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QUESTION 1 COMMENTING

```
% DO NOT REMOVE THE LINE BELOW
% MAKE SURE 'eel3135_lab05_comment.m' IS IN SAME DIRECTORY AS THIS
 FILE
clear; close all;
type('eel3135_lab05_comment.m')
```

```


%% USER-DEFINED VARIABLES

w = -pi:(pi/100):pi;
% <-- Answer: Why is w from -pi to pi?
% Because it repeats every 2pi.

%% HIGHPASS FILTER

% FREQUENCY RESPONSE
H2 = (1-exp(-1j*w*1));
% <-- Answer: What is the difference equation for this frequency
 response?

% -------------------> y[n] = x[n] - x[n-1] <----------------------

% PLOT
figure;
subplot(2,1,1)
plot(w,abs(H2)); % ==> What does the abs() function do? <== Returns
 the absolute value of the passed in parameter
grid on;
```

```
title('Magnitude Response')
xlabel('Normalized Radian Frequency');
ylabel('Amplitude');
subplot(2,1,2)
plot(w,angle(H2)); % ==> What does the angle() function do? <==
 Returns the phase angle in the interval -pi to pi
grid on;
title('Phase Response')
xlabel('Normalized Radian Frequency');
ylabel('Phase');

% <-- Answer: If you input a DC value into a highpass filter, what
 will be
%             its amplitude?
% It should block the DC value, making the amplitude 0.
%
```

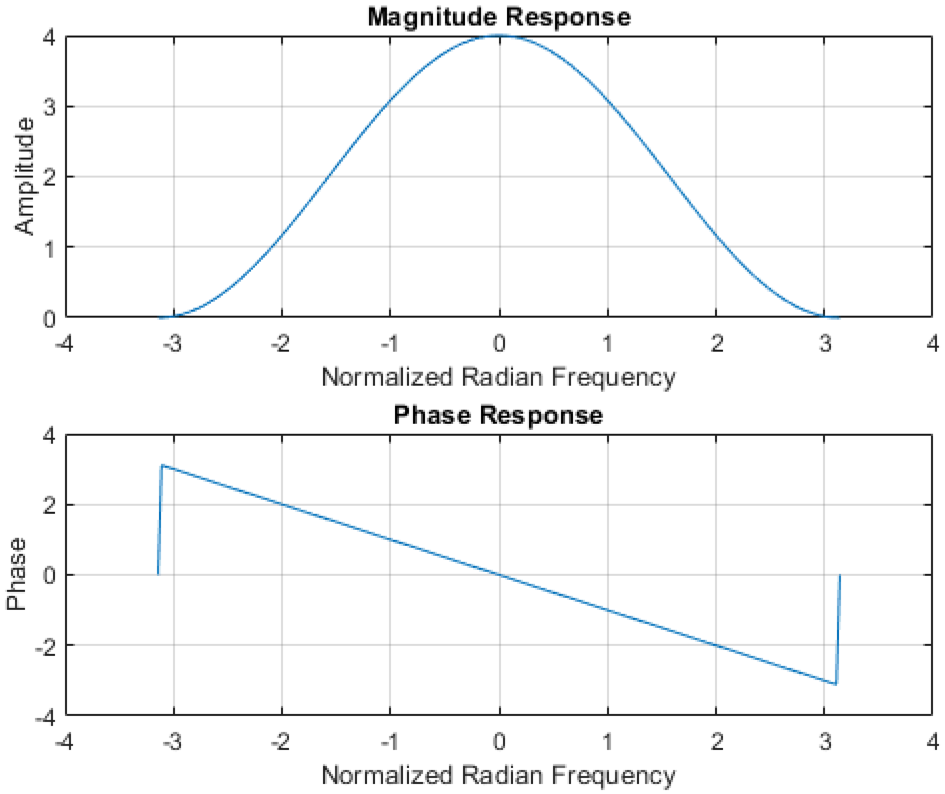
QUESTION 2 FREQUENCY FILTERING

2(a) FILL IN CODE

----------- Fill in FreqResponse function down below --------------

2(b) CALCULATE FREQUENCY RESPONSE

```
w = -pi:(pi/100):pi;
b = [1 2 1];
H = FreqResponse(b,w);
figure;
subplot(2,1,1)
plot(w,abs(H));
grid on;
title('Magnitude Response')
xlabel('Normalized Radian Frequency');
ylabel('Amplitude');
subplot(2,1,2)
plot(w,angle(H));
grid on;
title('Phase Response')
xlabel('Normalized Radian Frequency');
ylabel('Phase');
```



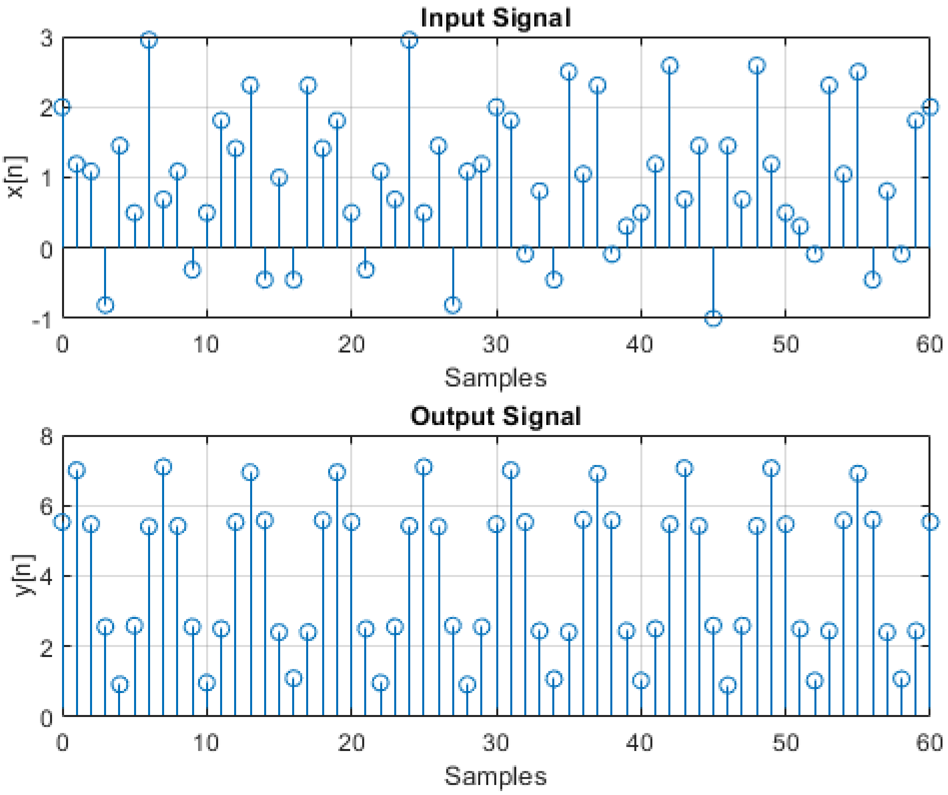
2(c) EVALUATE FREQUENCY RESPONSE FOR CERTAIN FREQUENCIES

```
disp("w = 0")
H1 = FreqResponse(b,0);
disp(H1);

disp("w = pi/3")
H2 = FreqResponse(b,pi/3);
disp(H2);

disp("w = 9pi/10")
H3 = FreqResponse(b,(9*pi)/10);
disp(H3);
```

```
w = 0
     4

w = pi/3
   1.5000 - 2.5981i

w = 9pi/10
  -0.0931 - 0.0302i
```

2(d) COMPUTE AND PLOT OUTPUT

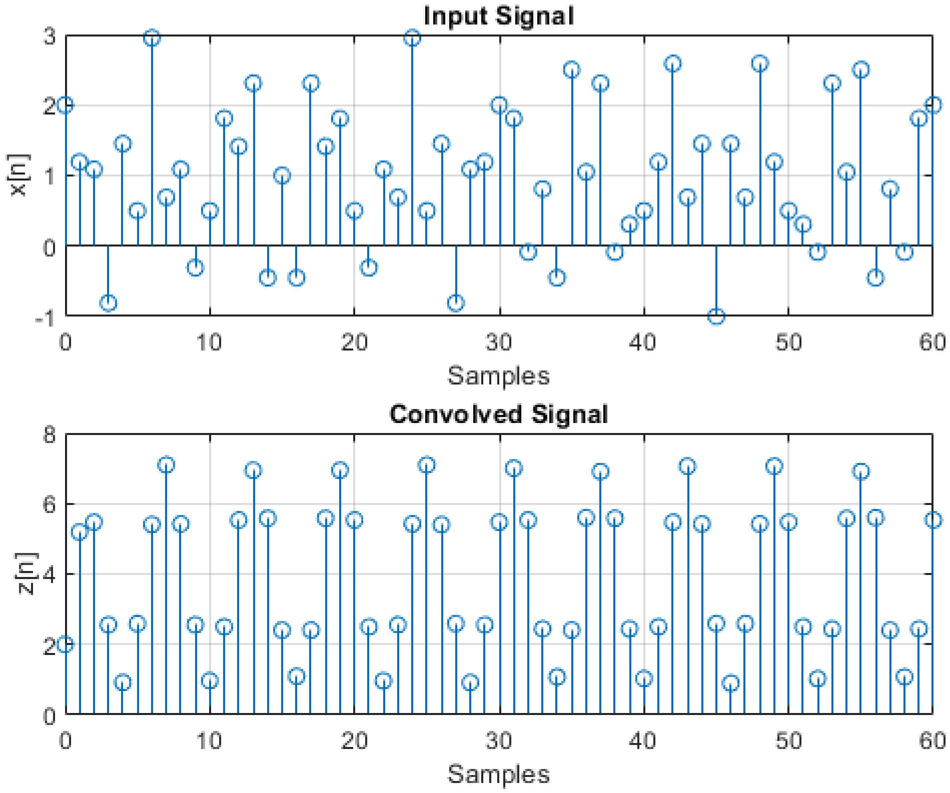
```
n = 0:1:60;
xn = 1 + cos((pi/3)*n) + cos(((9*pi)/10)*n + pi/2);
yn = abs(H1) + (abs(H2)*cos(angle(H2)+ (pi/3)*n)) +
 (abs(H3)*cos(angle(H3) + ((9*pi)/10)*n + pi/2));

figure;
subplot(2,1,1)
stem(n,xn);
grid on;
title('Input Signal')
xlabel('Samples');
ylabel('x[n]');
subplot(2,1,2)
stem(n,yn);
grid on;
title('Output Signal')
xlabel('Samples');
ylabel('y[n]');
```



2(e) COMPARE WITH CONVOLUTION

```
b = [1 2 1];
zn = conv(xn,b);
```

```
n1 = 0:1:62;

figure;
subplot(2,1,1)
stem(n,xn);
grid on;
title('Input Signal')
xlabel('Samples');
ylabel('x[n]');
subplot(2,1,2)
stem(n1,zn);
grid on;
title('Convolved Signal')
xlabel('Samples');
ylabel('z[n]');
xlim([0 60])
```



2(f) ANSWER QUESTION

Besides the first three points, z[n] and y[n] are indentical.

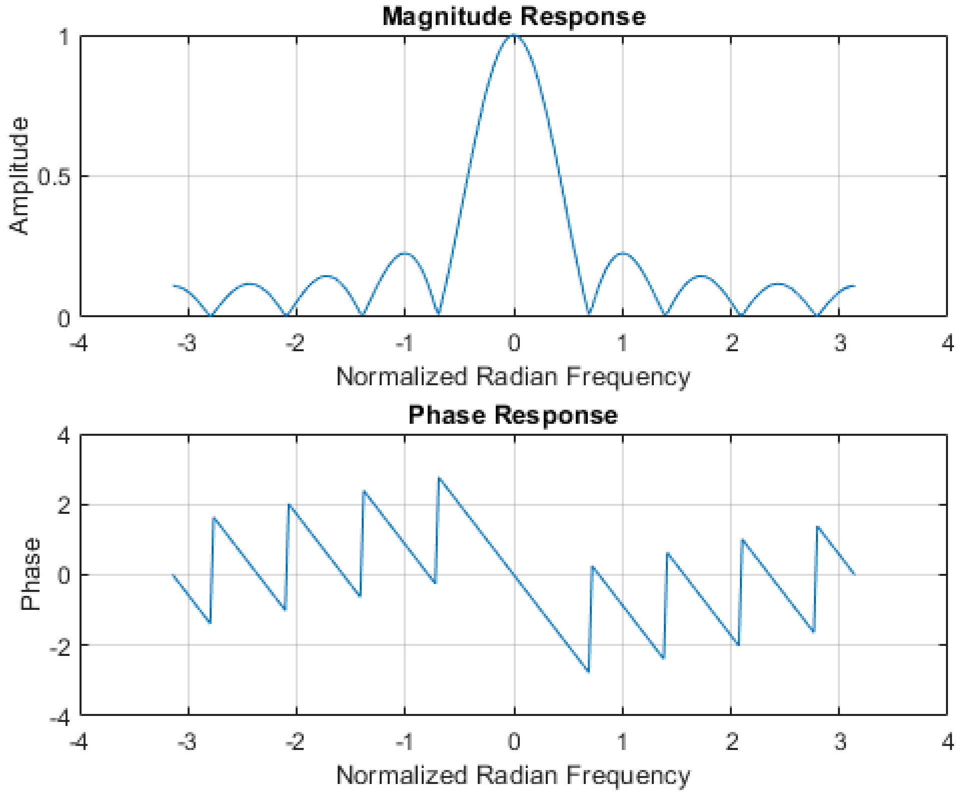
QUESTION 3

```
% DO NOT REMOVE THE LINE BELOW
% MAKE SURE 'jingle.wav' IS IN SAME DIRECTORY AS THIS FILE
```

```
[x, fs] = audioread('jingle11k.wav');
```

3(a) PLOT FREQUENCY RESPONSE

```
a = [1/9, 1/9, 1/9, 1/9, 1/9, 1/9, 1/9, 1/9, 1/9];
Ha = FreqResponse(a,w);

figure;
subplot(2,1,1)
plot(w,abs(Ha));
grid on;
title('Magnitude Response')
xlabel('Normalized Radian Frequency');
ylabel('Amplitude');
subplot(2,1,2)
plot(w,angle(Ha));
grid on;
title('Phase Response')
xlabel('Normalized Radian Frequency');
ylabel('Phase');

% <== ANSWER TO QUESTION ==>
% Lowpass filter
%
```

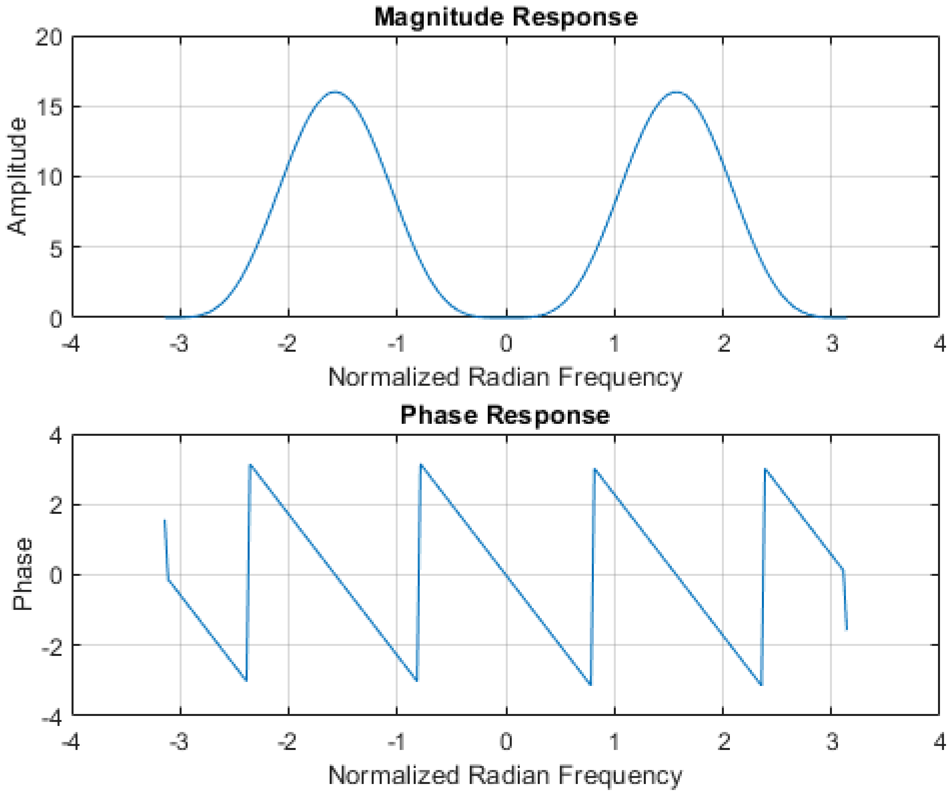


3(b) APPLY FILTER

```
soundsc(x,fs);

xa = conv(x,a);
soundsc(xa,fs)

% <==== ANSWER TO QUESTION ====>
% The filter removed higher freqeuncies from the sound.
%
```

3(c) PLOT FREQUENCY RESPONSE

```
b = [1, 0, -4, 0, 6, 0, -4, 0, 1];
Hb = FreqResponse(b,w);

figure;
subplot(2,1,1)
plot(w,abs(Hb));
grid on;
title('Magnitude Response')
xlabel('Normalized Radian Frequency');
ylabel('Amplitude');
subplot(2,1,2)
plot(w,angle(Hb));
grid on;
title('Phase Response')
xlabel('Normalized Radian Frequency');
ylabel('Phase');

% <==== ANSWER TO QUESTION ====>
% Bandpass filter
%
```



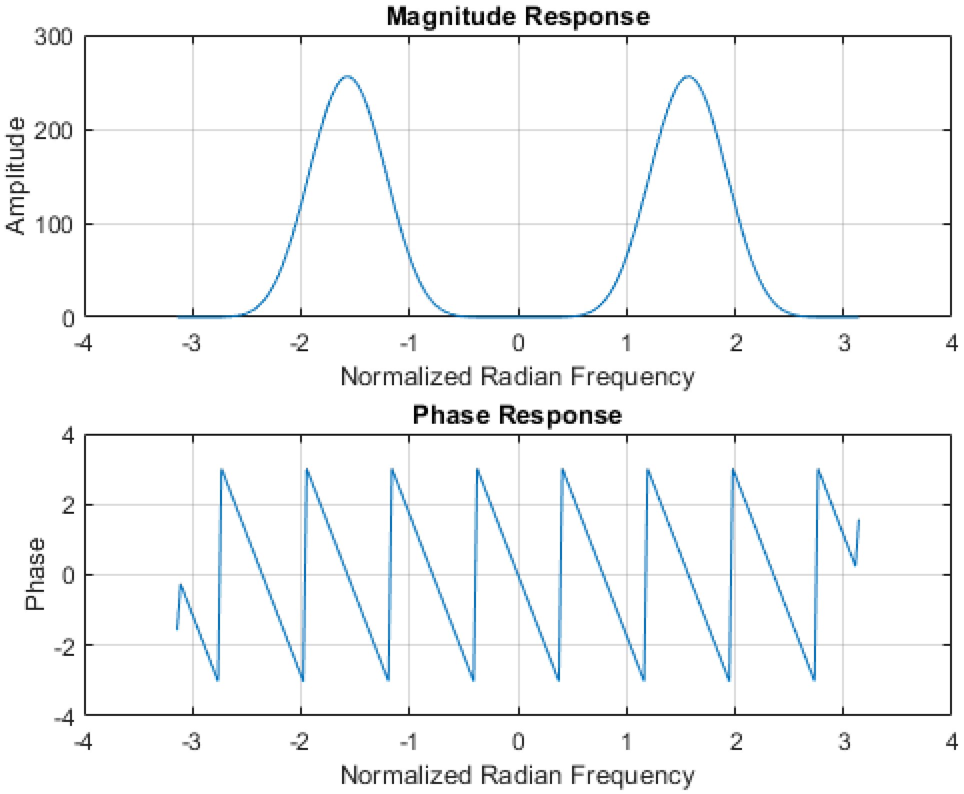
3(d) APPLY FILTER

```
xb = conv(x,b);
soundsc(xb,fs);

% <==== ANSWER TO QUESTION ====>
% The sound is flatter compared to the original while the freqeuncies
 that
% are being passed are louder.
```

3(e) PLOT FREQUENCY RESPONSE

```
c = conv(b,b);
Hc = FreqResponse(c,w);

figure;
subplot(2,1,1)
plot(w,abs(Hc));
grid on;
title('Magnitude Response')
xlabel('Normalized Radian Frequency');
ylabel('Amplitude');
subplot(2,1,2)
plot(w,angle(Hc));
grid on;
```

```
title('Phase Response')
xlabel('Normalized Radian Frequency');
ylabel('Phase');
% <==== ANSWER TO QUESTION ====>
% Bandpass filter
%
```



3(f) APPLY FILTER

```
xc = conv(x,c);
soundsc(xc,fs);

% <==== ANSWER TO QUESTION ====>
% The sound is similar to part e, but even more exaggerated with the
% frequencies that are allowed to pass.
```

ALL FUNCTIONS SUPPORTING THIS CODE % %

```
function H = FreqResponse(b,w)
%  ===> Describe function here <===
    H = zeros(1,length(w));
    for i = 1:length(b)
        H = H + b(i)*exp(-1j.*w*(i-1));
    end
end
```

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