Glasgow College, UESTC

Digital Signal Processing

Lab 2

Author: Changgang Zheng
UoG ID: 2289258Z
UESTC ID: 2016200302027
E-mail: chnaggangzheng@std.uestc.edu.cn

University of Glasgow

电子科技大学
University of Electronic Science and Technology of China

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CHANGGANG ZHENG[1]

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INTRODUCTION

This report is the homework that should be finished on the MATLAB, there are four questions about Digital Signal Processing. Which is about generate the complex exponential functions, explore their properties, understand the sampling theory and understand the true meaning of the autocorrelation.

1*Glasgow College, University of Electronic Science and Technology of China, ChengDu, China*

1 PROBLEM 1

Write a MATLAB program to compute the first L samples of the inverse of rational Z-transforms where the value of L is provided by the user through the command input. Using this program to compute and plot the first 50 samples of the inverse of following G(z). Use the command stem for plotting the sequence generated by the inverse transform.

$$G(z) = -2 + \frac{10}{4 + z^{-1}} - \frac{8}{2 + z^{-1}}, |z| > 0.5 \tag{1}$$

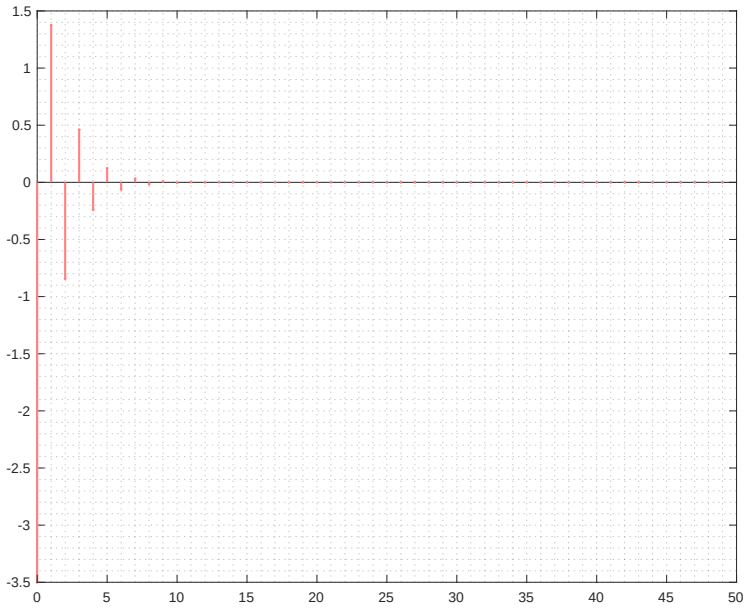


Figure 1: inverse transform

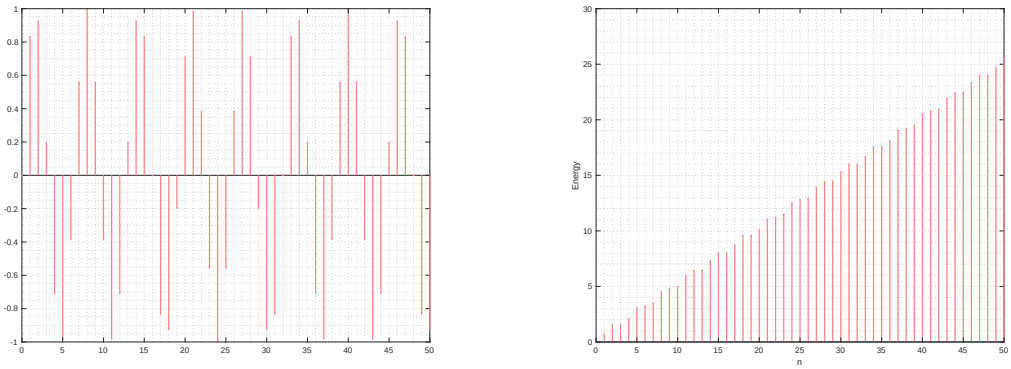
```
%% Problem 1
% L=input('input the L=');
L=50;
r=[10/4 -8/2];
p=[-1/4 -1/2];
k=-2;
[B,A]=residuez(r,p,k);
[h t]=impz(B,A,L);
p1 = figure;
stem(t,h,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
grid minor
set(p1, 'PaperPosition', [0.05 0.05 9 7]);
set(p1, 'PaperSize', [9.05 7.05]);
saveas(p1,['p1.pdf'],'pdf')
```

2 PROBLEM 2

Generate and plot a sequence with $0 \leqslant n \leqslant 50$. Compute the energy of the sequence.

$$x[n] = \sin\left(\frac{5\pi}{16}n\right) \tag{2}$$

Compute the energy of the sequence is 25.5449



plot of the sequence energy of the sequence

Figure 2: plot and energy of the sequence

```
%% Problem 2

n=0:50;
x=sin(5*pi*n/16);
p2 = figure;
stem(n,x,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
grid minor
set(p2, 'PaperPosition', [0.05 0.05 9 7]);
set(p2, 'PaperSize', [9.05 7.05]);
saveas(p2,['p2.pdf'],'pdf')

syms n;
x1=sin(5*pi*n/16).^2;
y1=zeros(1,50);
n1=1:50;
for i=1:50
    y=symsum(x1,n,0,i);
    y1(i)=double(y);
end
p22 = figure;
stem(n1,y1,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
xlabel('n');
ylabel('Energy');
grid minor
set(p22, 'PaperPosition', [0.05 0.05 9 7]);
```

```
26 set(p22, 'PaperSize', [9.05 7.05]);
27 saveas(p22,['p22.pdf'],'pdf')
```

3 PROBLEM 3

Writing a MATLAB program to compute the circular convolution of two length-N sequences via the DFT-based approach. Using this program to determine the following pair of sequences and plot the result sequence.

$$g[n] = \{7, 4, -9, 0, 2, -5\}, h[n] = \{1, -1, 2, 0, 10, 5\} \tag{3}$$

$$g[n] = e^{j\pi n/4}, h[n] = 2^n 0 \leqslant n \leqslant 15 \tag{4}$$

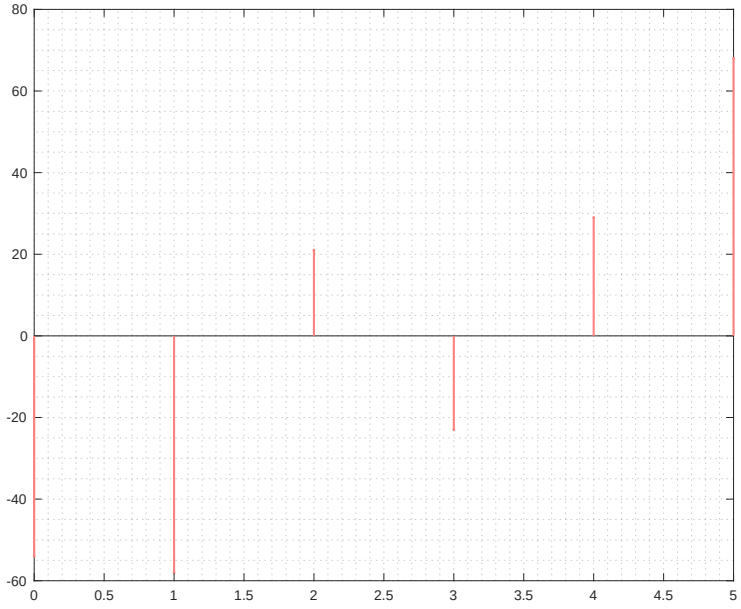


Figure 3: Magnitude and phase spectrum of the sampled sequence

```
1 %% Problem 3
2
3 x1=[7 4 -9 0 2 -5];
4 x2=[1 -1 2 0 10 5];
5 L=length(x1);
6 y=zeros(1,L);
7 x2tr = [x2(1) x2(L:-1:2)];
8 for k = 1:L
```

```
    sh = circshift(x2tr', k-1)';
    h = x1.*sh;
    y(k) = sum(h);
end
disp(y);
n=0:length(x1)-1;
p3 = figure;
stem(n,y,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
grid minor
set(p3, 'PaperPosition', [0.05 0.05 9 7]);
set(p3, 'PaperSize', [9.05 7.05]);
saveas(p3,['p3.pdf'],'pdf')
```

4 PROBLEM 4

Write a MATLAB program to compute and plot the response of input and a causal finite-dimensional discrete-time system characterized by a difference equation of the following form:

$$\begin{aligned} y[n] + 0.3 * y[n-1] + 0.5 * y[n-2] - 0.72 * y[n-3] = \\ 1.8 * x[n] + 0.34 * x[n-1] - 1.32 * x[n-2] - 0.86 * x[n-3] \end{aligned} \tag{5}$$

Generate and plot the first 31 samples of the sinusoidal response of the system.

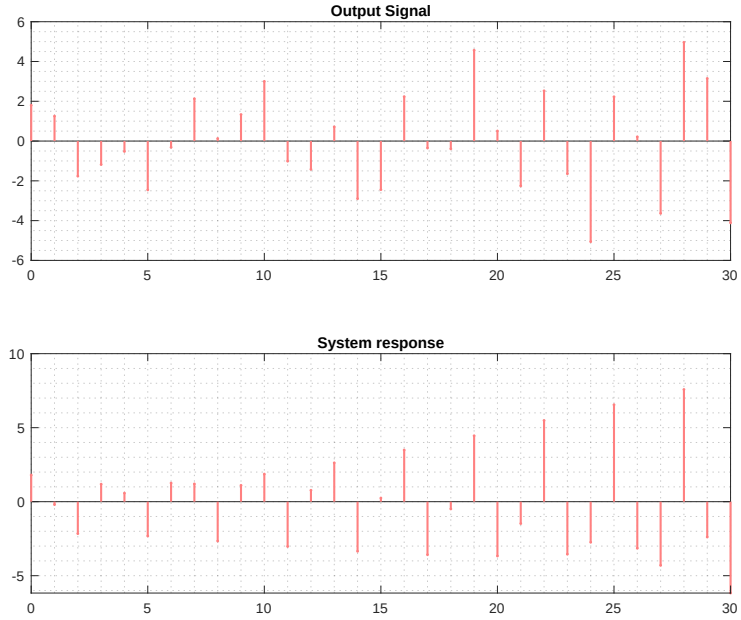


Figure 4: Magnitude and phase spectrum of the sampled sequence

```
1
2  %% Problem 4
3
4  num=[1.8 0.34 -1.32 -0.86];
5  den=[1 0.3 0.5 -0.72];
6  n=0:30;
7  x=cos(0.2*pi*n);
8  y=filter(num,den,x);
9  p4 = figure;
10 subplot(2,1,1)
11 stem(n,y,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
12 title('Output Signal');
13 grid minor
14 subplot(2,1,2)
15 [h,T]=impz(num,den,31);
16 stem(T,h,'.','LineWidth',1.5,'color',[1,0.5,0.5]);
17 title('System response');
18 grid minor
19 set(p4, 'PaperPosition', [0.05 0.05 9 7]);
20 set(p4, 'PaperSize', [9.05 7.05]);
21 saveas(p4,['p4.pdf'],'pdf')
```

5 SUMMARY

For this Homework, I understand more about Digital Signal Processing, as well as how to use the MATLAB to do the DFT, convolution and other operations. I also know more about the sampling theorem and the autocorrelation between signals. I also know how to use the unwarp function to fix the phase gap.

REFERENCES

[1] Changgang-Zheng/Signals-and-Systems/report.https://github.com/Changgang-Zheng/Signals-and-Systems

[2] Supplementary materials to the text book 'Digital Signal Processing: A Computer-Based Approach', 4th Edition. by S.K. Mitra, ISBN 0077320670. http://www.bb9.uestc.edu.cn/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1&url=%2Fwebapps%2Fblackboard%2Fexecute%2Flauncher%3Ftype%3DCourse%26id%3D_13014_1%26url%3D

[3] Digital Signal Processing: A Computer-Based Approach, 4th Edition. by S.K. Mitra, ISBN 0077320670.

[4] Summary of DSP course in school of communication, University of Electronic Science and Technology of China https://wenku.baidu.com/view/b3b2f5b289eb172dec63b708.html