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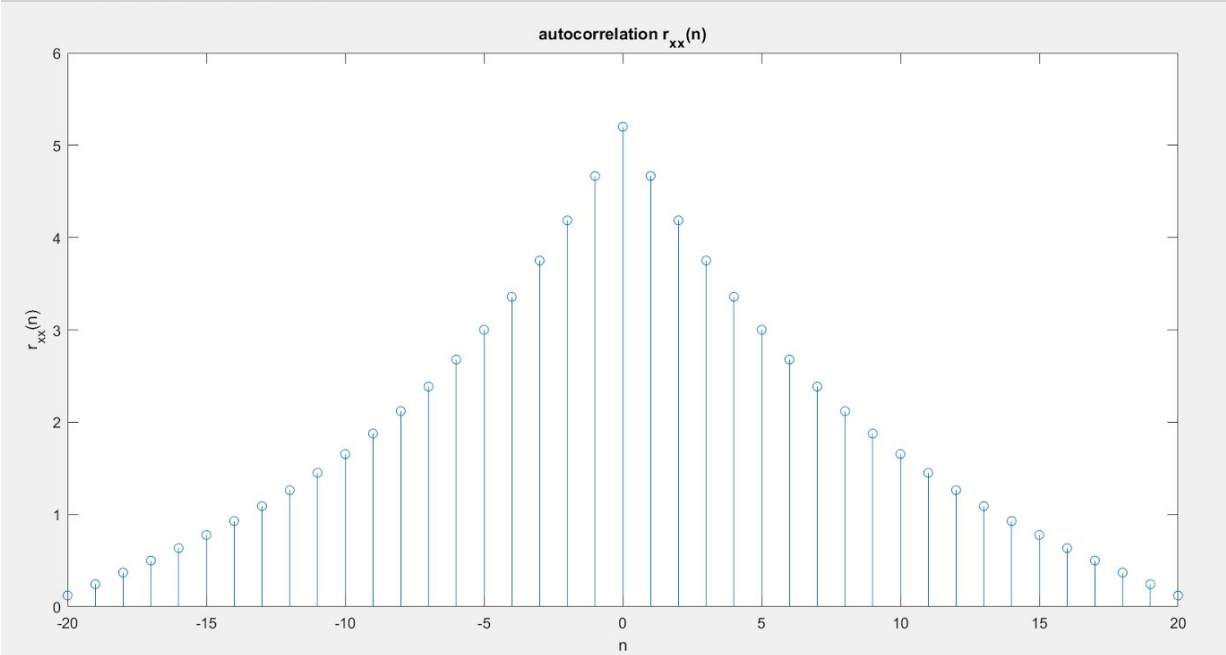
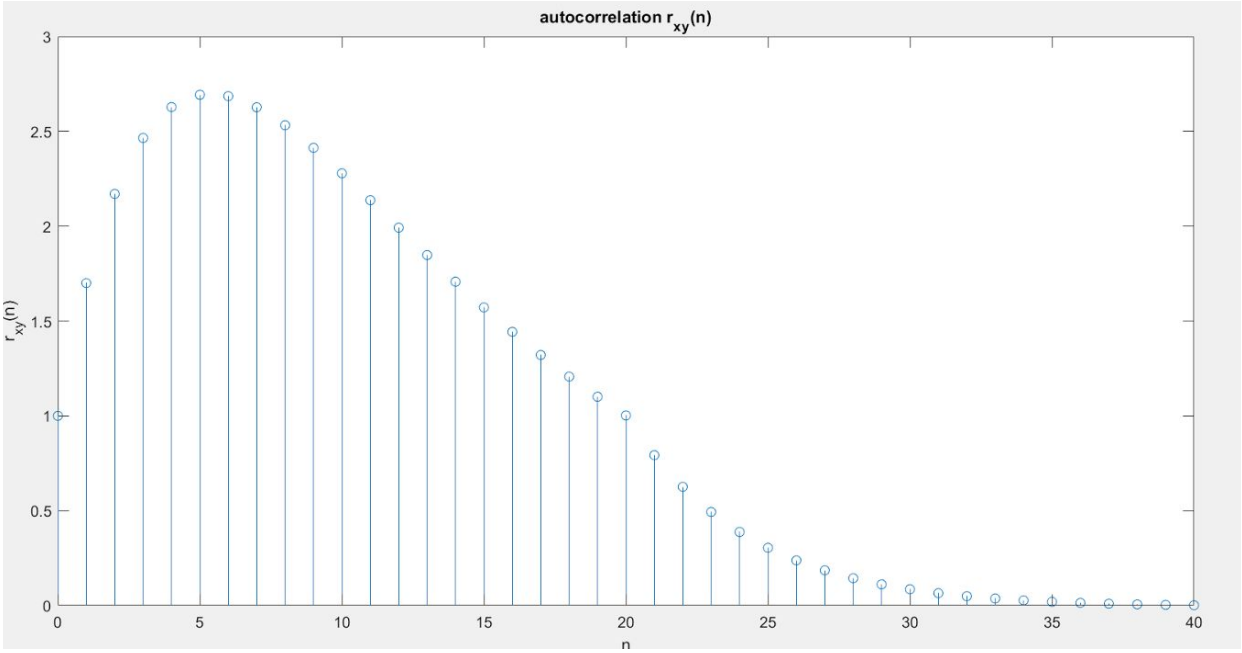
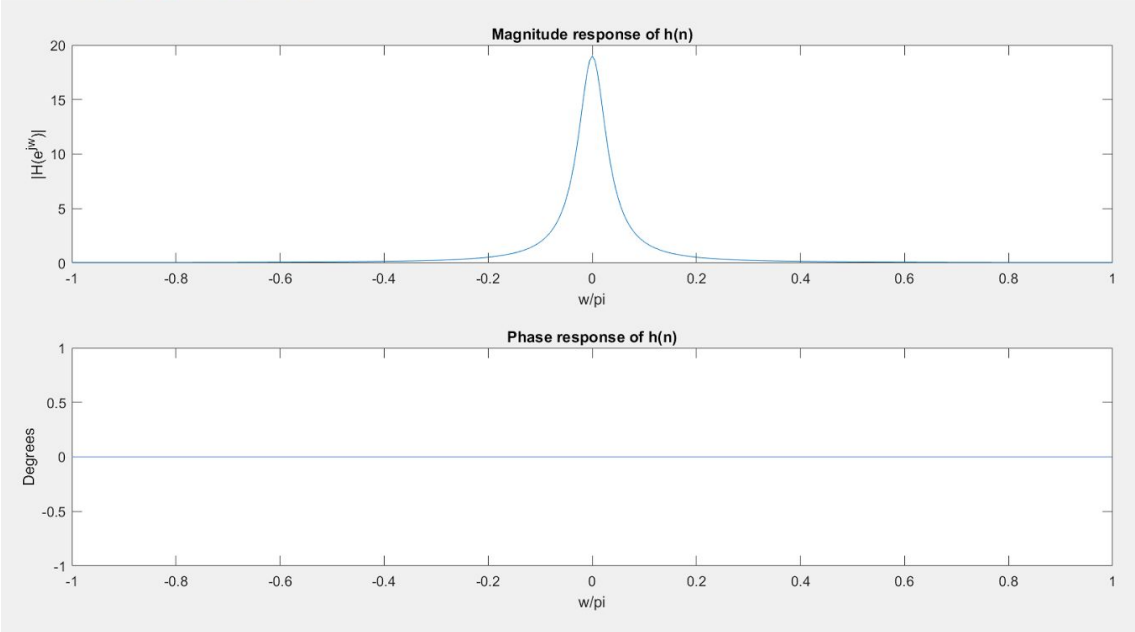
EE 442 Homework 1

1. Output

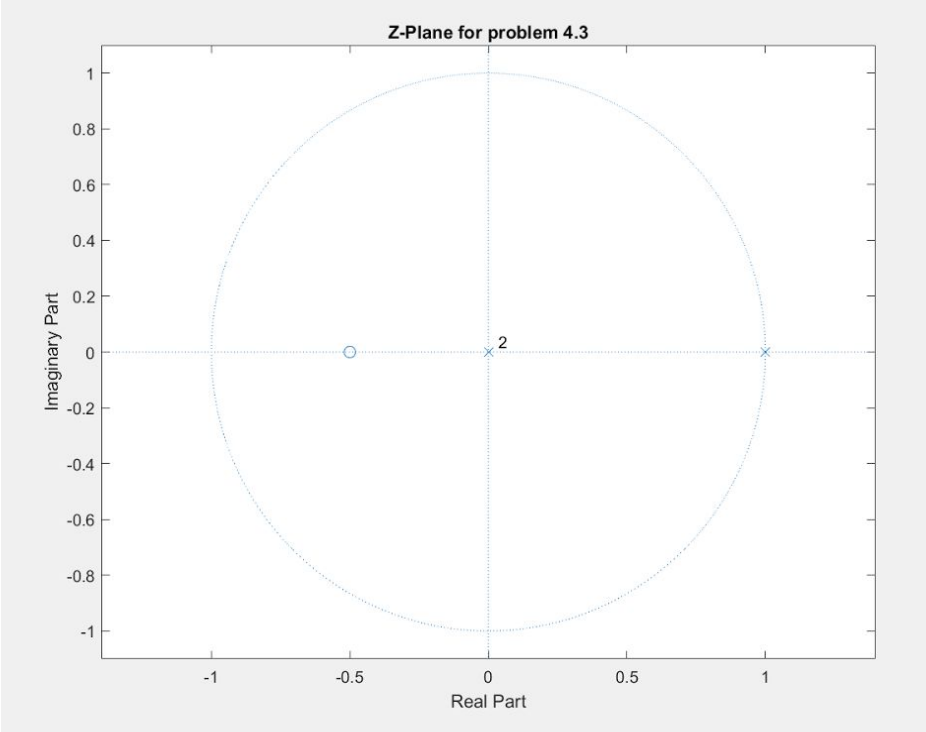




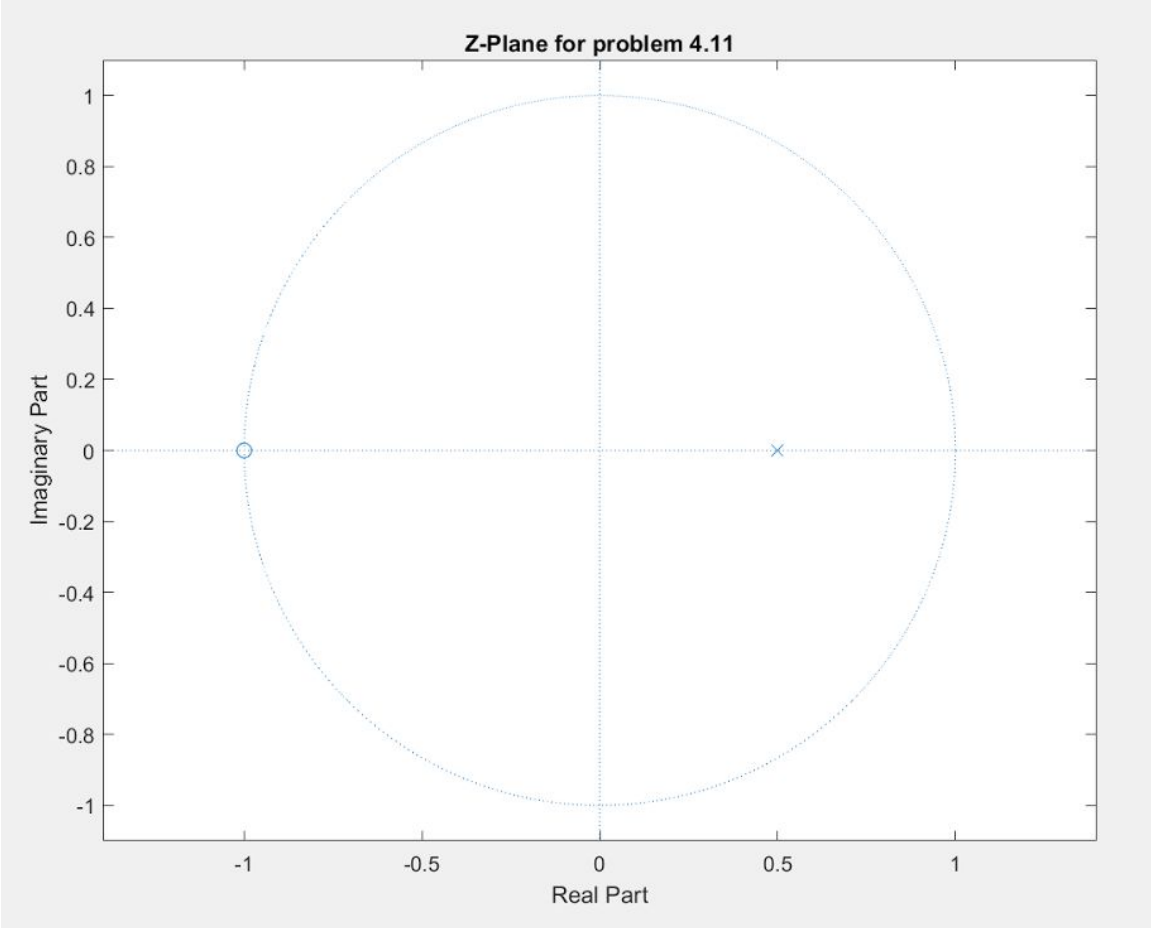
2.


Magnitude response of h(n)
|H(e^jw)|
w/pi
Phase response of h(n)
Degrees
w/pi

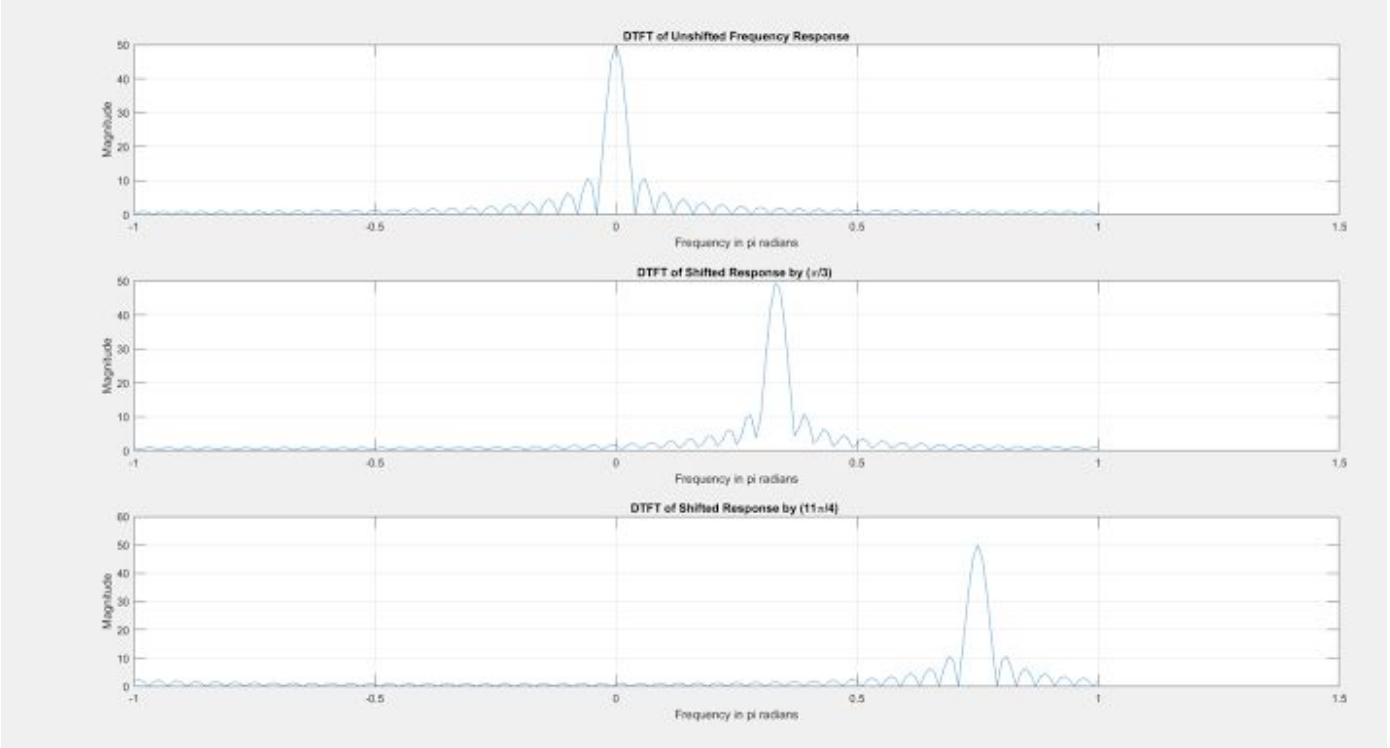
3.


Z-Plane for problem 4.3
Imaginary Part
Real Part
2

4.


Z-Plane for problem 4.11
Imaginary Part
Real Part
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1

5.



Code for Homework 1

```
%%
% Problem 2.9 Proakis Ingle
% part rxx
close all;
clear;
nX = 0:20;
x = 0.9.^nX;
[soln,axis] = conv_m(x, nX , fliplr(x), nX);
figure;
stem(-20:20,soln);
xlabel('n');
ylabel('r_x_x(n)');
title('autocorrelation r_x_x(n)');

% part rxy

nY = -20:0;
```

```
y = 0.8.^(-nY);
[soln2, axis2] = conv_m(x, nX, fliplr(y), nY);
figure(2);
stem(0:40, soln2);
xlabel('n');
ylabel('r_x_y(n)');
title('autocorrelation r_x_y(n)');
```

```
%%
close all;
clear;
% Problem 3.11 Proakis Ingle
w = (-200:200) * pi/200;
H = 0.19 * ones(size(w)) ./ (1.81 - 1.8 * cos(w));
mag = abs(H);
pha = angle(H);
figure;
subplot(2,1,1);
plot(w/pi, mag);
xlabel('w/pi');
ylabel('|H(e^j^w)|');
title('Magnitude response of h(n)');
subplot(2,1,2);
plot(w/pi, pha);
xlabel('w/pi');
ylabel('Degrees');
title('Phase response of h(n)');
```

```
%%
close all;
clear;
%Problem 4.3 Proakis Ingle
b = [0 0 2 1];
a = [1 -1];
figure;
zplane(b,a);
title('Z-Plane for problem 4.3');

%%
close all;
clear;
% Problem 4.11 Proakis Ingle
b = [1 1];
a = [1 -0.5];
figure;
zplane(b,a);
title('Z-Plane for problem 4.11');


%%
close all;
clear;
% Problem No 5 HW 1 EE 442
L = 50;
n = 1:L;
x = ones(1,L);
k = -100:100;
w = (pi/100)*k;
X = x * (exp(-1i*pi/100)).^(n'*k);
y = exp(1i*pi*n/3).*x;
Y = y * (exp(-1i*pi/100)).^(n'*k);
z = exp(1i*11*pi*n/4).*x;
Z = z * (exp(-1i*pi/100)).^(n'*k);

figure;
subplot(3,1,1);
plot(w/pi, abs(X));
```

```
grid;
title('DTFT of Unshifted Frequency Response');
xlabel('Frequency in pi radians');
ylabel('Magnitude');
subplot(3,1,2);
plot(w/pi, abs(Y));
grid;
title('DTFT of Shifted Response by (\pi/3) ');
xlabel('Frequency in pi radians');
ylabel('Magnitude');
subplot(3,1,3);
plot(w/pi, abs(Z));
grid;
title('DTFT of Shifted Response by (11\pi/4) ');
xlabel('Frequency in pi radians');
ylabel('Magnitude');
```

2. DTFT

$$H(e^{jw}) = \sum_{n=-\infty}^{n=\infty} 0.9^{|n|} e^{-jwn}$$

$$= \underbrace{\sum_{n=0}^{\infty} 0.9^{n} e^{-jwn}} + \sum_{n=-\infty}^{-1} 0.9^{-n} e^{-jwn}$$

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

$$= \frac{1-0.9^2}{1-2(0.9)\cos(w)+0.9^2} \Rightarrow \frac{1-a^2}{1-2a\cos w+a^2}$$

$$= \frac{0.19}{1.81-1.8\cos(w)}$$

3. $x(n) = 2\delta(n-2)+3u(n-3)$

Using table and properties

$$\Downarrow$$

$$2z^{-2}+3z^{-3}u(n)$$

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

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

$$= \frac{2z^{-2}+z^{-3}}{1-z^{-1}}, \text{ ROC } |z|>1$$

From $2\delta(n-2)$, ROC: All z

From $3u(n-3)$

ROC $|z|>1$

So ROC $|z|>1$

4.

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

$$= |z| > 0.5$$

i. impulse response

$$h[n] = 0.5^n u[n] + 0.5^{n-1} u[n-1]$$

ii. Difference equation

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

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

$$= y(n) - 0.5y[n-1] = x[n] + x[n-1]$$

$$= Y[n] = x[n] + x[n-1] + 0.5y[n-1]$$

iii. Pole zero plot given with the figures

iv. $x[n] = 3\cos\left[\frac{\pi n}{3}\right] u[n]$

$$= 3\left[\frac{1 - \cos\left(\frac{\pi}{3}\right)z^{-1}}{1 - 2\cos\left(\frac{\pi}{3}\right)z^{-1} + z^{-2}}\right] \quad |z| > 1$$

$$= 3\left[\frac{1-0.5z^{-1}}{1 - z^{-1} + z^{-2}}\right] \left[\frac{1+z^{-1}}{1-0.5z^{-1}}\right]$$

$$= 3\left[\frac{\cancel{1-0.5z^{-1}}(1+z^{-1})}{1 - z^{-1} + z^{-2}\cancel{(1-0.5z^{-1})}}\right] = 3\left[\frac{1+z^{-1}}{1-z^{-1}+z^{-2}}\right]$$

$$= 3\left[\frac{1-0.5z^{-1}+z^{-1}}{1-z^{-1}+z^{-2}}\right] = 3\,\frac{1-0.5z^{-1}}{1-z^{-1}+z^{-2}} + 3\sqrt{3}\,\frac{\frac{\sqrt{3}}{2}z^{-1}}{1-z^{-1}+z^{-2}}$$

$$y(n) = 3\cos\left(\frac{\pi n}{3}\right)u(n) + 3\sqrt{3}\sin\left(\frac{\pi n}{3}\right)u(n)$$