CECS 463 System On Chip II
FALL 2020

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Assignment #05 – More Z-Transforms of Chapter 4

10/22/2020

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% Kuldeep Gohil
% CECS 463 Fall20
% Assignment #05 Due: 10/22/2020

clc; close all;
```

Problem 1: Check your function on following operation.

```
% ((z^2 + z + 1 + z^-1 + z^-2 + z^-3) / (z + 2 + z^-1)) = ...
% = (z - 1 + 2z^-1 - 2z^-2 ) + ((3z^-2 + 3z^-3) / (z + 2 + z^-1))

disp('Lab 05');
disp('Problem 1:');
A = [1, 2, 1];
B = [1, 1, 1, 1, 1, 1];
NA = [-1 : 1];
NB = [-2 : 3];
[P, NP, R, NR] = deconv_m(B, NB, A, NA)
disp(' = (z - 1 + 2z^-1 - 2z^-2) + ( (3z^-2 + 3z^-3)/(z + 2 + z^-1) )');
```

```
Lab 05

Problem 1:

P = 1    -1     2    -2

NP = -1     0     1     2

R = 0     0     0     0     3     3

NR = -2    -1     0     1     2     3

= (z - 1 + 2z^-1 - 2z^-2) + ( (3z^-2 + 3z^-3)/(z + 2 + z^-1) )
```

Problem 2: Determine the following inverse z-transforms using the partial fraction expansion method.

```
% x(z) = ( z / (z^3 + 2z^2 + 1.25z + 0.25)) with ROC |z| > 1
% = ( (z^-2) / (1 + 2z^-1 + 1.25z^-2 + 0.25z^-3) )


disp('Problem 2:');
A = [1, 2, 1.25, 0.25];
B = [0, 0, 1];
[R, P, K] = residuez(B, A)
disp('Inverse z-transform: ');
disp('( 4/(1-(-0.5z^-1) ) + ( 4z((0.5z^-1)/([1-(-0.5)z^-1]^2) ) ...');
disp('... -(4 (1/(1 - (0.5^-1)) ) + (4z ((0.5z^-1)/((1 - (0.5^-1)^2 ), |z| < 0.5');
```

```
Problem 2:



R = 4.0000 + 0.0000i

    0.0000 + 0.0000i

   -4.0000 + 0.0000i

P = -1.0000 + 0.0000i

    -0.5000 + 0.0000i

    -0.5000 - 0.0000i

K = []

Inverse z-transform:

( 4/(1-(-0.5z^-1) ) + ( 4z((0.5z^-1)/([1-(-0.5)z^-1]^2) ) ...

... -(4 (1/(1 - (0.5^-1)) ) + (4z ((0.5z^-1)/((1 - (0.5^-1)^2 ), |z| < 0.5
```

Problem 3: Solved on Paper

```
disp('Problem 3:');
prob3_1 = imread('Prob3.1.jpg');
prob3_2 = imread('Prob3.2.jpg');
prob3_3 = imread('Prob3.3.jpg');
prob3_4 = imread('Prob3.4.jpg');


figure('NumberTitle','off','Name','Problem 3.i');
%Prob3.i
imshow(prob3_1)
figure('NumberTitle','off','Name','Problem 3.ii');
%Prob3.ii
imshow(prob3_2)
figure('NumberTitle','off','Name','Problem 3.iii');
%Prob3.iii
imshow(prob3_3)
figure('NumberTitle','off','Name','Problem 3.iv');
%Prob3.iv
imshow(prob3_4)
```

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Problem 3:
```
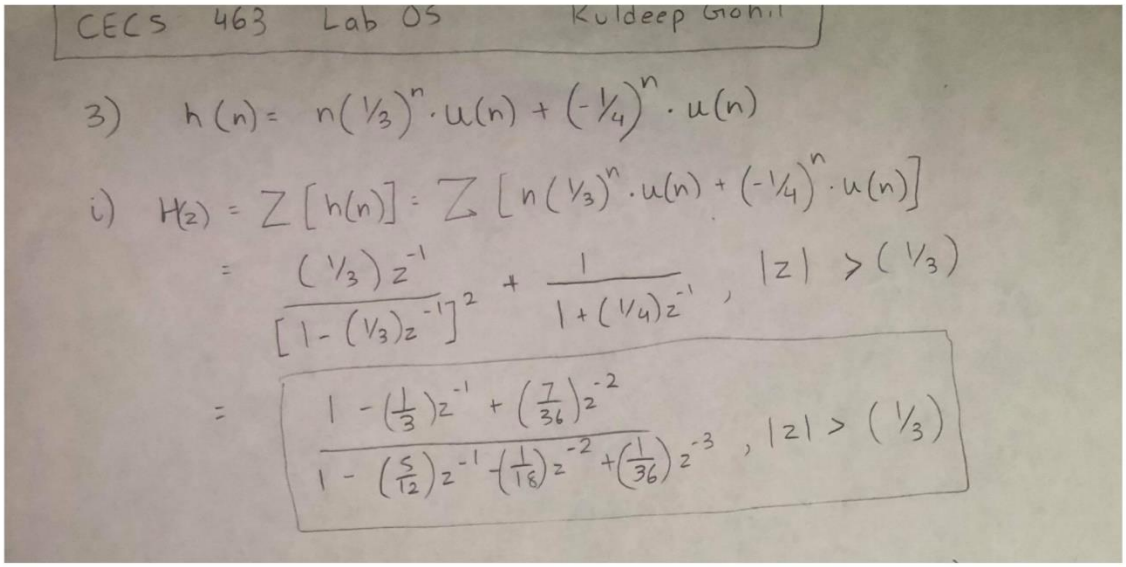
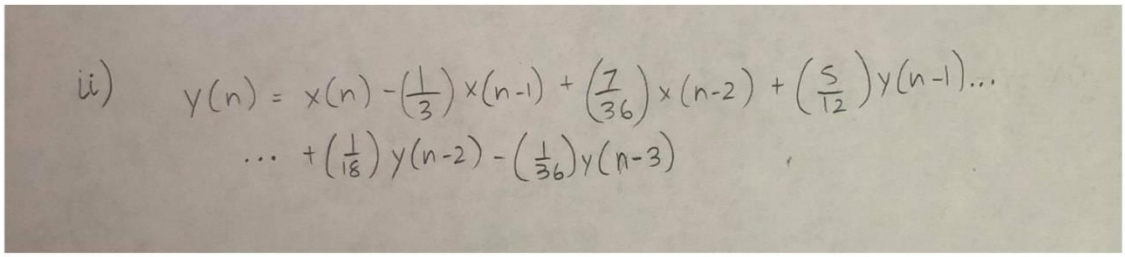
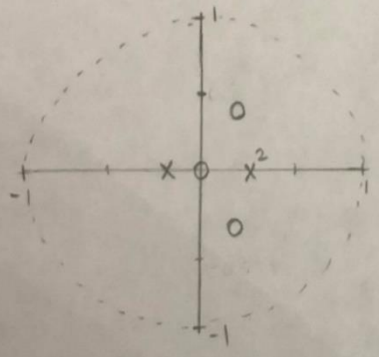





iii) **Pole-Zero Plot**



- should look something like that

iv) $Y(z) = H(z)\,X(z)$, $|z| > 1/3$

$$H(z) = \left(\frac{1 - (1/3)z^{-1} + \frac{7}{36}z^{-2}}{1 - \frac{5}{12}z^{-1} - \frac{1}{18}z^{-2} + \frac{1}{36}z^{-3}}\right)$$

$$X(z) = \left(\frac{1}{1 - 0.25z^{-1}}\right)$$

$$Y(z) = \frac{-16}{1-(\frac{1}{3})z^{-1}} + \frac{4}{(1-(\frac{1}{3})z^{-1})^2} + \frac{(1/2)}{(1+(1/4)z^{-1})} + \frac{25/2}{(1-\frac{1}{4}z^{-1})}, \quad |z| > 1/3$$

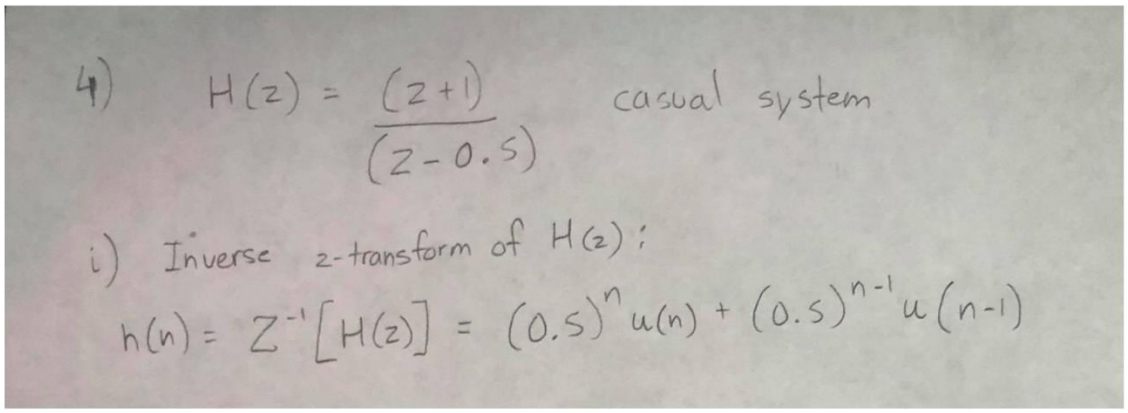
$$= \frac{-16}{1-(1/3z^{-1})} + 12z\left(\frac{(1/3)z^{-1}}{(1-(\frac{1}{3})z^{-1})^2}\right) + \left(\frac{(1/2)}{(1+1/4\,z^{-1})}\right) + \left(\frac{(25/2)}{(1-(1/4)z^{-1})}\right), \quad |z| > 1/3$$

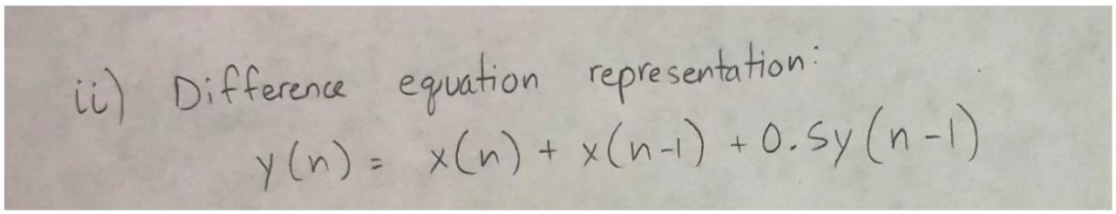
$$y(n) = -16(1/3)^n u\cdot n + 12(n+1)(1/3)^{n+1}\cdot u(n+1) + \frac{1}{2}(-1/4)^n \cdot u(n) + \frac{25}{2}(1/4)^n \cdot u(n)$$

Problem 4: Solved on Paper

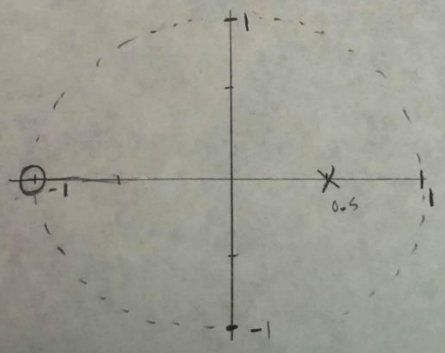
```
disp('Problem 4:');
prob4_1 = imread('Prob4.1.jpg');
prob4_2 = imread('Prob4.2.jpg');
prob4_3 = imread('Prob4.3.jpg');
prob4_4 = imread('Prob4.4.jpg');

figure('NumberTitle','off','Name','Problem 4.i');
%Prob4.i
imshow(prob4_1)
figure('NumberTitle','off','Name','Problem 4.ii');
%Prob4.ii
imshow(prob4_2)
figure('NumberTitle','off','Name','Problem 4.iii');
%Prob4.iii
imshow(prob4_3)
figure('NumberTitle','off','Name','Problem 4.iv');
%Prob4.iv
imshow(prob4_4)
```

```
Problem 4:
```





iii) Pole - zero plot



iv) $y(n)$ output if input is $x(n) = 5\left(\frac{1}{4}\right)^n \cdot u(n)$

$$X(z) = Z\left[3\cos\left(\pi n/3\right)\cdot u(n)\right] = 3\left(\frac{1-\left[\cos(\pi/3)\right]\cdot z^{-1}}{1-\left[2\cos(\pi/3)\right]z^{-1}+z^{-2}}\right.$$

$$= 3\left(\frac{1-0.5z^{-1}}{1-z^{-1}+z^{-2}}\right), \quad |z|>1$$

z-transform of $y(n)$:

$$y(z) = H(z)\,X(z)$$

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

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

$$y(z) = 3\left(\frac{1+z^{-1}}{1-z^{-1}+z^{-2}}\right) = 3\left(\frac{1-0.5z^{-1}+1.5z^{-1}}{1-z^{-1}+z^{-2}}\right)$$

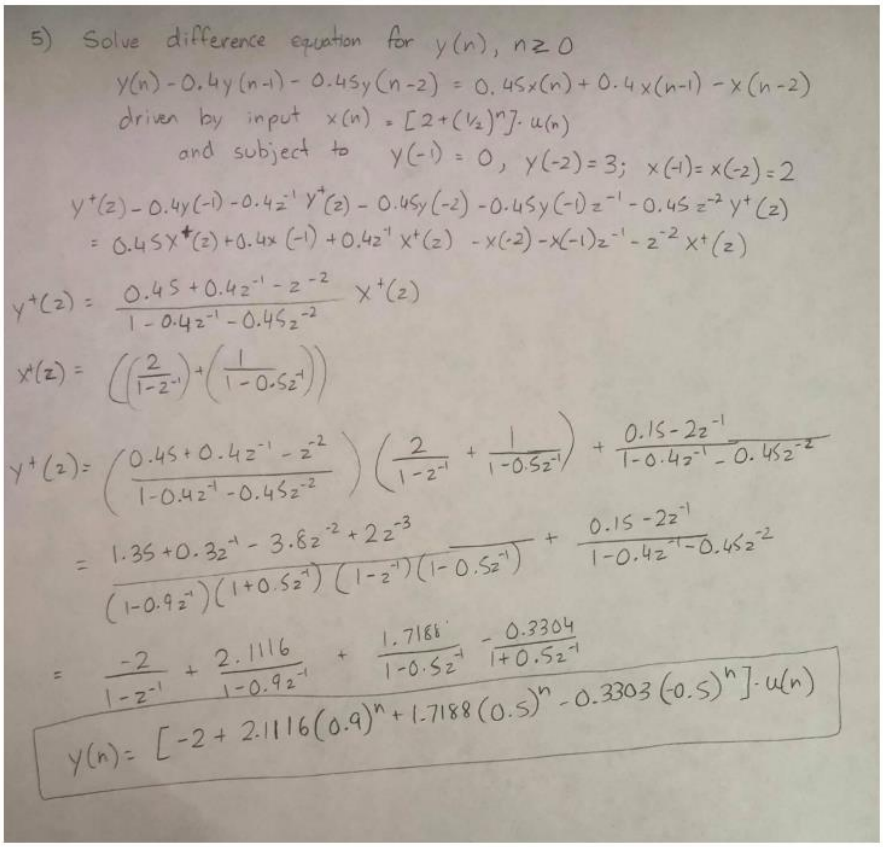
$$= 3\left(\frac{1-0.5z^{-1}}{1-z^{-1}+z^{-2}}\right) + 3\sqrt{3}\left(\frac{\left(\frac{\sqrt{3}}{2}\right)z^{-1}}{1-z^{-1}+z^{-2}}\right), \quad |z|>1$$

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

Problem 5: Solved on Paper

```
disp('Problem 5:');
prob5_yn = imread('Prob5.jpg');
prob5_1 = imread('Prob5.1.jpg');
prob5_2 = imread('Prob5.2.jpg');
prob5_3 = imread('Prob5.3.jpg');
prob5_4 = imread('Prob5.4.jpg');

figure('NumberTitle','off','Name','Problem 5 y(n)');
%Prob5 Solution of y(n)
imshow(prob5_yn)
figure('NumberTitle','off','Name','Problem 5.i');
%Prob5.i
imshow(prob5_1)
figure('NumberTitle','off','Name','Problem 5.ii');
%Prob5.ii
imshow(prob5_2)
figure('NumberTitle','off','Name','Problem 5.iii');
%Prob5.iii
imshow(prob5_3)
figure('NumberTitle','off','Name','Problem 5.iv');
%Prob5.iv
imshow(prob5_4)
```

```
Problem 5:
```



i) Transient Response:

$$y_{tr}(n) = [2.1116(0.9)^n + 1.7188(0.5)^n - 0.3303(-0.5)^n] \cdot u(n)$$

ii) Steady-State Response:

$$y_{ss}(n) = -2$$

iii) Zero-input Response:

$$Y_{zi}^{+}(z) = \frac{0.15 - 2z^{-1}}{1 - 0.4z^{-1} - 0.45z^{-2}} = \frac{-1.3321}{1 - 0.9z^{-1}} + \frac{1.4821}{1 + 0.5z^{-1}}$$

or

$$y_{zi}(n) = [-1.3321(0.9)^n + 1.4821(-0.5)^n] \cdot u(n)$$

iv) Zero - state Response :

$$Y_{zs}^{+}(z) = \frac{1.35 + 0.3z^{-1} - 3.8z^{-2} + 2z^{-3}}{(1-0.9z^{-1})(1+0.5z^{-1})(1-z^{-1})(1-0.5z^{-1})}$$

$$= \frac{-2}{1-z^{-1}} + \frac{3.4438}{1-0.9z^{-1}} + \frac{1.7187}{1-0.5z^{-1}} - \frac{1.8125}{1+0.5z^{-1}}$$

or

$$Y_{zs}(n) = \left[-2 + 3.4438(0.9)^n + 1.7187(0.5)^n - 1.8125(-0.5)^n\right] \cdot u(n)$$