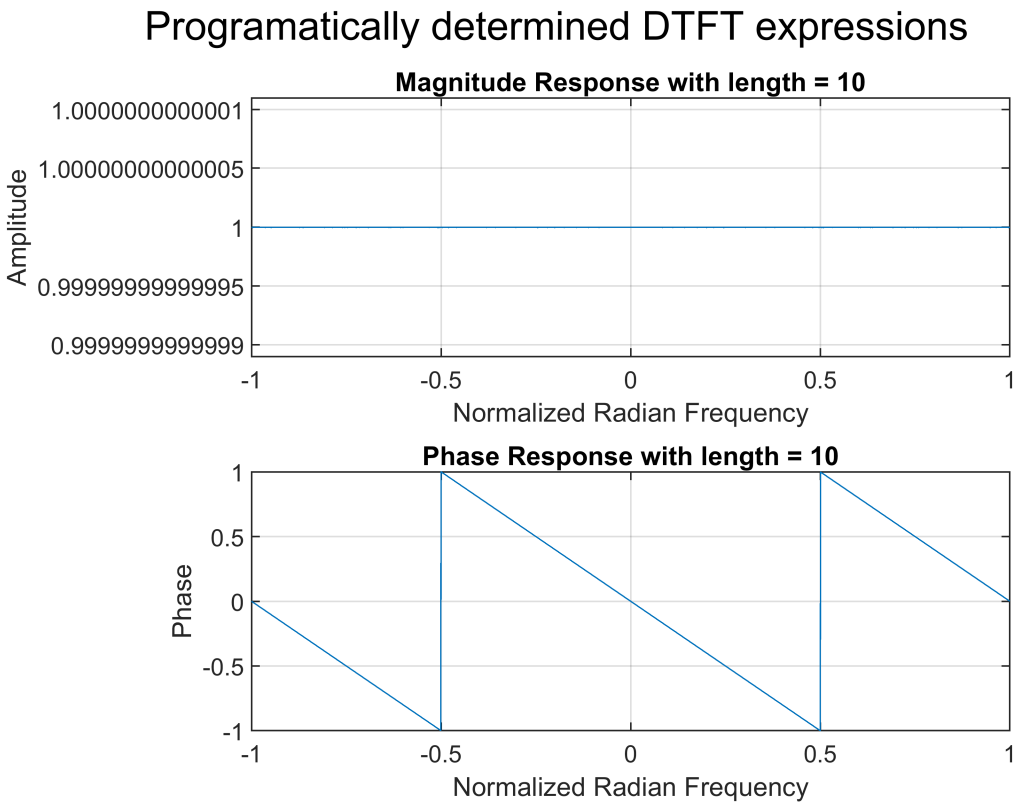
Exercise 5.1

Part A

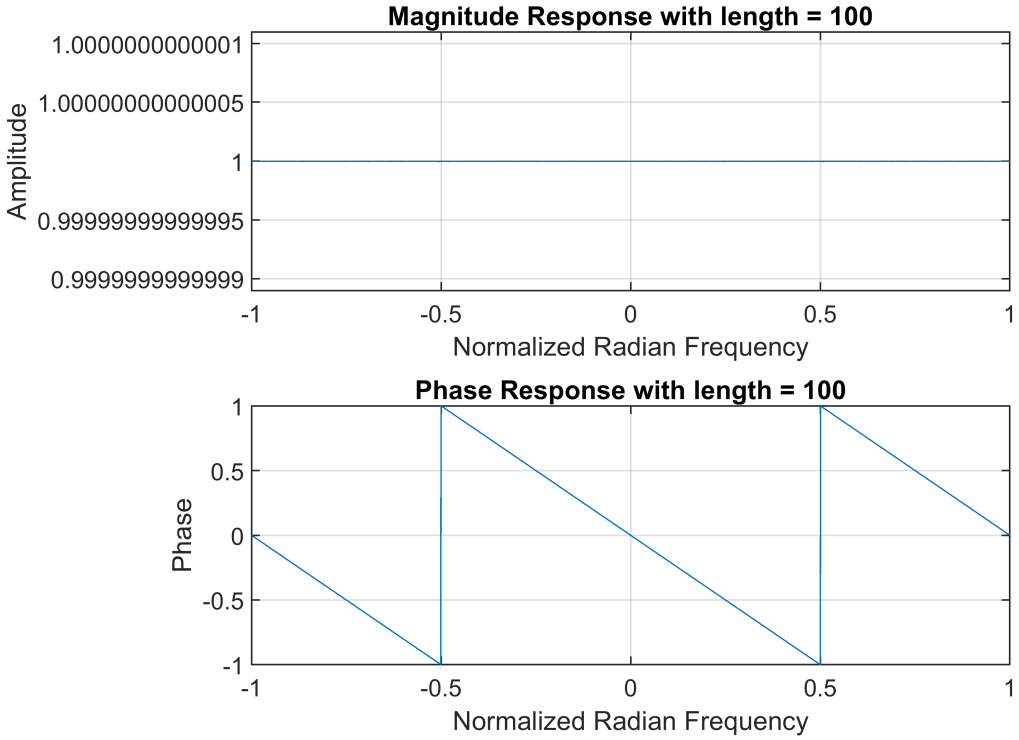
```
w = -pi:pi/1000:pi;

i = 10;
x = zeros(i,1);
x(3) = 1;
H = dtft(x,w); % FREQUENCY RESPONSE
figure(1);
plotRes(H,w,i);
```

```
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software OpenGL. For
more information, click here.
```

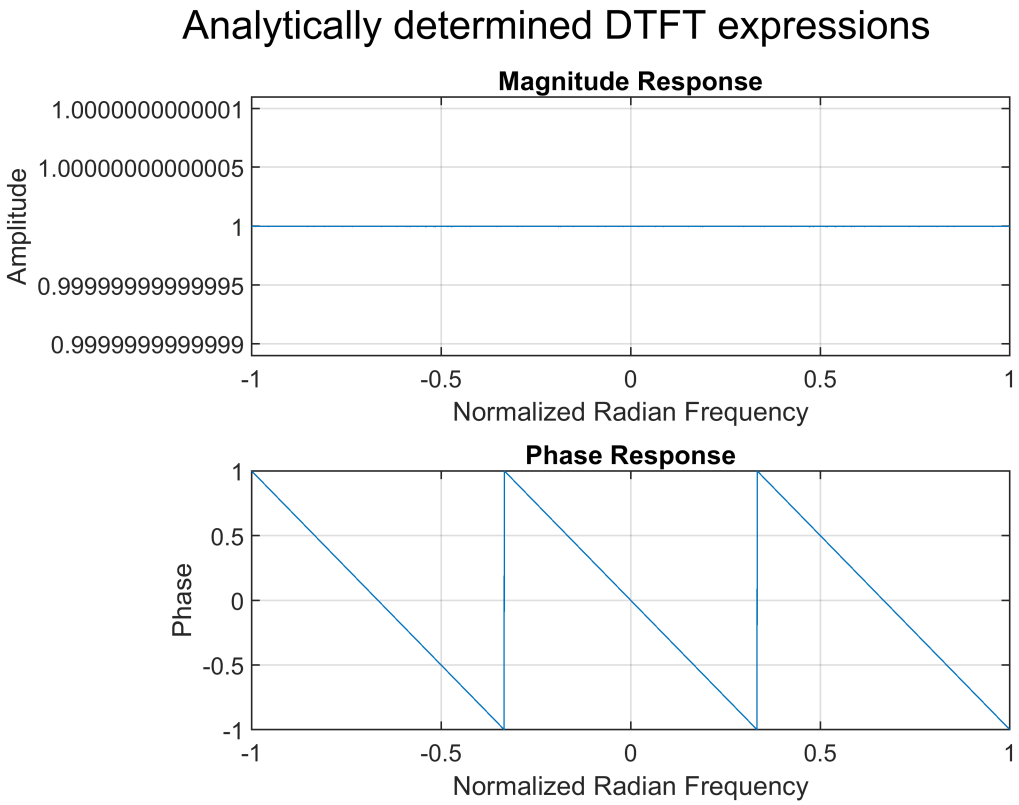



```
i = 100;
x = zeros(i,1);
x(3) = 1;
H = dtft(x,w); % FREQUENCY RESPONSE
figure(2);
plotRes(H,w,i);
```

Programatically determined DTFT expressions




```
H = exp(-3*j*w);
figure(3);
plotAn(H,w);
```

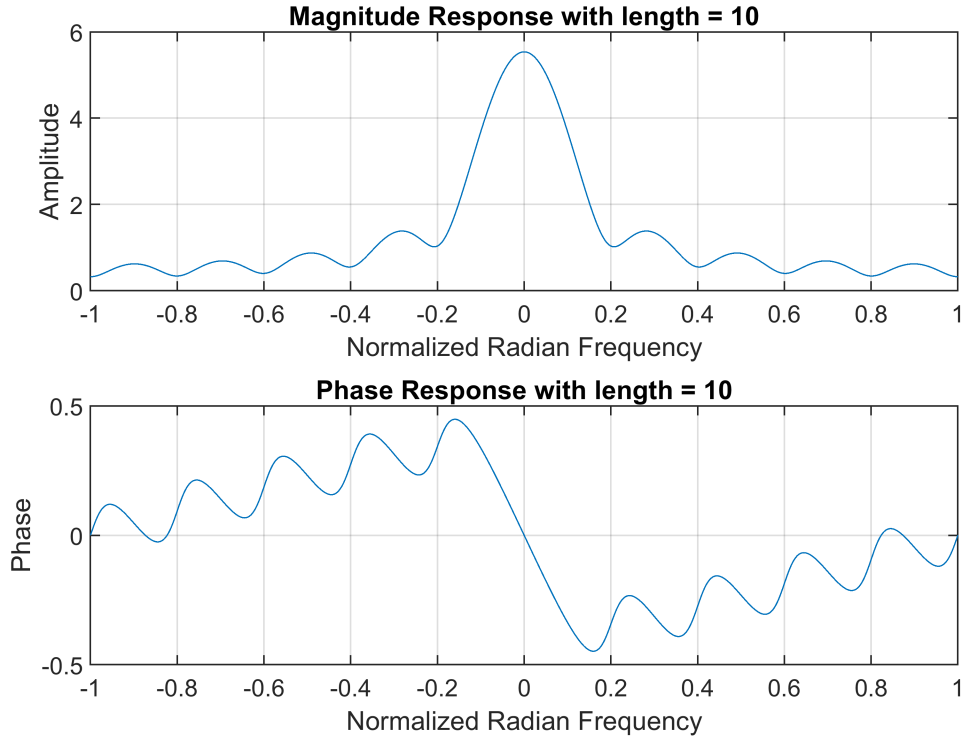


The magnitude response matches, but the phase response seems to be stretched. More signal length does not affect this DTFT.

Part B

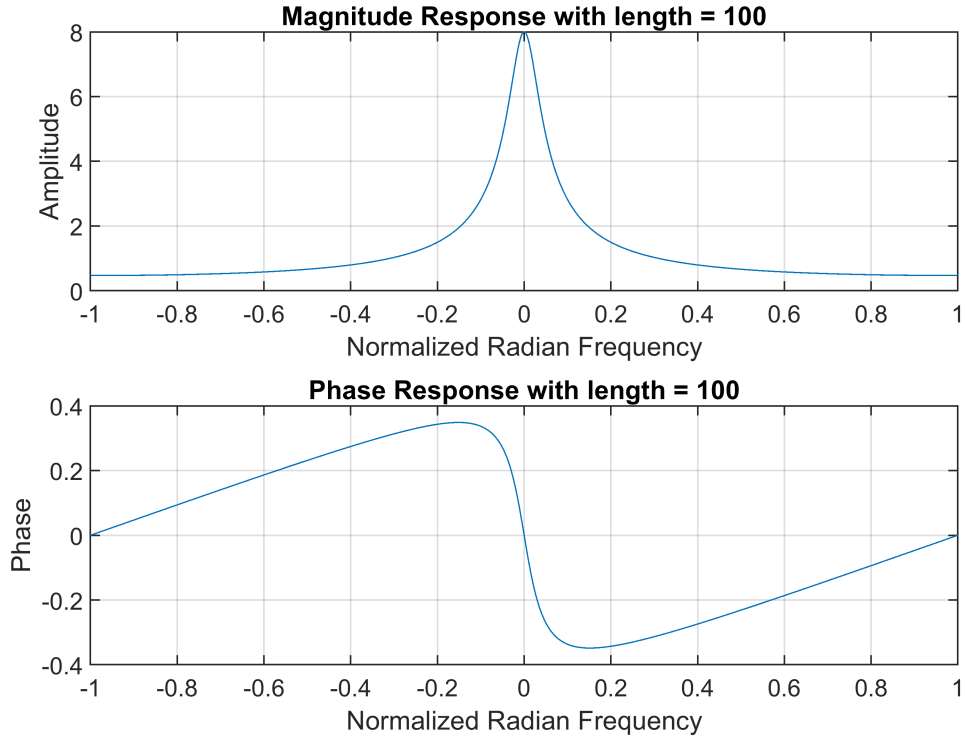
```
i = 10;
x = ((8/9).^(1:i))';
H = dtft(x,w); % FREQUENCY RESPONSE
figure(4);
plotRes(H,w,i);
```

Programatically determined DTFT expressions

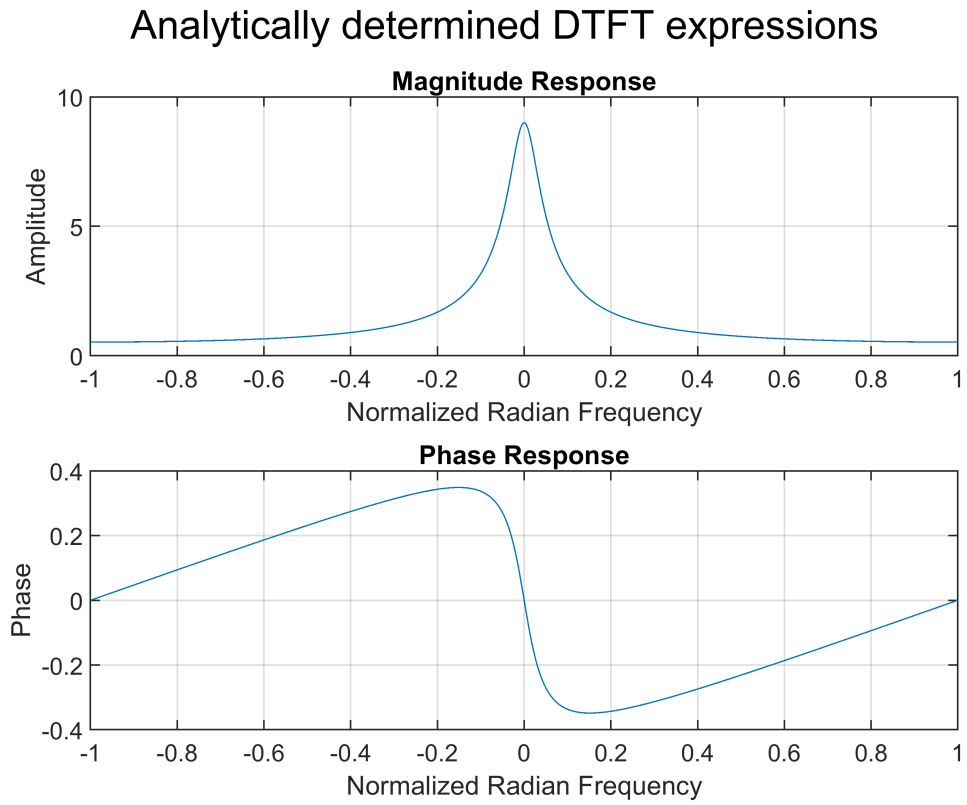



```
i = 100;
x = ((8/9).^(1:i))';
H = dtft(x,w); % FREQUENCY RESPONSE
figure(5);
plotRes(H,w,i);
```

Programatically determined DTFT expressions




```
H = 1./(1-(8/9)*exp(-1j*w));
figure(6);
plotAn(H,w);
```

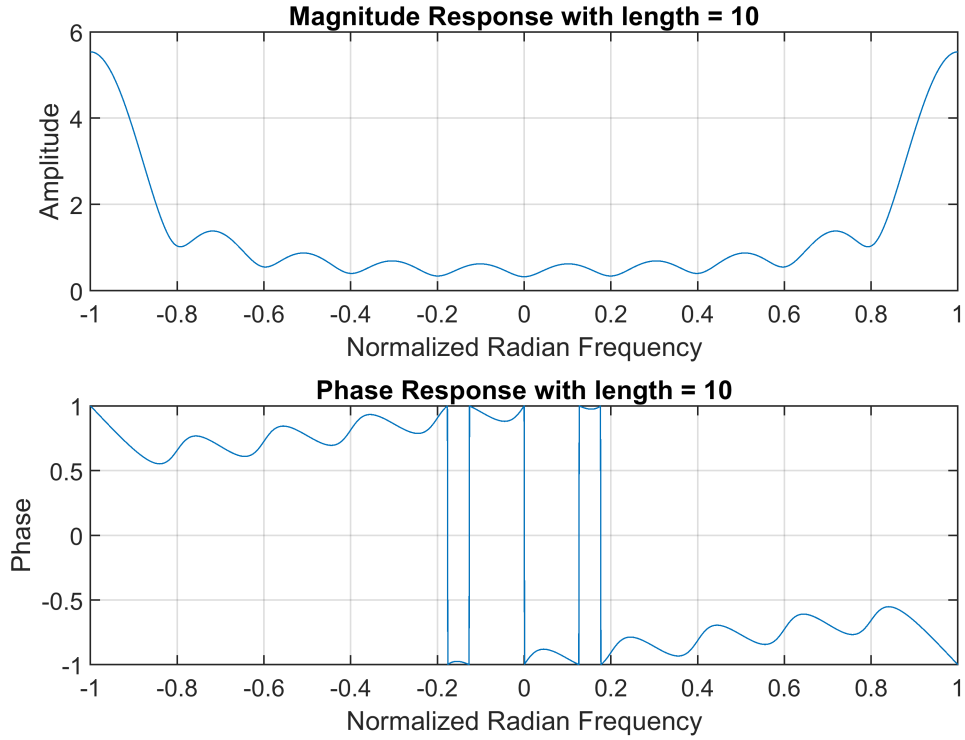


The magnitide and phase response of the signal with length = 100 matches the analytical approach. This shows that more length in the signal gets us closer to the real, analytical value.

Part C

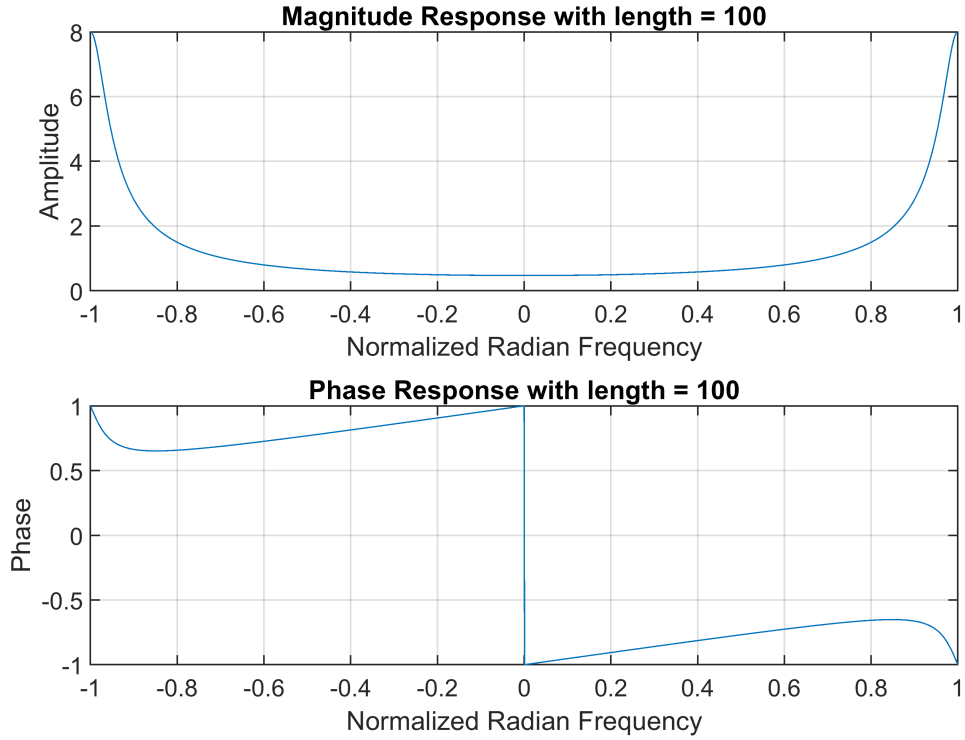
```
i = 10;
x = ((-8/9).^(1:i))';
H = dtft(x,w); % FREQUENCY RESPONSE
figure(7);
plotRes(H,w,i);
```

Programatically determined DTFT expressions

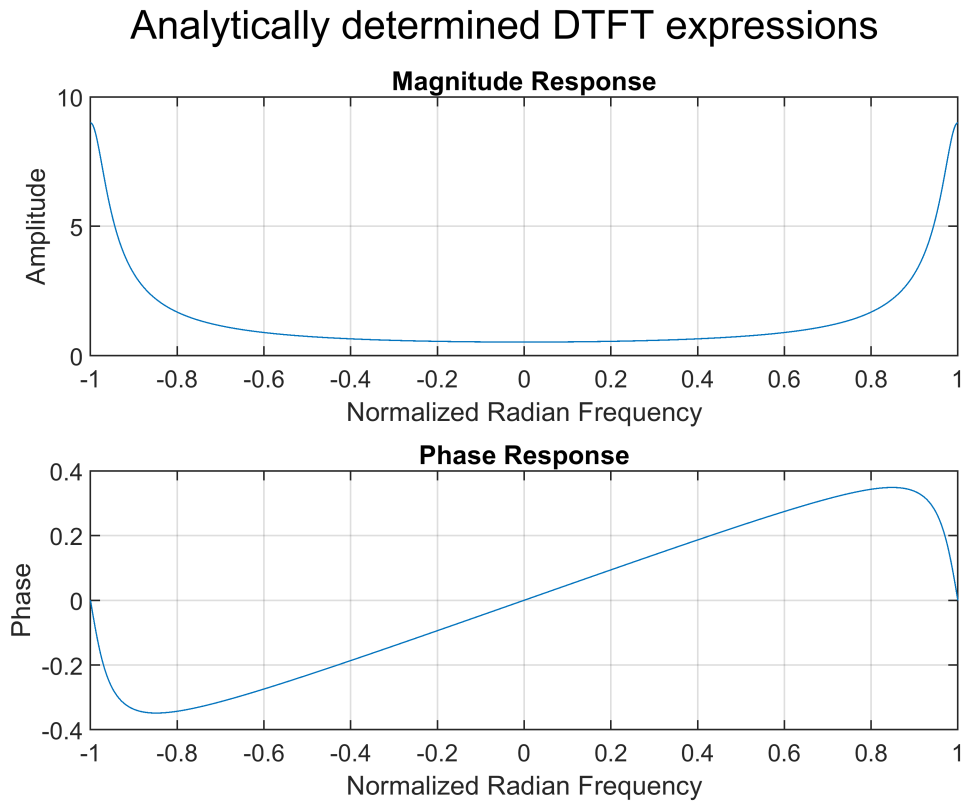



```
i = 100;
x = ((-8/9).^(1:i))';
H = dtft(x,w); % FREQUENCY RESPONSE
figure(8);
plotRes(H,w,i);
```

Programatically determined DTFT expressions




```
H = 1./(1-(-8/9)*exp(-1j*w));
figure(9);
plotAn(H,w);
```

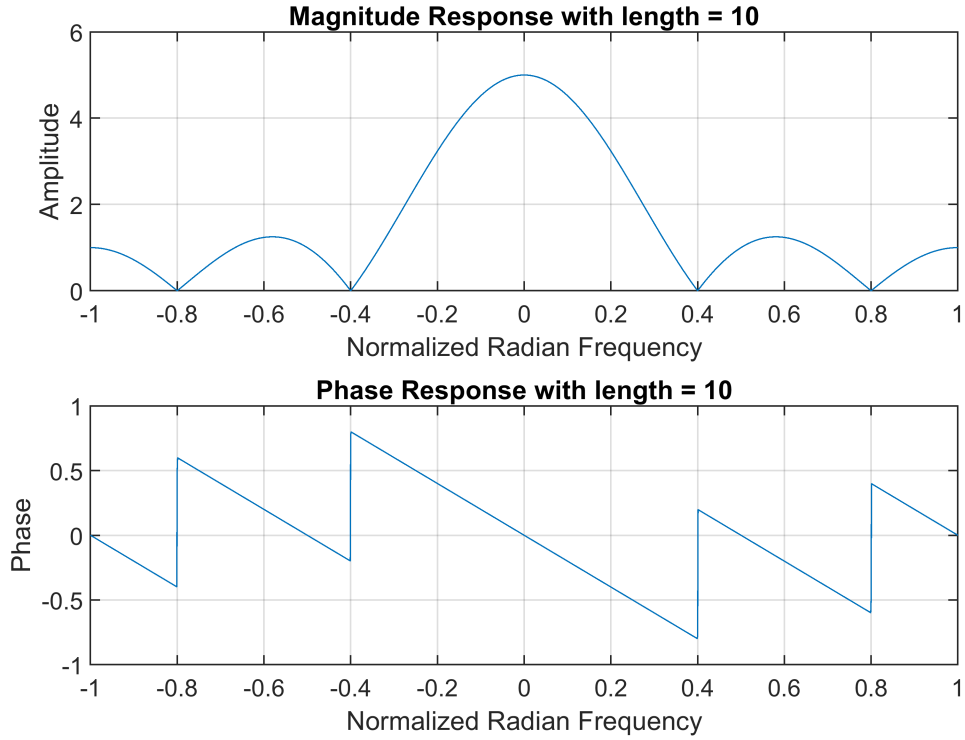


This DTFT is interesting, for the signal with length = 100, the magnitide response closely matches the analytical magnitude response approach. However, with the phase response, the slope (rate of change) matches, but not the value itself, it seems to be translated by a complete phase, starting at 1 in the calculated approach, and 0 in the analytical appraoch.

Part D

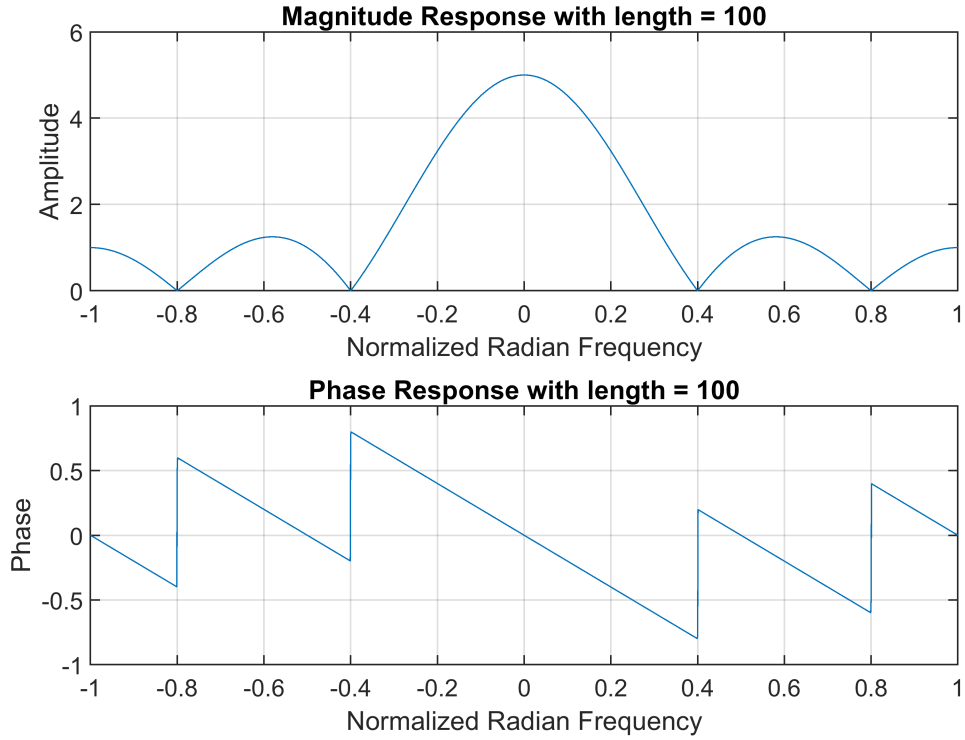
```
i = 10;
t = (zeros(i,1) + 1);
t(1:5) = 0;
x = (zeros(i,1) + 1) - t;
H = dtft(x,w); % FREQUENCY RESPONSE
figure(10);
plotRes(H,w,i);
```

Programatically determined DTFT expressions

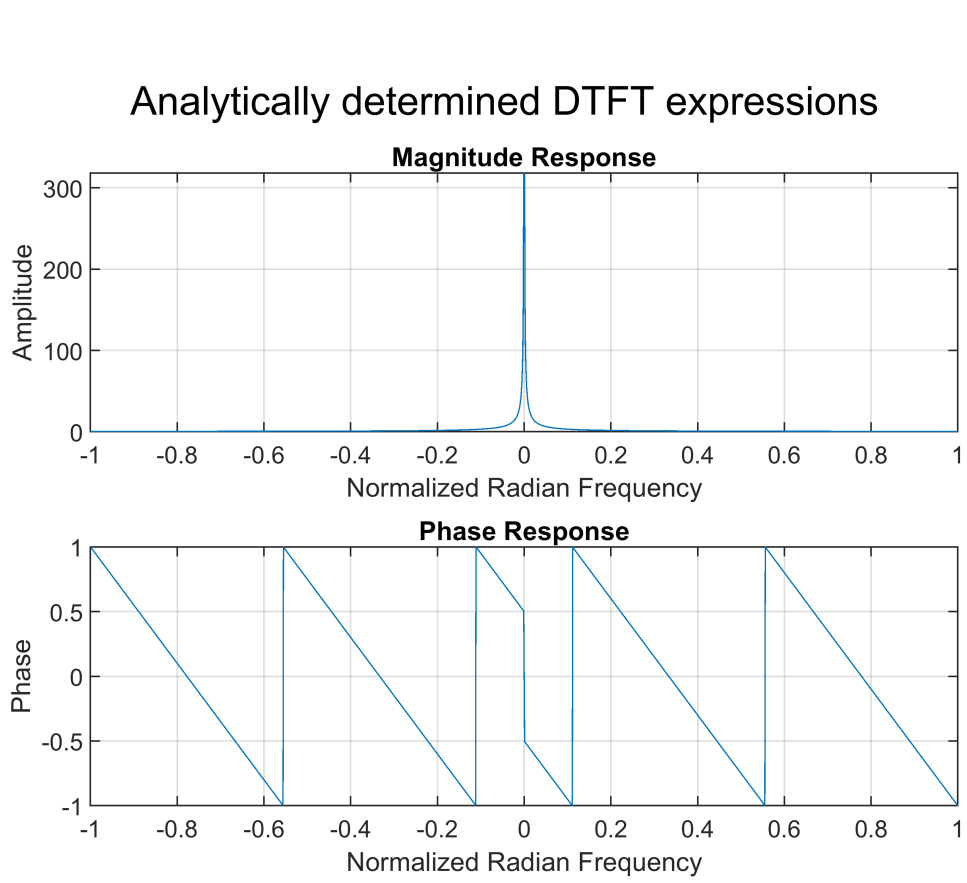



```
i = 100;
t = (zeros(i,1) + 1);
t(1:5) = 0;
x = (zeros(i,1) + 1) - t;
H = dtft(x,w); % FREQUENCY RESPONSE
figure(11);
plotRes(H,w,i);
```

Programatically determined DTFT expressions




```
H = (1./(1-exp(-1j*w)) + pi*(dirac(w))).*exp(-1j*w*5);
figure(12);
plotAn(H,w);
```

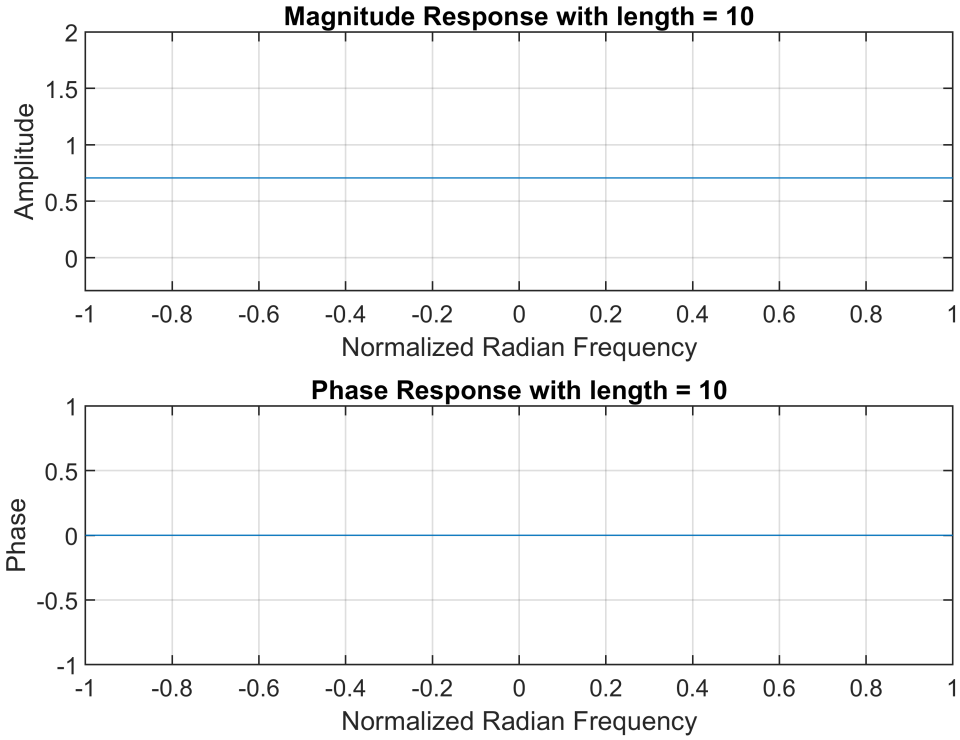


I am tempted that this one is wrong, but I tried everything I could think of and didnt find my mistake. Clearly this does not match. However, the signal length does not affect this response at all, likely due to the fact that there are only 5 non-zero values.

Part E

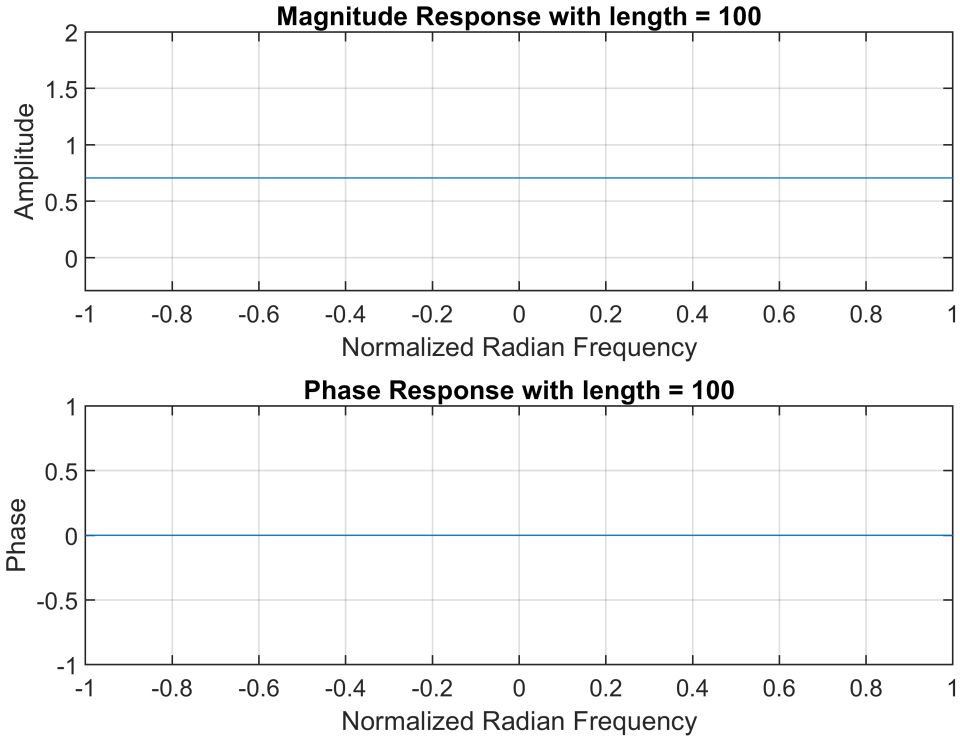
```
i = 10;
x = cos(pi/4 * (1:i));
H = dtft(x,w); % FREQUENCY RESPONSE
figure(13);
plotRes(H,w,i);
```

Programatically determined DTFT expressions

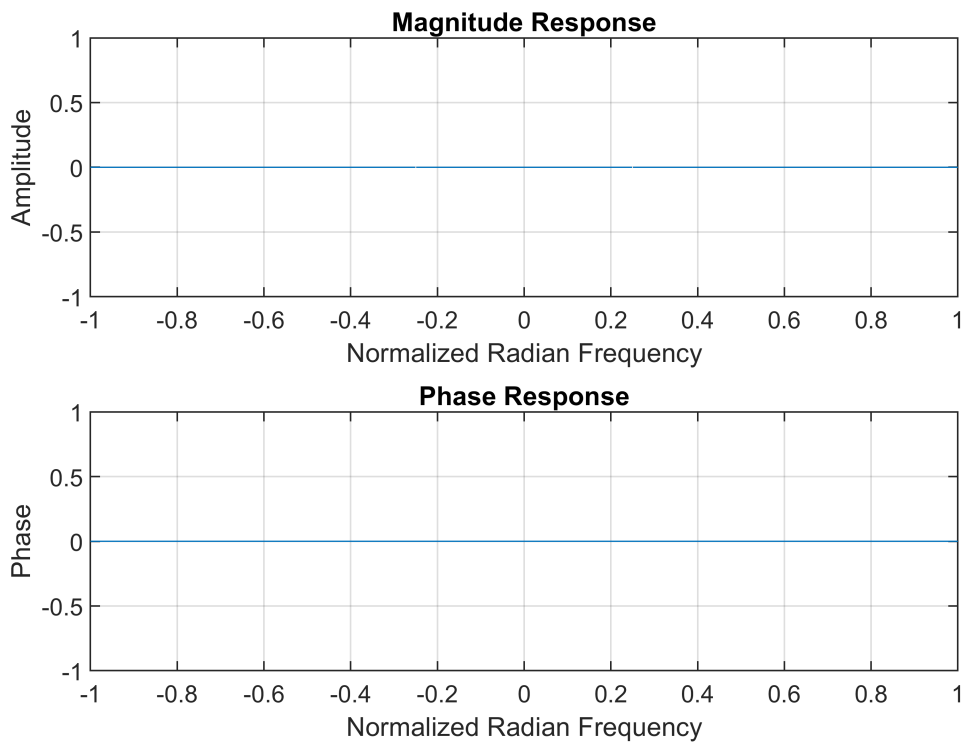



```
i = 100;
x = cos(pi/4 * (1:i));
H = dtft(x,w); % FREQUENCY RESPONSE
figure(14);
plotRes(H,w,i);
```

Programatically determined DTFT expressions




```
H = pi*(dirac(w-(pi/4))+dirac(w+(pi/4)));
figure(15);
plotAn(H,w);
```



These graphs match 1 to 1, but the question is are they correct? I cannot answer that, which clearly indicates that I need to review the material in the class better.

Exercise 6.2

```
[y,Fs]=audioread("corrupted_wannabe.wav");
w0 = 0.135
```

```
w0 = 0.1350
```

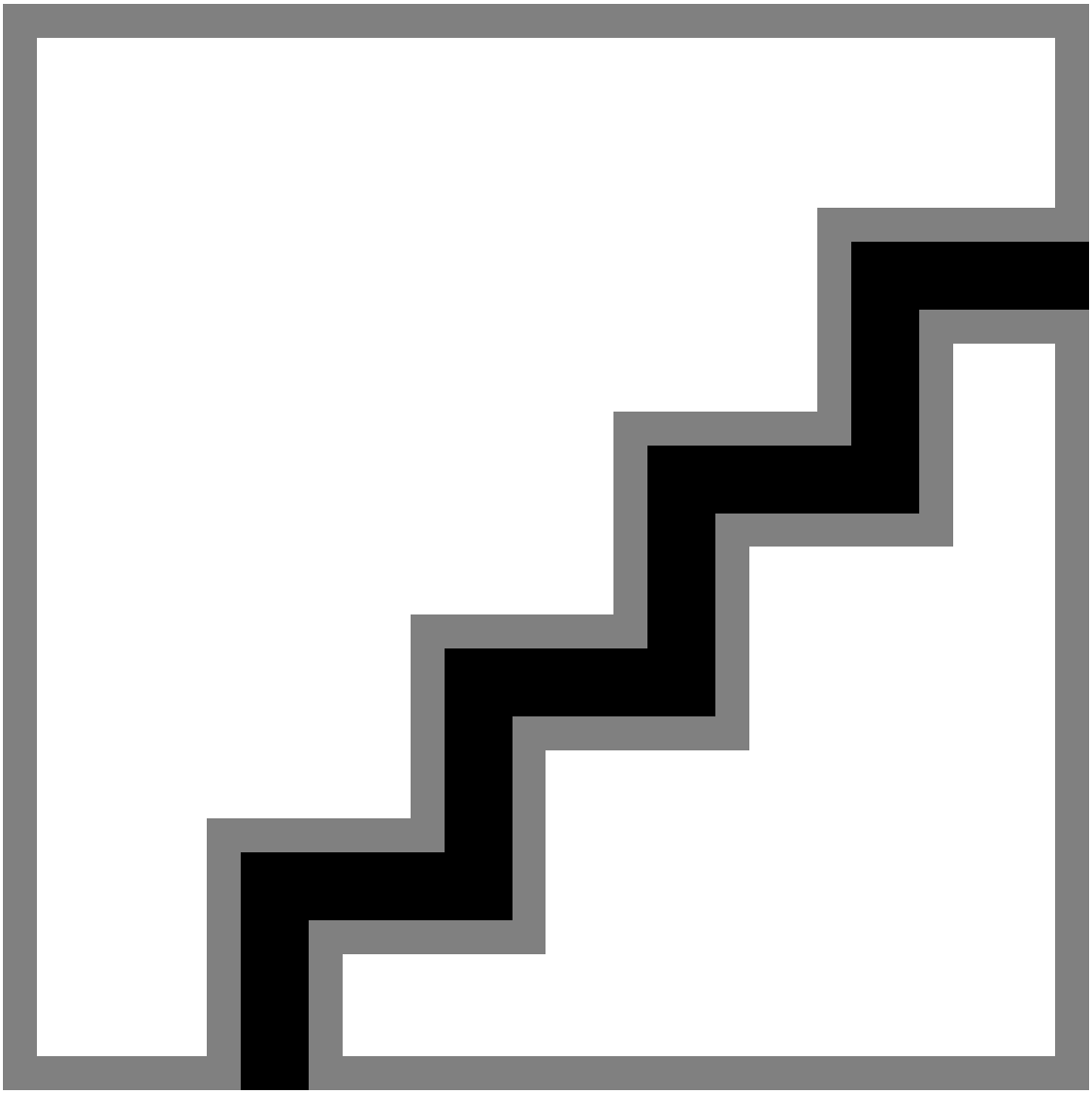
```
display("Normalized Radian Frequency,"+ w0)
```

```
    "Normalized Radian Frequency,0.135"
```

```
display("Cyclic Frequency" + (2*pi*w0/Fs))
```

```
    "Cyclic Frequency3.8468e-05"
```

```
h = filter(y, w0);
soundsc(h',Fs);
H = dtft(y, w);
H1 = dtft(h', w);
plotAn(H,w);
plotAn(H1,w);
```

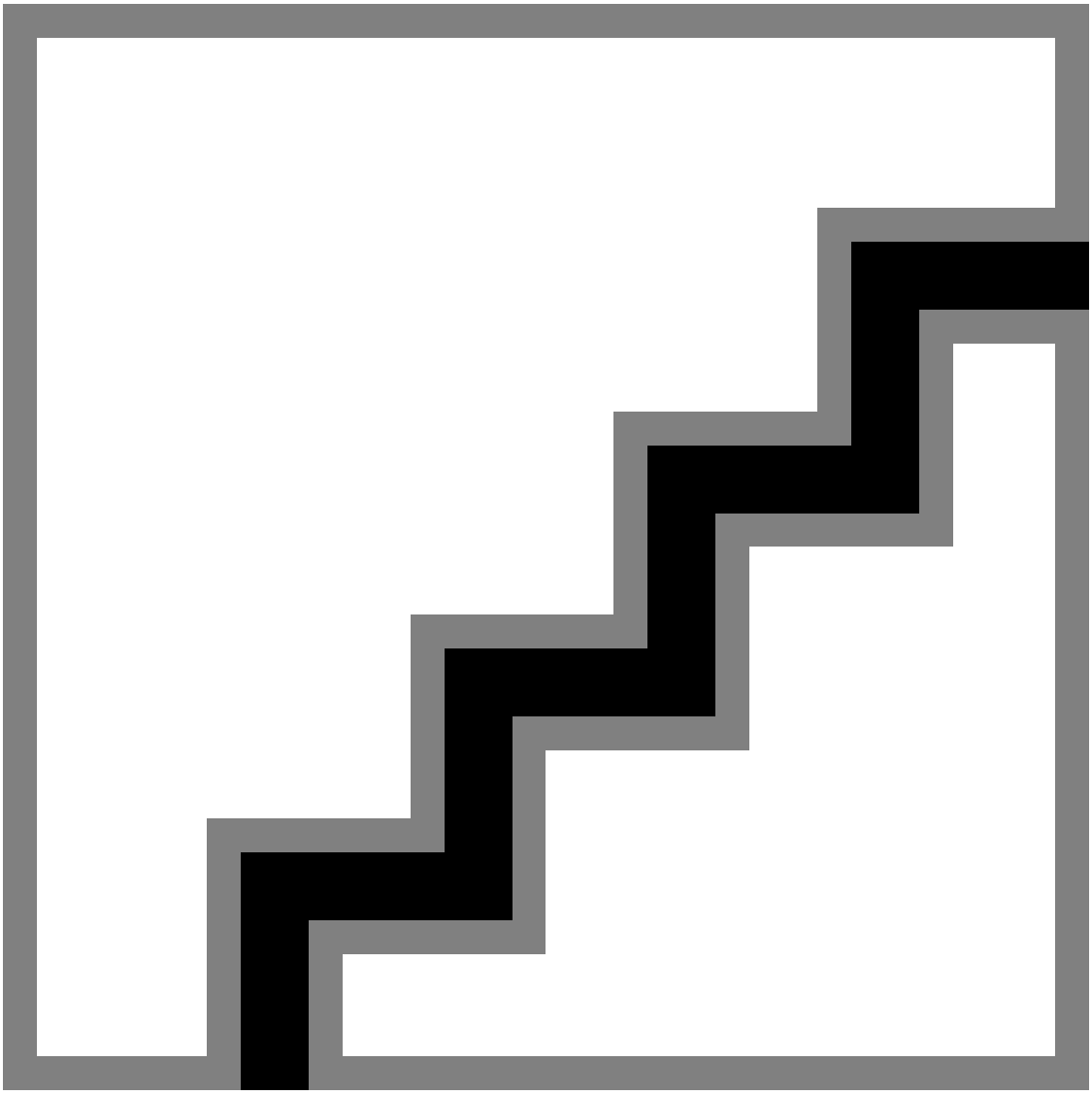


After at least an hour of tries to get a practical sounding output, I am unable to figure it out by myself. I would have liked to go to office hours, but with my job and my training, I cannot fit everything into the schedule. There is no way that the output is correct, its a short 'tap' sound.

In terms of the differences between the DTFTs of the original audio and the output, it seems that both the magnitidue and the phase response and minimized around the area of what I believe to be the interfering signal frequency.

A jab at the extra credit

```
[y,Fs] = audioread("what_did_he_say.wav");
soundsc(y,Fs);
H = dtft(y, w);
plotAn(H,w);
```



```
display("This was the filter I generated, unable to apply it" + FF);
```

```
  1×17 string array

  Columns 1 through 3

    "This was the filt…"    "This was the filt…"    "This was the filt…"

  Columns 4 through 6

    "This was the filt…"    "This was the filt…"    "This was the filt…"

  Columns 7 through 9

    "This was the filt…"    "This was the filt…"    "This was the filt…"

  Columns 10 through 12

    "This was the filt…"    "This was the filt…"    "This was the filt…"

  Columns 13 through 15

    "This was the filt…"    "This was the filt…"    "This was the filt…"
```

```
  Columns 16 through 17

    "This was the filt…"    "This was the filt…"
```

```
function H = dtft(x, w)
    %x = input signal vector
    %w = (normalized radian) frequency vector
    H = 0;
    for k = 1:size(x,1)
        H = H + x(k) * exp(-1j*w*(k-1));
    end
end

function h = filter(z,w0)
    h = size(z,1);
    for i = 3:size(z,1)
        h(i) = z(i) - (2 * cos(w0)*z(i-1)) + z(i-2);
    end
end

function plotRes(H,w,i)
    i = int2str(i);
    subplot(2, 1, 1)
    plot(w/pi , abs(H));
    grid on;
    title(['Magnitude Response with length = ', i]);
    xlabel('Normalized Radian Frequency');
    ylabel('Amplitude');
    subplot(2, 1, 2)
    plot(w/pi , angle(H)/pi);
    grid on;
    title(['Phase Response with length = ', i ]);
    xlabel('Normalized Radian Frequency');
    ylabel('Phase');
    sgtitle('Programatically determined DTFT expressions');
end

function plotAn(H,w)
    subplot(2, 1, 1)
    plot(w/pi , abs(H));
    grid on;
    title('Magnitude Response');
    xlabel('Normalized Radian Frequency');
    ylabel('Amplitude');
    subplot(2, 1, 2)
    plot(w/pi , angle(H)/pi);
    grid on;
    title('Phase Response');
    xlabel('Normalized Radian Frequency');
    ylabel('Phase');
    sgtitle('Analytically determined DTFT expressions');
end
```