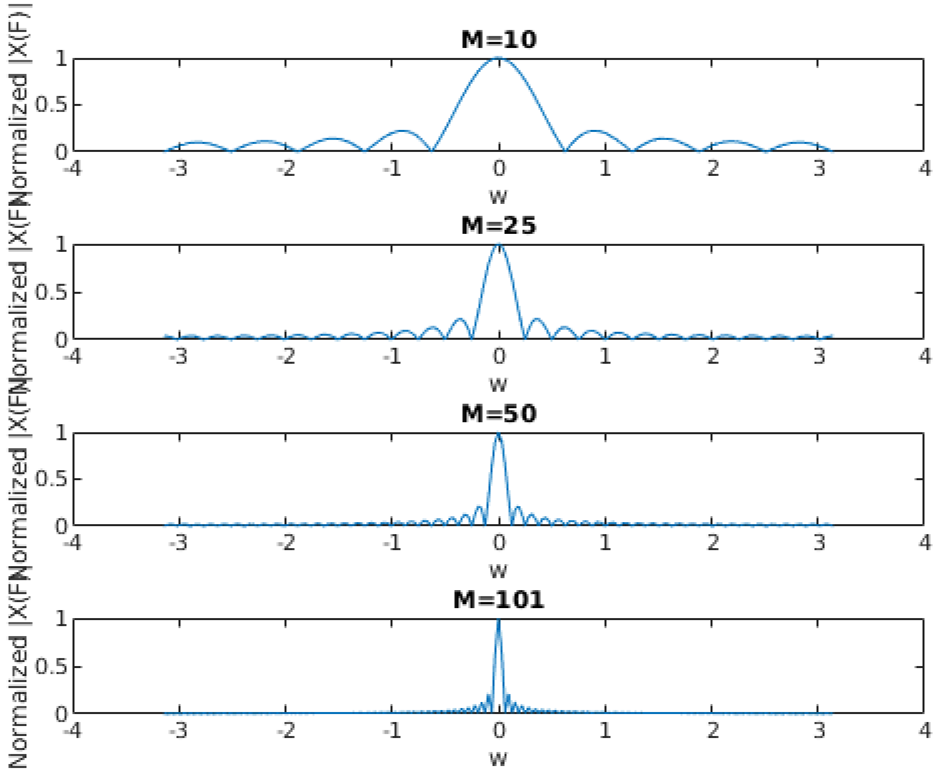
```
%!-----------------------------------------------------------------------------------------
%! DSP HW4 #2
%!  - Calculate the DTFT, plot and see the difference of longer pulses
%!-----------------------------------------------------------------------------------------

%! Enviorment
n = 0:149;               % 150 Samples
w = (-100:100)*pi/100;    % -pi:pi

% Create Signal
r = zeros(4, length(n));
delay = [10, 25, 50, 101];
for i=1:4
    r(i, :) = unit_step(0, n) - unit_step(delay(i), n);
end

% Take DTFT
rf = zeros(4, length(w));
for i=1:4
    rf(i, :) = dtft(r(i,:), n, w);
    rf(i, :) = rf(i, :) ./ max(abs(rf(i, :)));
end

% Plot
subplot(4,1,1)
plot(w, abs(rf(1,:)))
xlabel('w')
ylabel('Normalized |X(F)|')
title('M=10')

subplot(4,1,2)
plot(w, abs(rf(2,:)))
xlabel('w')
ylabel('Normalized |X(F)|')
title('M=25')

subplot(4,1,3)
plot(w, abs(rf(3,:)))
xlabel('w')
ylabel('Normalized |X(F)|')
title('M=50')

subplot(4,1,4)
plot(w, abs(rf(4,:)))
xlabel('w')
ylabel('Normalized |X(F)|')
title('M=101')

% Comment on the behaviour
disp(['As the number of samples increases the bandwidth range shrinks. The
 number' ...
```

```
    'frequency componets that are a large impact decrease as the wider the
 pulse is.' ...
    'I think this is since when the pulse is short, it takes a larger amount
 of frequency' ...
    'to synthesis the curve than it does with longer pulses.'])
```

As the number of samples increases the bandwidth range shrinks. The numberfrequency componets that are a large impact decrease as the wider the pulse is.I think this is since when the pulse is short, it takes a larger amount of frequencyto synthesis the curve than it does with longer pulses.



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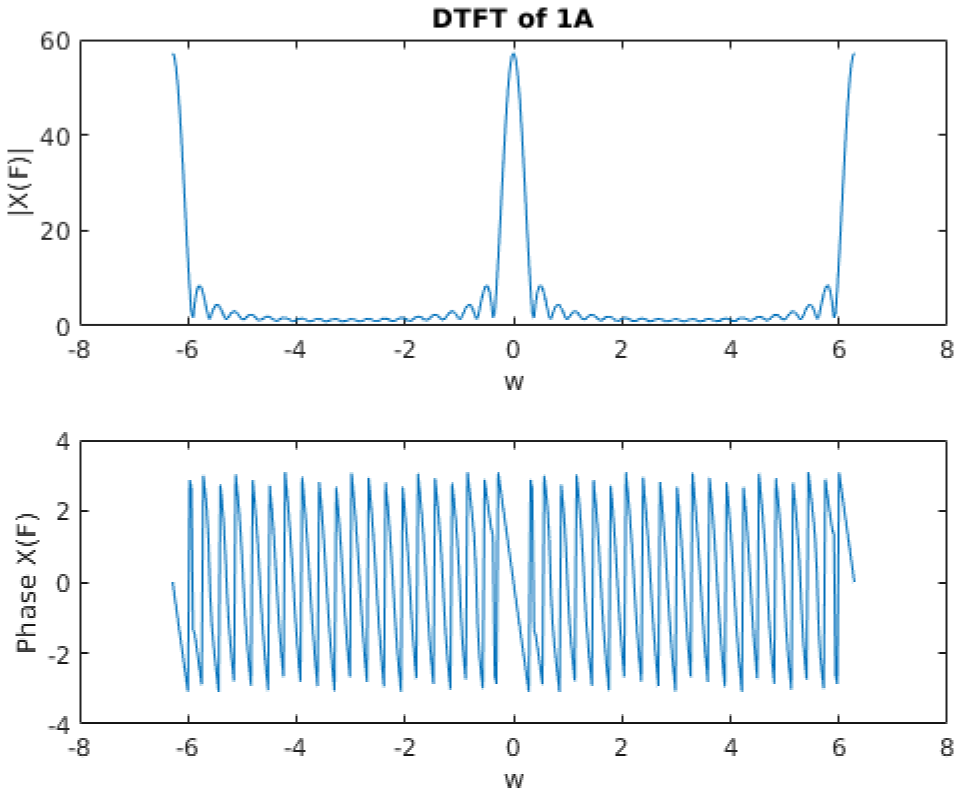
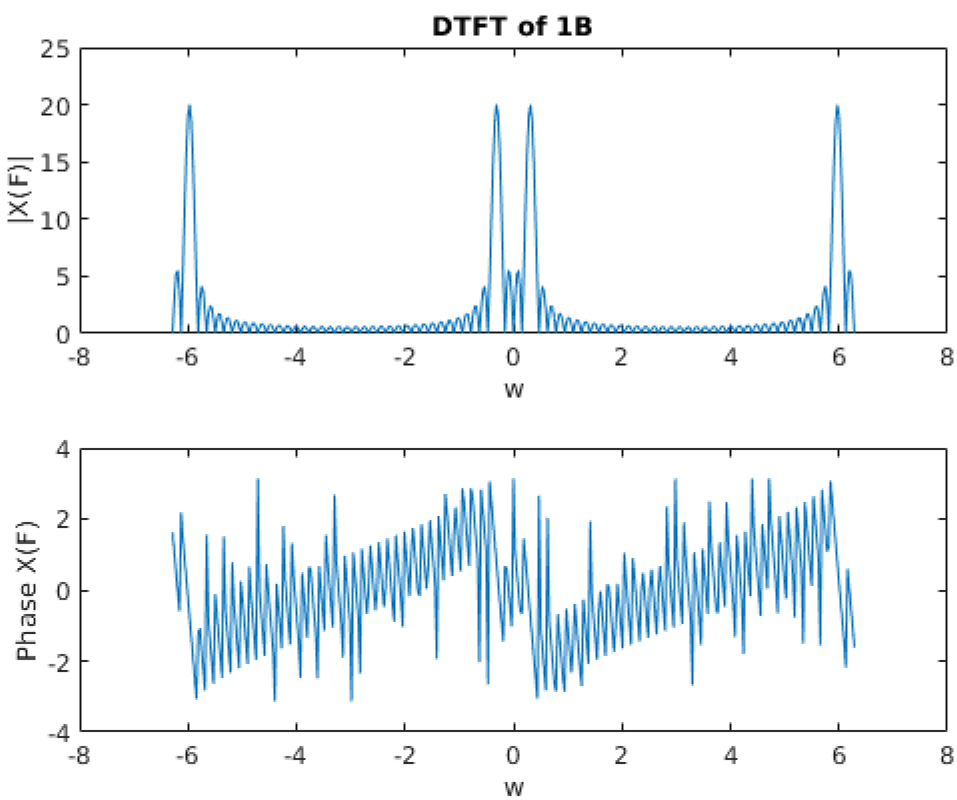
```
%!-----------------------------------------------------------------------------------------
%! DSP HW4 #1
%!  - use dtft.m to compute the magnutude and phase
%!-----------------------------------------------------------------------------------------

%! Enviorment
n = 0:49;               % 50 samples
w= (-200:200)*pi/100;   % -2pi:2pi

% Signals
x0 = n .* (.9).^n .*(unit_step(0, n) - unit_step(21, n));
x1 = cos(pi/10.*n-pi/4).*(unit_step(0, n) - unit_step(40, n));

% Take Fourier Transform
xf0 = dtft(x0, n, w);
xf1 = dtft(x1, n, w);

% Plot
figure(1)
subplot(2,1,1)
plot(w, abs(xf0))
title('DTFT of 1A')
ylabel('|X(F)|')
xlabel('w')
subplot(2,1,2)
plot(w, angle(xf0))
ylabel('Phase X(F)')
xlabel('w')

figure(2)
subplot(2,1,1)
plot(w, abs(xf1))
title('DTFT of 1B')
ylabel('|X(F)|')
xlabel('w')
subplot(2,1,2)
plot(w, angle(xf1))
ylabel('Phase X(F)')
xlabel('w')
```


DTFT of 1A
|X(F)|
w
Phase X(F)
w


DTFT of 1B
|X(F)|
w
Phase X(F)
w

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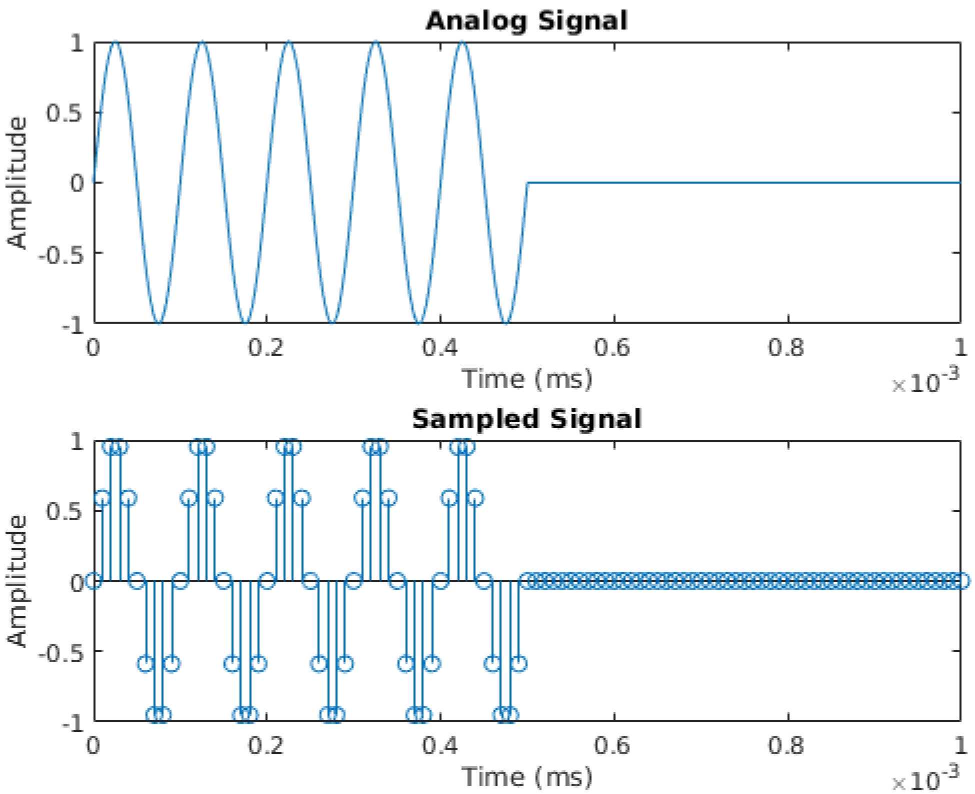
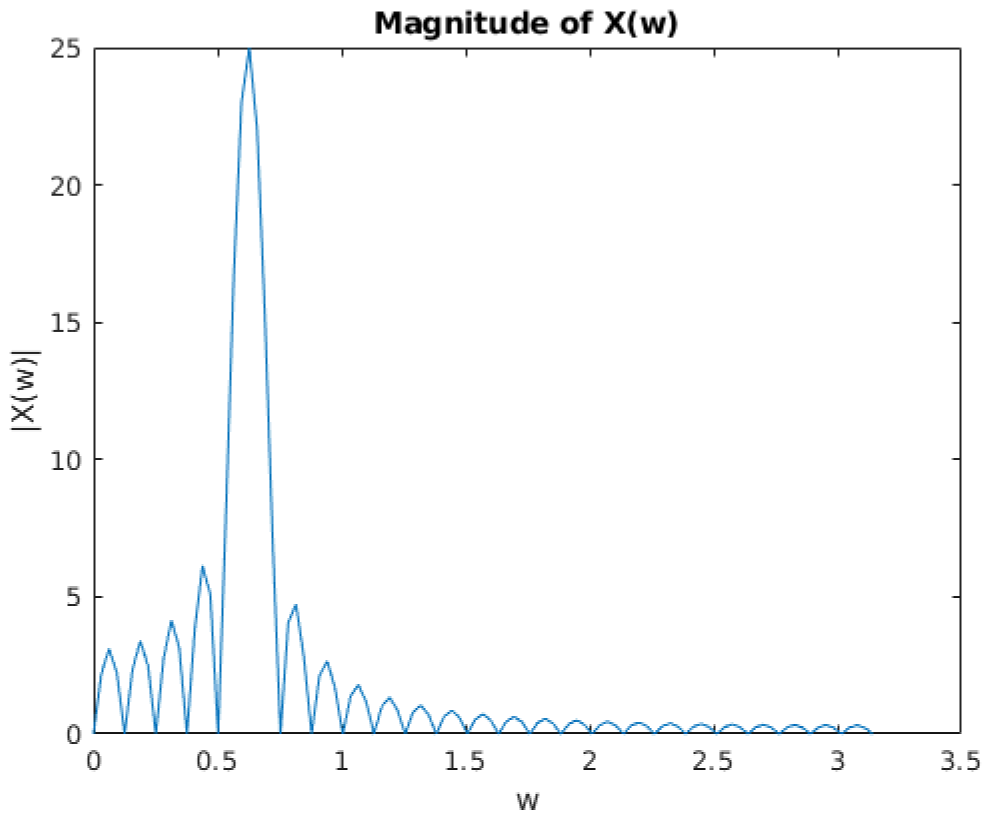
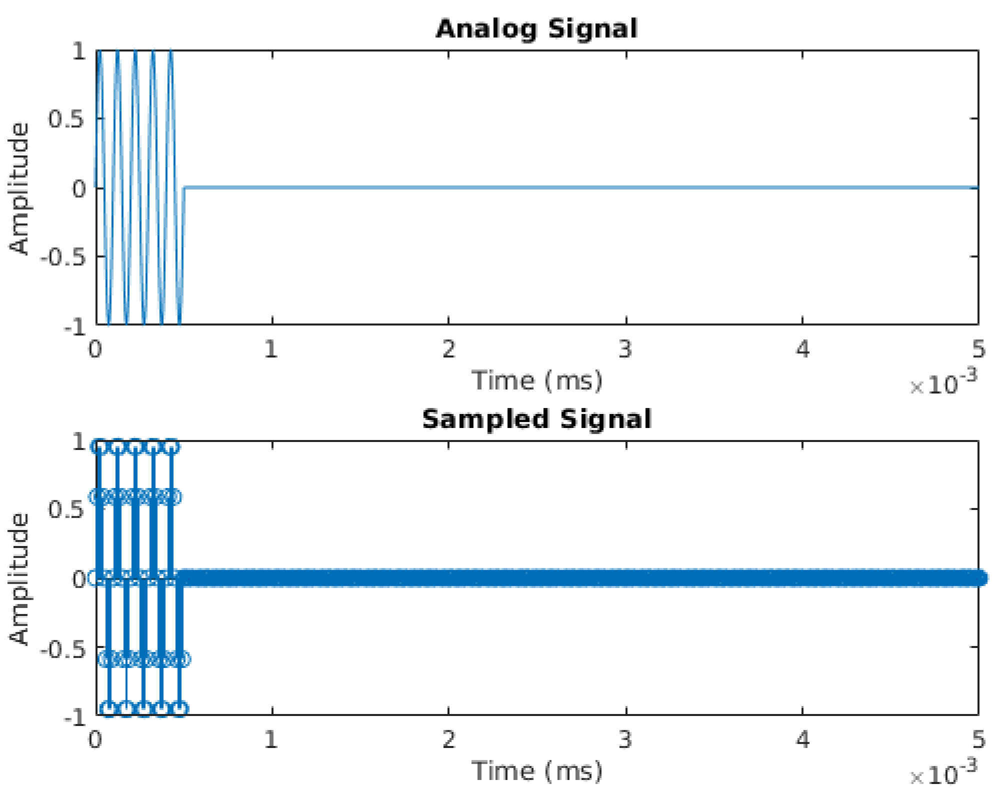
```
%!----------------------------------------------------------------------------
%! DSP HW4 #5
%!  - Generate a pulsed sine wave with f=10kHz and pulse width of .5ms
%!      starting at 0 and ending at T-stop
%!  - Sample the analog signal with Ts=.01ms
%!  - Compute and display the magnitude of the DTFT
%!----------------------------------------------------------------------------

%! Enviorment
t_stop = [.001, .005];
f = 10000;
pulse_width = .0005;

for i=1:length(t_stop)
    t = 0:.000001:t_stop(i); % Analog sample times
    sample_rate = .00001/.000001;
    n = t(1:int32(sample_rate):end);
    w = linspace(0, pi, length(n));

    % Signal
    xt = sin(2*pi*f*t) .* ((t - pulse_width) <= 0);
    xn = sin(2*pi*f*n) .* ((n - pulse_width) <= 0);

    % Plot time domain signals
    figure((i-1)*2+1)
    subplot(2,1,1)
    plot(t, xt)
    xlabel('Time (ms)')
    ylabel('Amplitude')
    title('Analog Signal')
    subplot(2,1,2)
    stem(n, xn)
    xlabel('Time (ms)')
    ylabel('Amplitude')
    title('Sampled Signal')

    % Take DTFT
    n = n * 100000;
    xf = dtft(xn, n, w);
    figure((i-1)*2+2)
    plot(w, abs(xf))
    xlabel('w')
    ylabel('|X(w)|')
    title('Magnitude of X(w)')
end

disp(['The major frequency component is at w = .628319 rad/sample which ' ...
    'translates to F = 10kHz with f = F/Fs and Fs = 100000kHz. It looks like
 there is ' ...
    'a minor peak about every 2000Hz which most likely comes from the
 step' ...
```

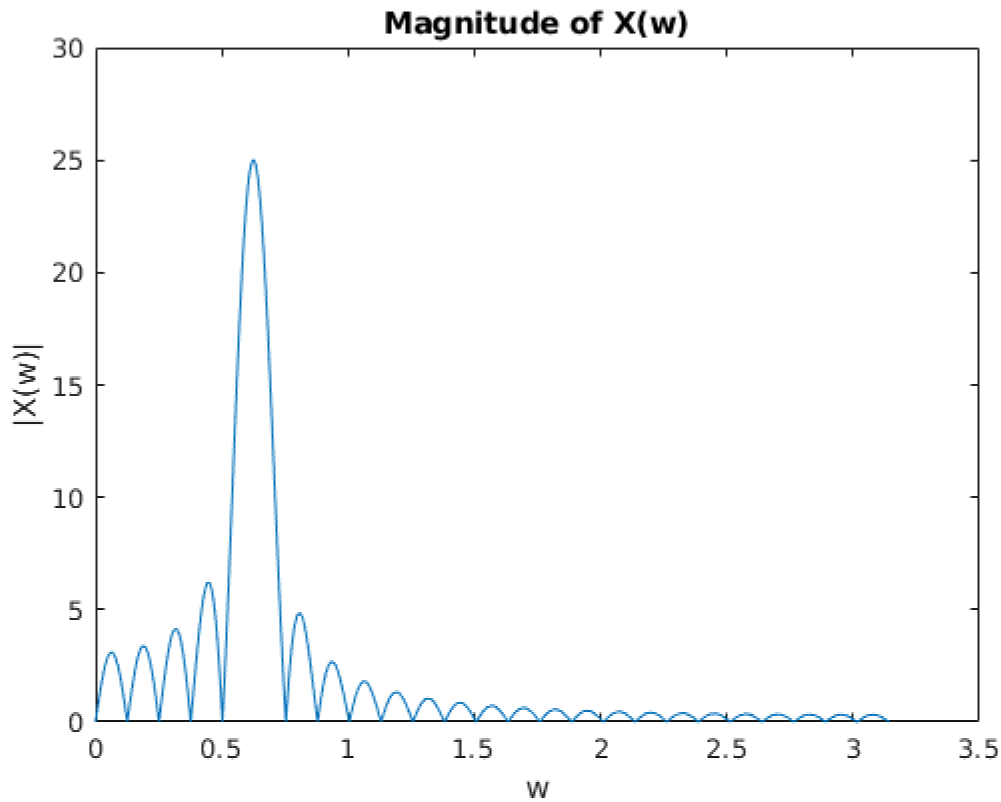
```
    'function. The DTFT of the signals look pretty much the same as
 eachother.'])
```

The major frequency component is at w = .628319 rad/sample which translates to F = 10kHz with f = F/Fs and Fs = 100000kHz. It looks like there is a minor peak about every 2000Hz which most likely comes from the stepfunction. The DTFT of the signals look pretty much the same as eachother.




Magnitude of X(w)
|X(w)|
w
0
0.5
1
1.5
2
2.5
3
3.5
5
10
15
20
25


Analog Signal
Amplitude
Time (ms)
$\times 10^{-3}$
Sampled Signal
Amplitude
Time (ms)
$\times 10^{-3}$



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DSP Ch4 HW

3) Find $x[n]$ given $X(\omega)$

a) $X(\omega) = 3 + 2\cos(\omega) + 4\cos(2\omega)$

FT Pair : $\mathcal{F}\{\delta[n]\} = 1$

Time shift : $\mathcal{F}\{\delta[n-n_0]\} = e^{j\omega n_0}$

$$X(f) = \sum_n x[n] e^{-j\omega n} = 3 + e^{j\omega} + e^{-j\omega} + 2e^{j2\omega} + 2e^{-j2\omega}$$

when $n = 0$, $x[n] = \delta(n)$

when $n = 1$, $x[n] = \delta[n-1]$

$\vdots$

cont

$$\boxed{\therefore\ x[n] = \delta[n] + \delta[n+1] + \delta[n-1] + 2\delta[n+2] + 2\delta[n-2]}$$

b) $X(\omega) = [1 - 6\cos[3\omega] + 8\cos[5\omega]]\, e^{-j\omega 3}$

Time shift 3 $\rightarrow x(n-k) = X(\omega)e^{-j\omega k}$

Following a) $\mathcal{F}^{-1}\{\cos(A\omega)\} = \delta[n+A] + \delta[n-A]$

Before time shift $\rightarrow$ $\delta[n] - 3\delta[n+3] - 3\delta[n-3] + 4\delta[n+5] + 4\delta[n-5]$

$$\therefore \boxed{x[n] = \delta[n-3] - 3\delta[n] - 3\delta[n-6] + 4\delta[n+2] + 4\delta[n-8]}$$

4) Plot $|H(\omega)|$ and $\measuredangle H(\omega)$

$y[n] = x[n] - x[n-1] + x[n-2] + .95y[n-1] - .9025y[n-2]$

$y[n] - .95y[n-1] + .9025y[n-2] = x[n] - x[n-1] + x[n-2]$

$Y(\omega) - .95Y(\omega)e^{-j\omega} + .9025Y(\omega)e^{-2j\omega} = X(\omega) - X(\omega)e^{-j\omega} + X(\omega)e^{-2j\omega}$

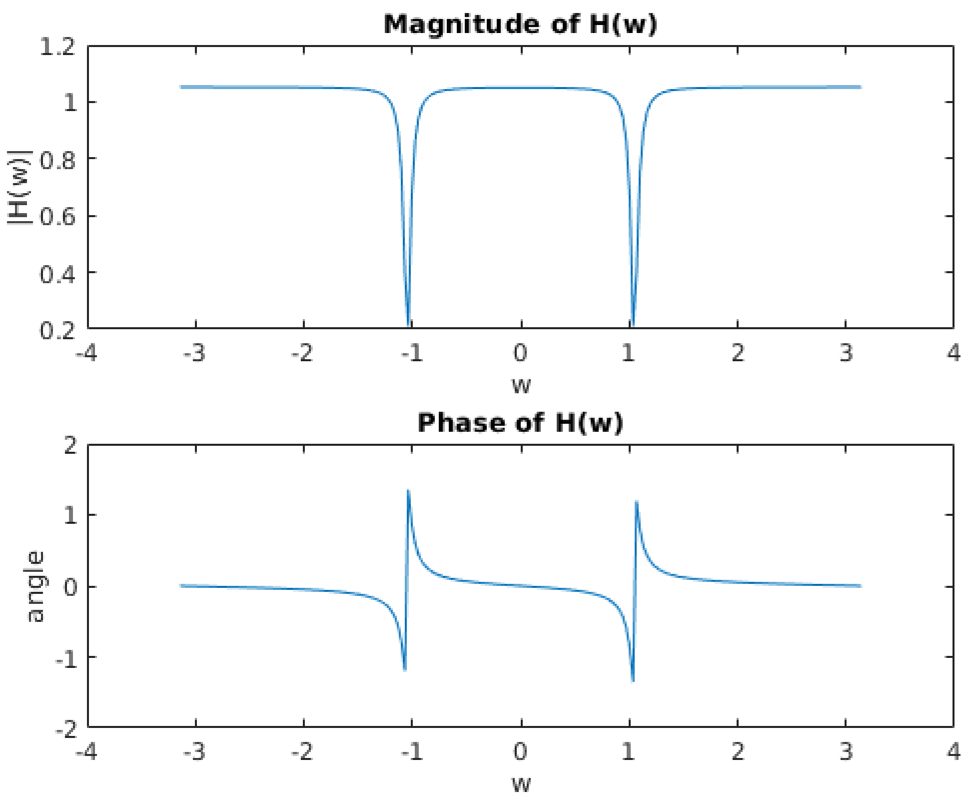
$$\boxed{H(\omega) = \frac{Y(\omega)}{X(\omega)} = \frac{1 - e^{-j\omega} + e^{-2j\omega}}{1 - .95e^{-j\omega} + .9025e^{-j2\omega}}}$$

```
%!----------------------------------------------------------------------------------------
%! DSP HW4 #4
%!  - Plot magnitude and phase of H(w)
%!----------------------------------------------------------------------------------------

%! Enviorment
w = (-100:100)*pi/100;    % -pi:pi

% Signal
h = (1 - exp(-1j*w) + exp(-2j*w)) ./ ...
    (1 - .95*exp(-1j*w) + .9025*exp(-2j*w));

% Plot
subplot(2,1,1)
plot(w, abs(h))
title('Magnitude of H(w)')
ylabel('|H(w)|')
xlabel('w')
subplot(2,1,2)
plot(w, angle(h))
title('Phase of H(w)')
ylabel('angle')
xlabel('w')
```



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