# HW1 442

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(2) $h(n) = (0.9)^{|n|}$

$$H(e^{jw}) = \sum_{n=-\infty}^{\infty} h[n] e^{-jwn} = \sum_{n=0}^{\infty} (0.9)^n e^{-jwn} + \sum_{-\infty}^{0} (0.9)^{-n} e^{-jwn} \quad \left[\begin{matrix}\text{geometric} \\ \text{sum}\end{matrix}\right]$$

See phase and mag plot

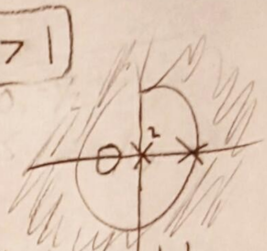
$$H(e^{jw}) = \frac{1}{1-0.9e^{-jw}} + \frac{0.9e^{jw}}{1-0.9e^{jw}}$$

(3) $x(n) = 2\delta(n-2) + 3u(n-3) \rightarrow Y(n) = 2z^{-2} + \frac{3z^{-3}}{1-z^{-1}} = \frac{2z^{-2}(1-z^{-3}) + 3z^{-3}}{1-z^{-3}}$

$$= \frac{2z^{-2} - z^{-5} + 3z^{-3}}{1-z^{-3}} = \frac{2z^{-2} + z^{-3}}{1-z^{-1}}$$

$\boxed{\text{ROC} \quad |z| > 1}$

right sided



$$= \frac{2z+1}{z^3 - z^2} \rightarrow \boxed{\begin{matrix}\text{zeros} = -0.5 \\ \text{poles} = 0 \text{ and } 1\end{matrix}}$$

See Matlab function and printout

(1) $r_{xx}$ is symmetrical with a peak in the center, meaning high correlation
$r_{yx}$ seems to be more correlated at lower values (optimal ≈ 5)
since $r_{xx}$ is autocorrelation, it should be highly correlated

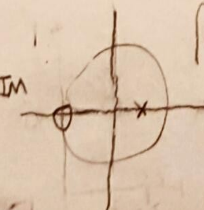
(4) $H(z) = \frac{z}{z-0.5} + \frac{1}{z-0.5}$ $\quad H(z) = \frac{z+1}{z-0.5}$ (causal) $= \frac{1}{1-0.5z^{-1}} + \frac{z^{-1}}{1-0.5z^{-1}}$

(i) $H(z) = \frac{z+1}{z-0.5} = \boxed{0.5^n u(n-1) + 0.5^{(n-1)} u(n-1) = h(n)}$

(ii) $H(z) = \frac{1+z^{-1}}{1-0.5z^{-1}} = \frac{Y(z)}{X(z)} \rightarrow Y(z)(1-0.5z^{-1}) = X(z)(1+z^{-1})$

$Y(z) = X(z) + z^{-1}X(z) + 0.5z^{-1}Y(z)$

$\boxed{y(n) = x(n) + x(n-1) + 0.5\,y(n-1)}$




(iii) $\boxed{\begin{matrix}\text{Zeros: } -1 \\ \text{Poles: } 0.5\end{matrix}}$

$x(n) = 3\cos(\pi n/3)u(n)$

(iv) $X(z) = \frac{1 - z^{-1}\cos\frac{\pi}{3}}{1-2z^{-1}\cos\frac{\pi}{3} + z^{-2}} = \frac{1-z^{-1}\left(\frac{1}{2}\right)}{1-z^{-1}+z^{-2}}$ $\quad X(z) * H(z) = \boxed{\frac{z^{-1}+1}{z^{-2}-z^{-1}+1} = Y(z)}$

$$Y(z) = \frac{z+z^2}{1-z+z^2} \rightarrow \frac{1}{z-1} + \frac{1}{z+1} \rightarrow \boxed{Y(n) = u(n-1) + (-1)^{n-1} u(n-1)}$$

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**CONV_M FUNCTION**

```
function [y, ny] = conv_m(x, nx, h, nh)
nyb = nx(1) + nh(1);
nye = nx(length(x)) + nh(length(h));
ny = [nyb:nye];
y = conv(x,h);
end
```

**PZ FUNCTION**

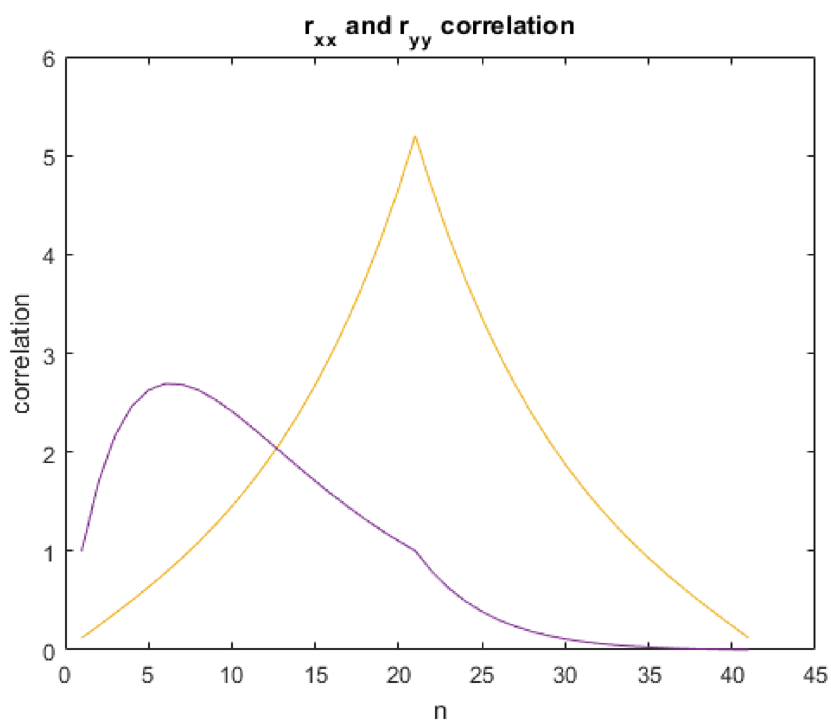
```
function [ z, p, k ] = pz( b, a )
fvtool(b,a,'polezero')
[b,a] = eqtflength(b,a);
[z,p,k] = tf2zp(b,a);
text(real(z)+.1,imag(z),'Zero')
text(real(p)+.1,imag(p),'Pole')

end
```

**CODE AND PLOTS**

```
%% Part 1
figure(1)
n = 0:20;
x = (0.9).^n;
n = -20:0;
y = (0.8).^-n;
% rxx
rxx = conv_m(x, n, fliplr(x), n);
plot(rxx); hold on
% rxy
ryy = conv_m(x, n, fliplr(y), n);
plot(ryy)

title('r_x_x and r_y_y correlation')
xlabel('n')
ylabel('correlation')
```



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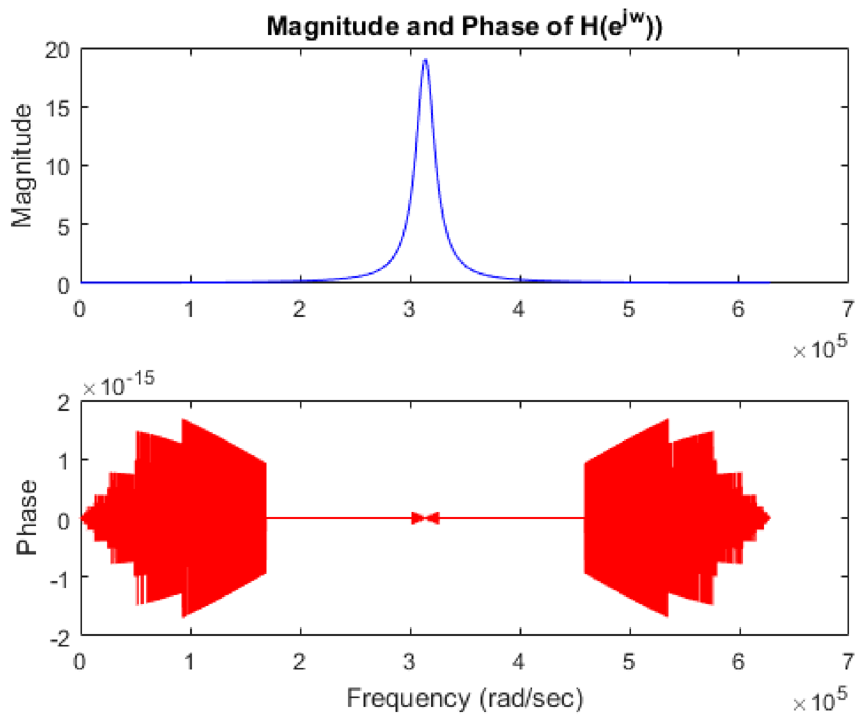
```
%% Part 2
figure(2)
w = -pi:0.00001:pi;
H = 0.9*exp(1i*w)./(1-0.9*exp(1i*w)) + 1./(1-0.9*exp(-1i*w));
subplot(2,1,1); plot(abs(H), 'b')
title('Magnitude and Phase of H(e^j^w))')
ylabel('Magnitude')
subplot(2,1,2); plot(angle(H), 'r')
ylabel('Phase')
xlabel('Frequency (rad/sec)')
```




```
%% Part 3
syms n
z_tran = ztrans(2*dirac(n-2) + 3*heaviside(n-3));

N = [0 0 2 1];
D = [1 -1 0 0]
[ z, p, k ] = pz(N, D)


% Using ztrans, the transfer function was verified. Also using my pz (pole zero)
function, I verified the pole zero plot
```

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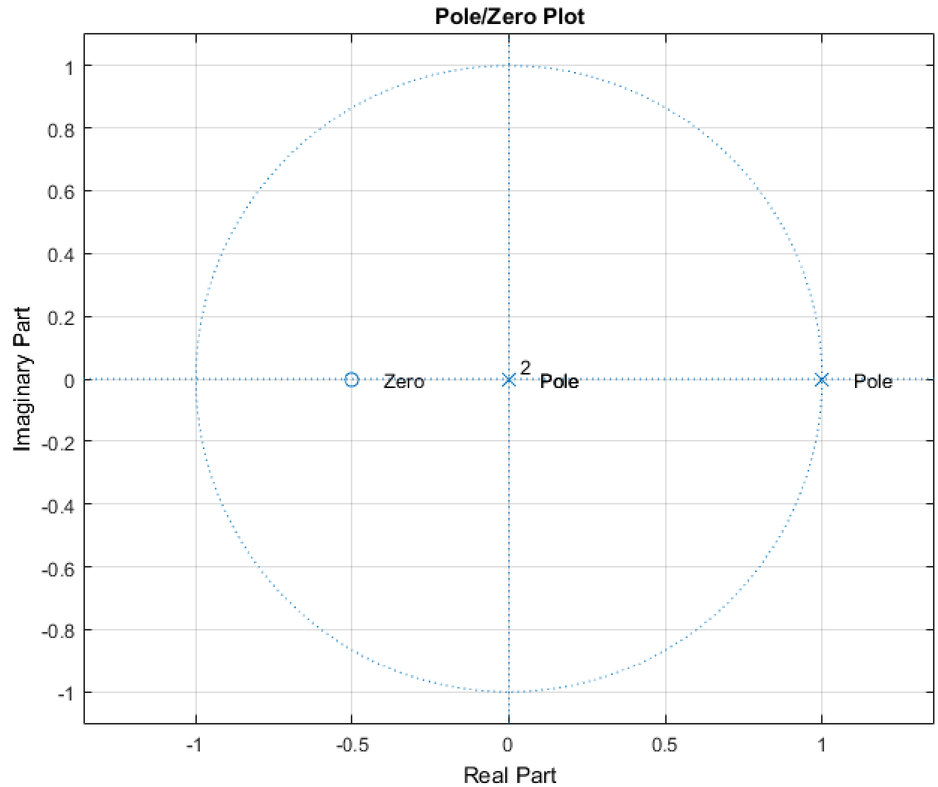
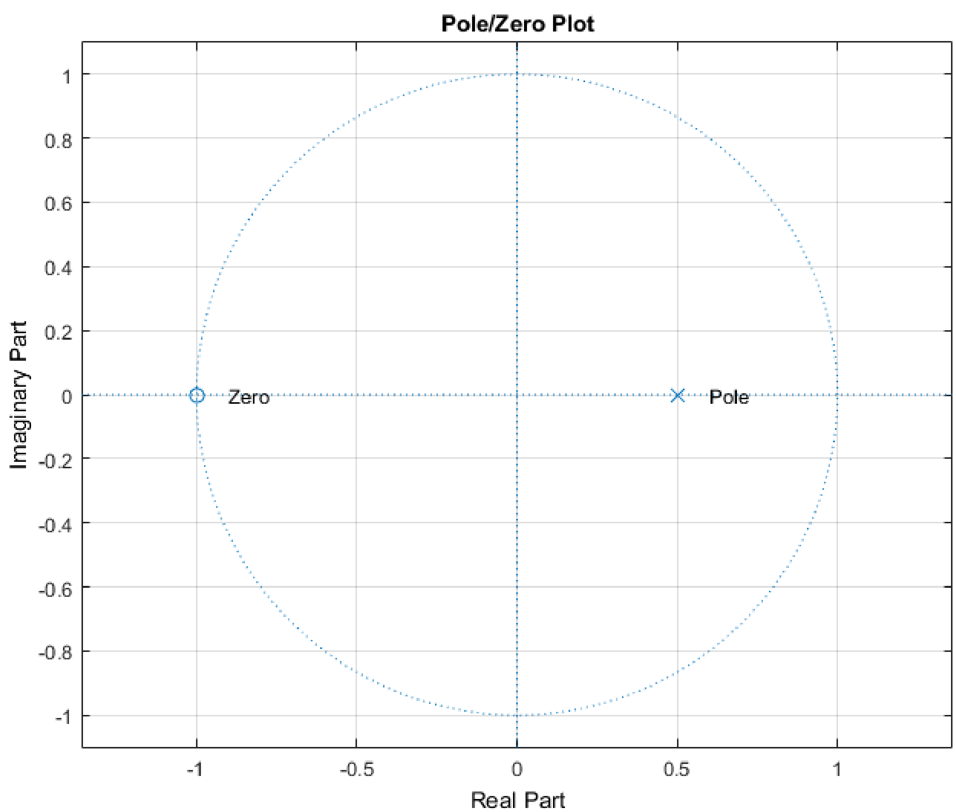



```
%% Part 4
N = [1 1];
D = [1 -0.5];
[ z, p, k ] = pz(N, D)
```



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```
%% Part 5
figure(3)
n= -100:0.1:100;
w = 100*n*2*pi/length(n);
x = heaviside(n)-heaviside(n-50);
x_shif = x.*exp(1i*pi/3*n);
x_shif2 = x.*exp(1i*pi/3*n);

% plots
subplot(5,1,1); plot(n, x)
title('Shifting rect in frequency
domain')
xlabel('n')
ylabel('Magnitude')
subplot(5,1,2); plot(n, x_shif)
xlabel('n (times exp)')
ylabel('Magnitude')
X = fftshift(fft(x));
X_shif = fftshift(fft(x_shif));
X_shif2 = fftshift(fft(x_shif2));

% plots
subplot(5,1,3); plot(w, abs(X))
xlabel('w')
xlim([-2*pi, 2*pi])
ylabel('Magnitude')
subplot(5,1,4); plot(w, abs(X_shif));
xlabel('w (shifted pi/3')
xlim([-2*pi, 2*pi])
ylabel('Magnitude')
subplot(5,1,5); plot(w, abs(X_shif));
xlabel('w (shifted 11*pi/3)')
xlim([-2*pi, 2*pi])
ylabel('Magnitude')
```