous (Additional).
stem(x);%Discrete.
xlabel('n');
ylabel('x[n]');
title('x[t]');
%DONE
```

Figure 1: Part a code

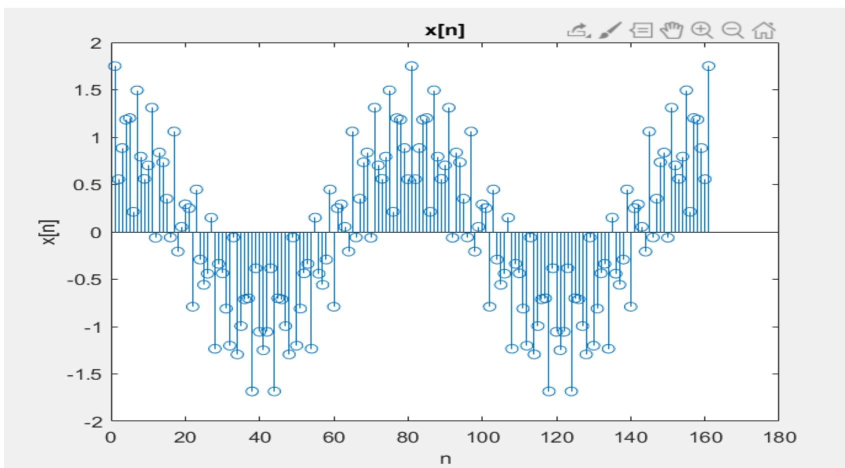

Figure 2: Part a plotting x[n] in discrete

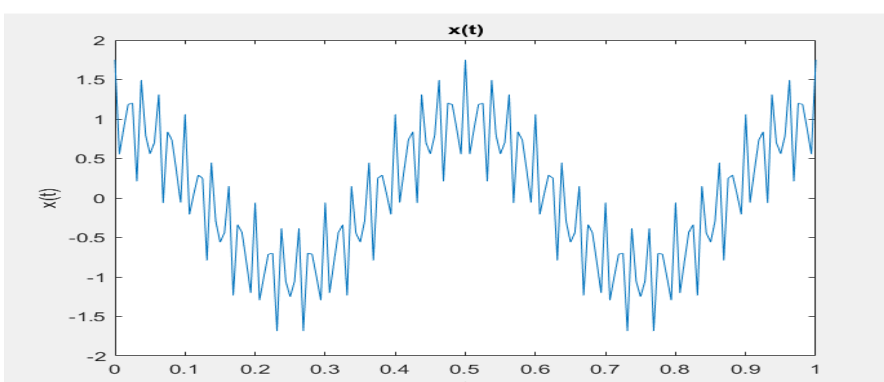

Figure 3: Additional plotting x (t)

Part B

Consider the moving average filter y[n] = (1/ (M+1)) * Σ[x [n-k]], for k = 0 to M (M: window size)

Plot the filter frequency response |H (e^jw)| for different values of M (M=0, M=4, M=10), give your conclusions.

QuestionB.m

```
%Mohammad Abu Shams
%1200549
%Sec2
Values_for_M=[1,4,10];
for i=1:length(Values_for_M)
    M=Values_for_M(i);
    b=(1/(M+1))*ones(1,M+1);% Coficient for X.
    a=1;% Coficient for Y.
    [H,w]=freqz(b,a,453);
    subplot(length(Values_for_M),1,i);
    plot((w/(pi)),abs(H));
    xlabel('Frequency');
    ylabel('|H(e^{j\omega})|');
    title(['The Filter Frequency Response for M=',num2str(M)]);
end
```

Figure 4: Part b code

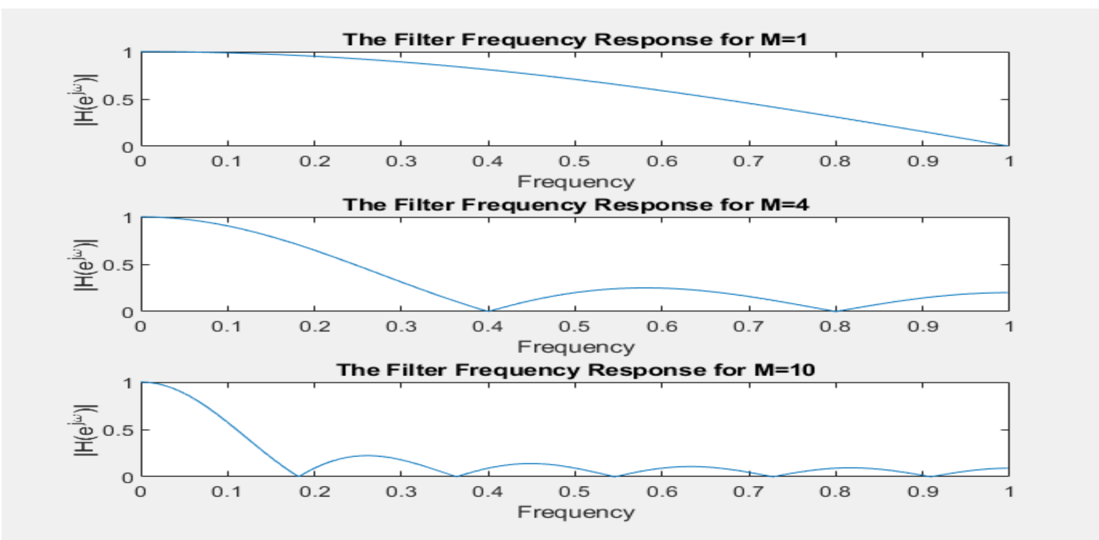

Figure 5: Part b plotting the filter frequency response

The frequency response will change based on the window size (M).

Part C

Plot the response (output sequence y[n]) for the different window size.

```
%Mohammad Abu Shams
%1200549
%Sec2
Values_for_M=[1,4,10];
for i=1:length(Values_for_M)
    M=Values_for_M(i);
    b=(1/(M+1))*ones(1,M+1);% Coeficient for X.
    a=1;% Coeficient for Y.
    y=filter(b,a,x);
    subplot(length(Values_for_M),1,i);
    stem(y);
    %plot(t,y);%Additional
    xlabel('n');
    ylabel('y[n]');
    title(['The response (output sequence y[n]) for M=',num2str(M)]);
end
```

Figure 6: Part C code

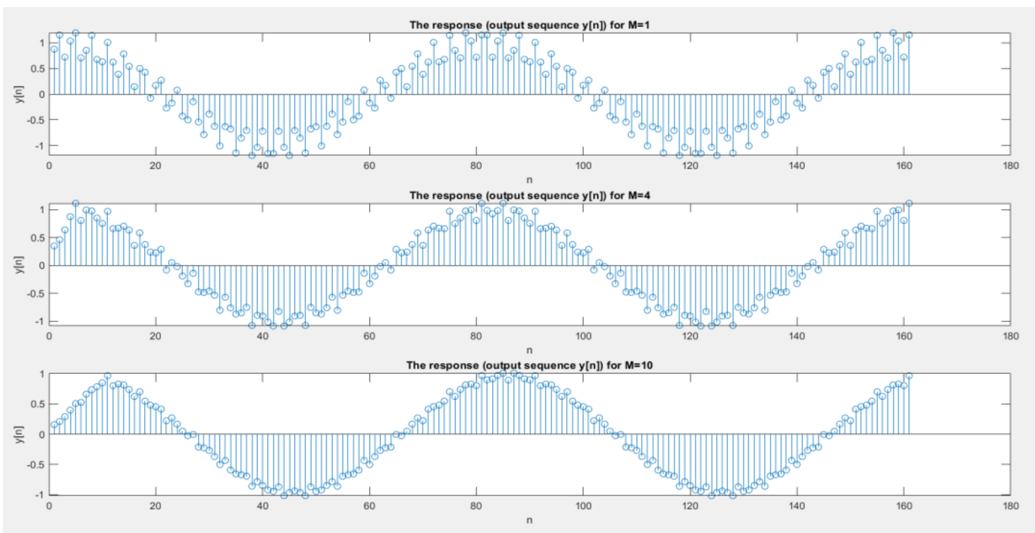

Figure 7: Part C Plotting Y[n]

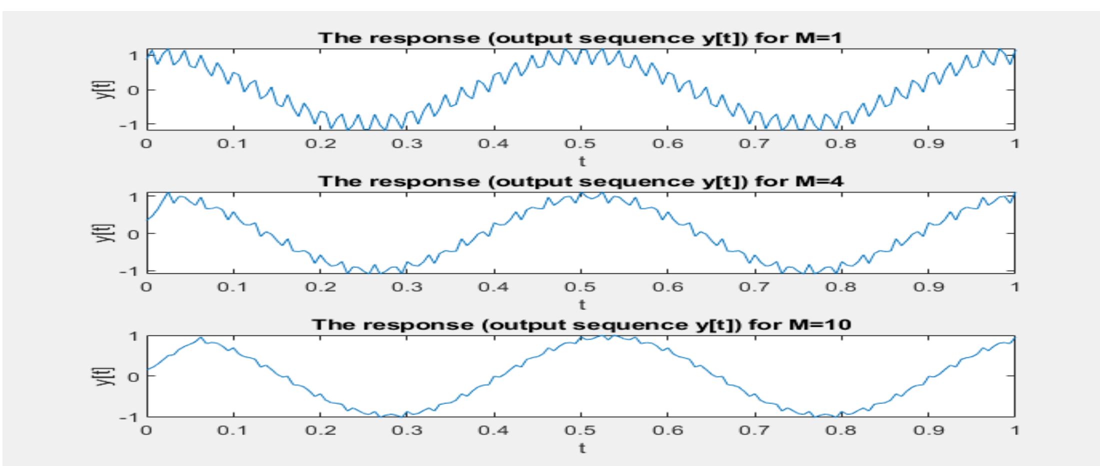

Figure 8: Part C plotting y (t) additional

Part D

Plot the input signal frequency spectrum |X (e^jw)| and the output frequency spectrum |Y (e^jw)|.

QuestionD.m

```
%Mohammad Abu Shams
%1200549
%Sec2
n=0:1/Fs:1;
N=length(n);
Values_for_M=[1,4,10];
figure;
X=fft(x);
plot(abs(X)/N);
xlabel('frequency');
ylabel('|X(e^{j\omega})|');
title('input frequency spectrum');
figure;
for i=1:length(Values_for_M)
    M=Values_for_M(i);
    b=(1/(M+1))*ones(1,M+1);% Coficient for X.
    a=1;% Coficient for Y.
    X=fft(x);
    y=filter(b,a,x);
    Y=fft(y);
    subplot(length(Values_for_M),1,i);
    plot(abs(Y)/N);
    xlabel('frequency');
    ylabel('|Y(e^{j\omega})|');
    title(['output frequency spectrum for M=',num2str(M)]);
end
```

Figure 9: Part D code

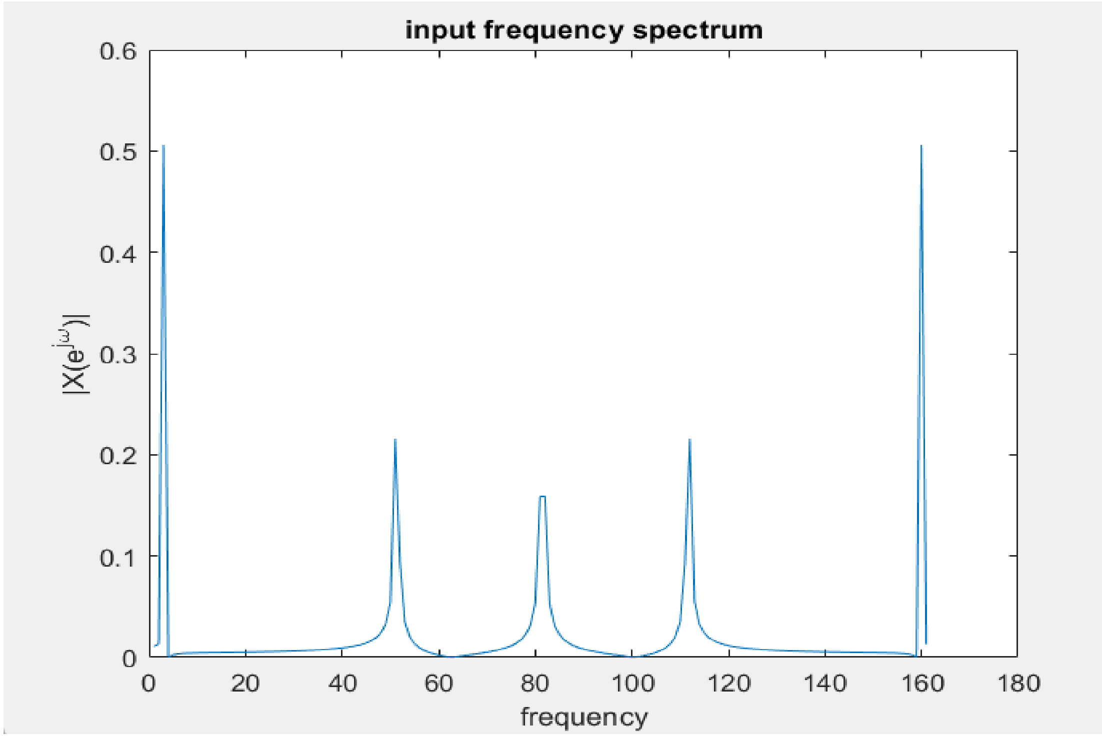

Figure 10: Part D Input Spectrum

It is the same input for M=1, 4, 10.

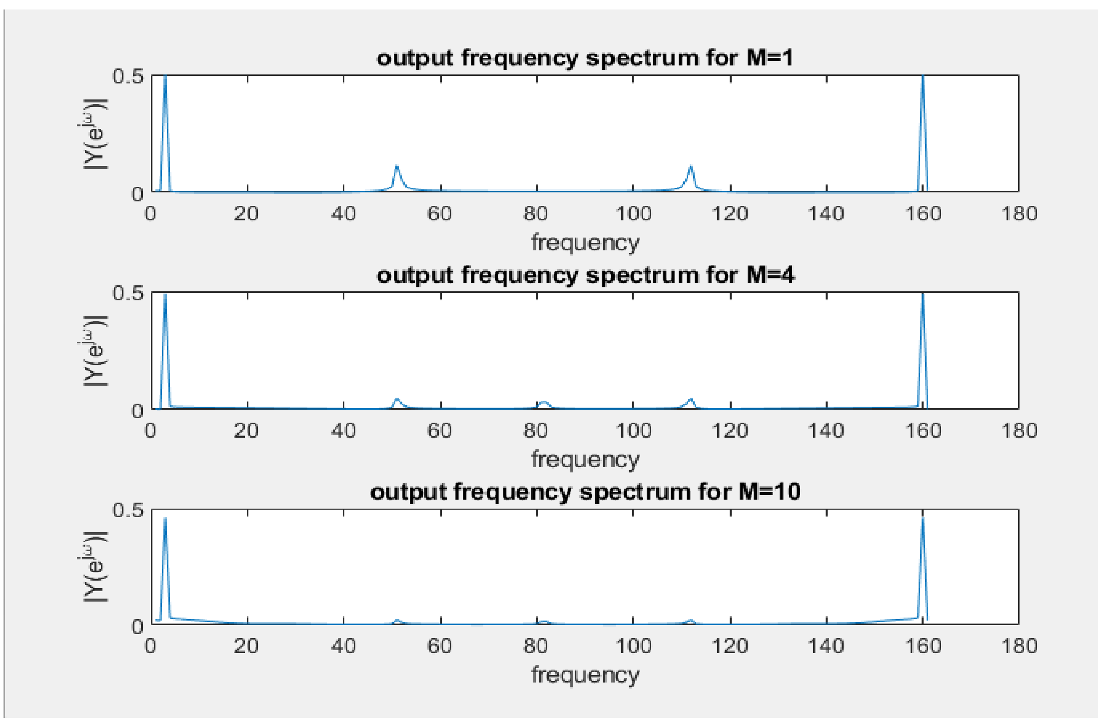

Figure 11: Part D Output Spectrum

Part E

e) Find the optimum window size (M) to obtain the first sinusoidal signal (cos (2pi.2.t))

I found that the best optimal window size (M) to obtain the first sinusoidal signal (cos (2pi.2.t)) is M=15, because it’s plotting has least bumps.

```
QuestionE.m
%Mohammad Abu Shams
%1200549
%Sec2
n=0:1/Fs:1;
N=length(n);
figure;
b=(1/(15+1))*ones(1,15+1);% Cooficient for X.
a=1;% Cooficient for Y.
y=filter(b,a,x);
Y=fft(y);
plot(abs(Y)/N);
xlabel('frequency');
ylabel('|Y(e^{j\omega})|');
title('output frequency spectrum for M=15');
figure;
X=fft(x);
plot(abs(X)/N);
xlabel('frequency');
ylabel('|X(e^{j\omega})|');
title('input frequency spectrum for M=15');
```

Figure 12: Part E code

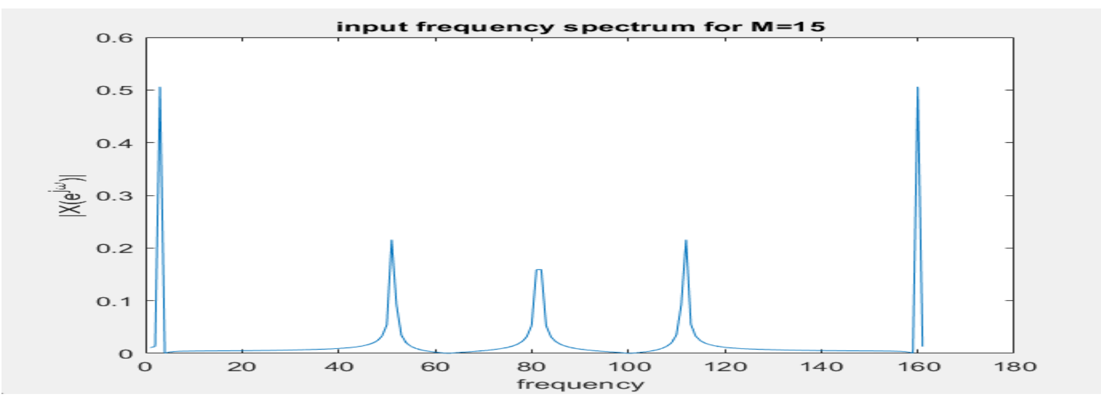

Figure 13: Part E plotting input spectrum with M=15

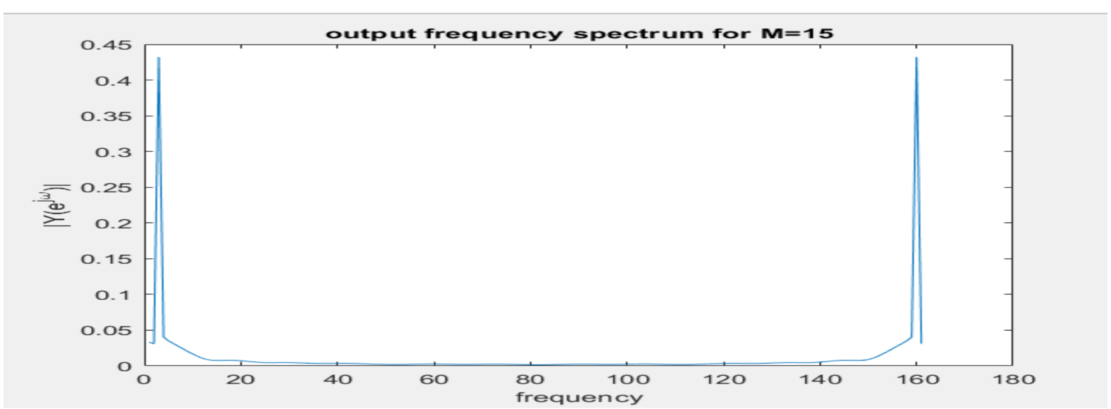

Figure 14: Part E plotting output spectrum with M=15

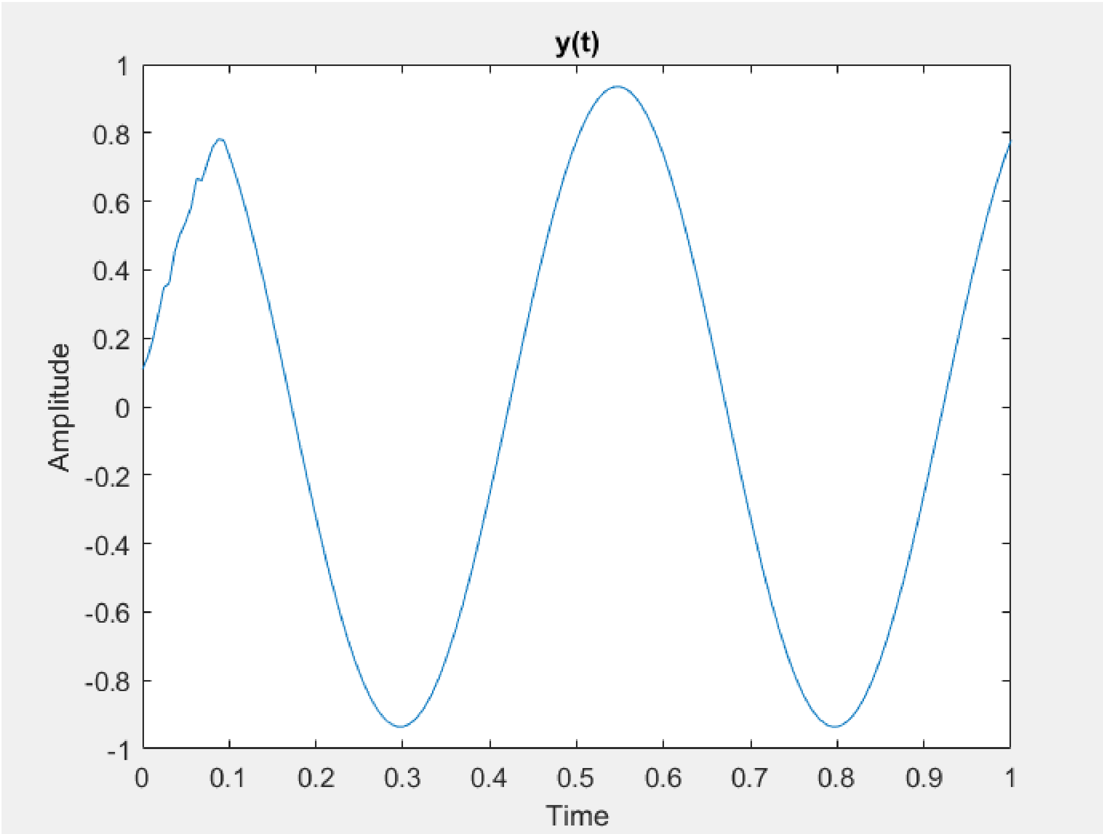

Figure 15: Part E Plotting y (t)

For M=15, this figure is the closest to the signal (cos (2pi.2.t)).