Glasgow College, UESTC

Digital Signal Processing

Homework 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.

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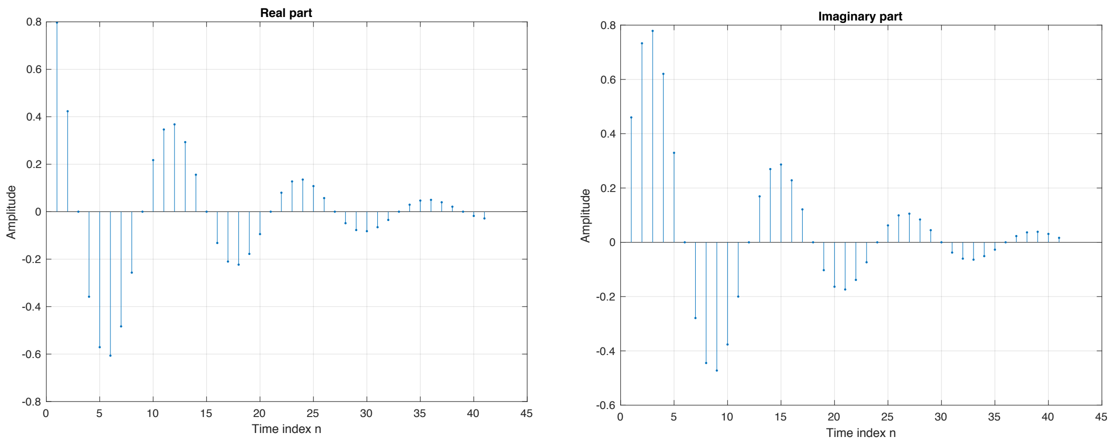
1 PROBLEM M2.2

1.1 Question a

Generate the complex exponential functions, and compare them with the figure shown in Figure 2.23 and Figure 2.24: [2]

For solving this question, we use the code from bb9 [1], this question is simply tell us how to use MATLAB to plot some special functions.



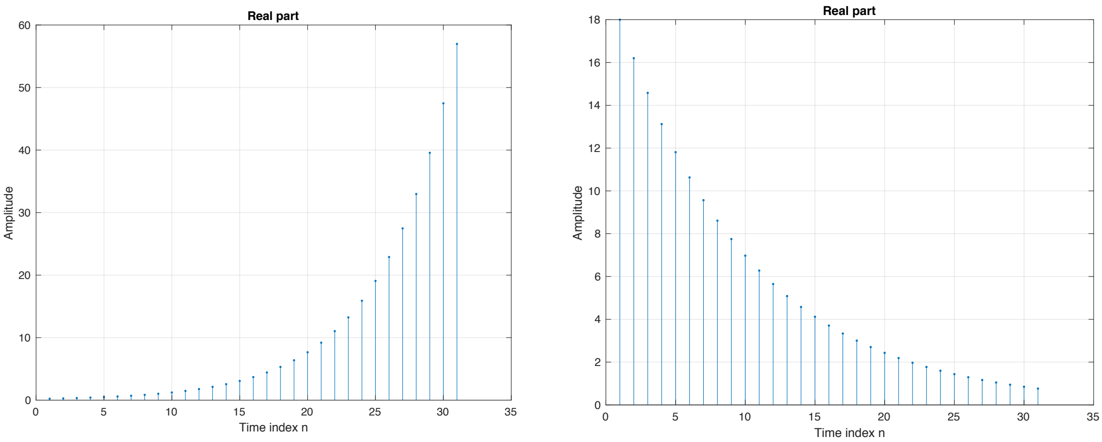
real part   imaginary part

Figure 1: Real and Imaginary part of time index n

```
% Generation of complex exponential sequence
%
a = input('Type in real exponent = ');
b = input('Type in imaginary exponent = ');
c = a + b*i;
K = input('Type in the gain constant = ');
N = input ('Type in length of sequence = ');
n = 1:N;
x = K*exp(c*n);%Generate the sequence
stem(n,real(x),'.');%Plot the real part
grid on
xlabel('Time index n');ylabel('Amplitude');
title('Real part');
disp('PRESS RETURN for imaginary part');
pause
stem(n,imag(x),'.');%Plot the imaginary part
grid on
xlabel('Time index n');ylabel('Amplitude');
title('Imaginary part');
```

I pressing the following code to generate the results as shown in Figure 1.

```
% Program 2_3
%
% Type in real exponent = -1/12
% Type in imaginary exponent = pi/6
% Type in the gain constant = 1
% Type in length of sequence = 41
% PRESS RETURN for imaginary part
%
```



function a function b

Figure 2: Amplitude of time index n

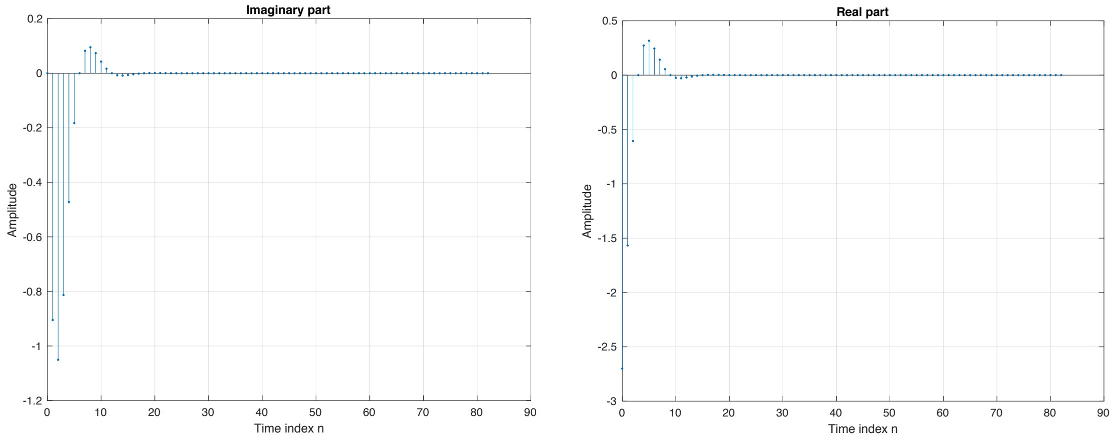
I pressing the following code to generate the results, as shown in Figure 2.

```
% Program 2_3
%
% Type in real exponent = log(1.2)
% Type in imaginary exponent = 0
% Type in the gain constant = 0.2
% Type in length of sequence = 31
% PRESS RETURN for imaginary part
%
% Type in real exponent = log(0.9)
% Type in imaginary exponent = 0
% Type in the gain constant = 20
% Type in length of sequence = 31
% PRESS RETURN for imaginary part
% ETURN for imaginary part
%
```

1.2 Question b

Generate the complex exponential sequence shown in reference book in range from 0 to 82:

I pressing the following code and use the function: program 2.2.3 to generate the results, as shown in Figure 3.



imaginary part　　　　real part

Figure 3: Real and Imaginary part for that function

```
% Program 2_3
%
% Type in real exponent = -0.4
% Type in imaginary exponent = pi/6
% Type in the gain constant = -2.7
% Type in length of sequence = 8
% PRESS RETURN for imaginary part
%
```

2 PROBLEM M2.7

Verify the family of continuous time sinusoids given by EQ 2.56, which lead to same sampled signal

For this question, it aims to tell us what will happen if we do not apply the Shannon sampling theorem. Which means the sampling frequency is less than twice of the signal frequency. If we do not apply it, the result may be overlap and the information lost is too much to reconstruct the signal.

I pressing the following code to generate the results, as shown in Figure 4.

```
t = 0:0.001:0.85;
g1 = cos(6*pi*t);
g2 = cos(14*pi*t);
g3 = cos(26*pi*t);
figure;
```

```
plot(t/0.85,g1,'-', t/0.85, g2, '--', t/0.85, g3,':');
xlabel('time');
ylabel('Amplitude');
hold
n = 0:1:8;
gs = cos(0.6*pi*n);
plot(n/8.5,gs,'o');
grid on;
hold off
```

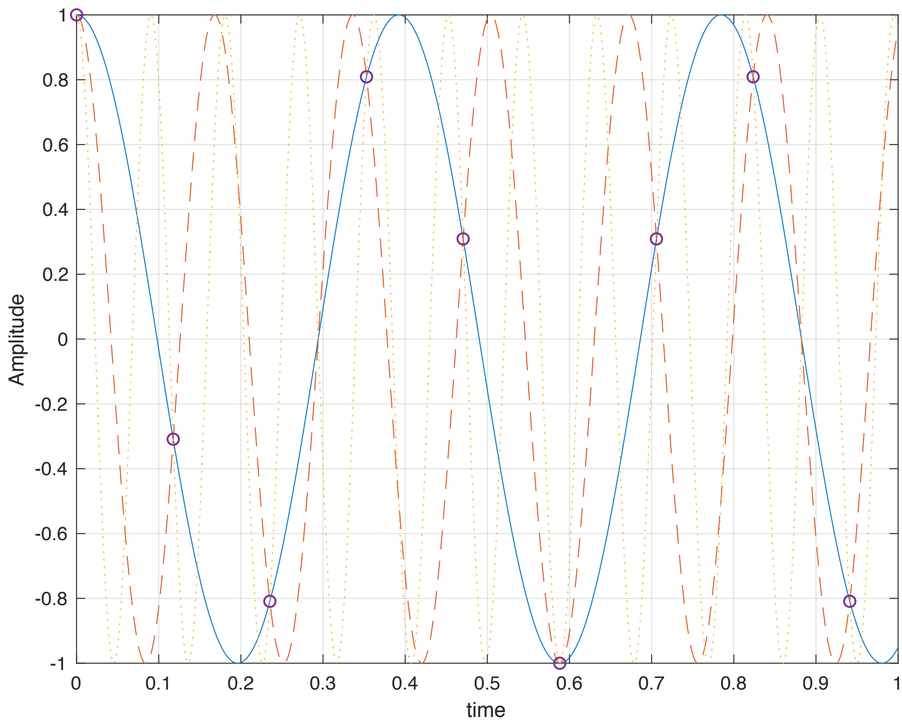


Figure 4: Overlapping if do not apply Shannon sampling theorem

3 PROBLEM M2.9

Demonstrate the corrolation of a noise-corruption function have a peak at zero:

From the question, we can see the way of calculating the correlation function, which is similar to the convolution. we do the convolution, it is simply that the result got max when the value is zero.

On the other hand, we can understand it intuitively. We understand if there is a long time between the happening of two incident, the correlation between them is low. If the two (similar) thing happened together, the correlated should be high.

I pressing the following code to generate the results, as shown in Figure 5.

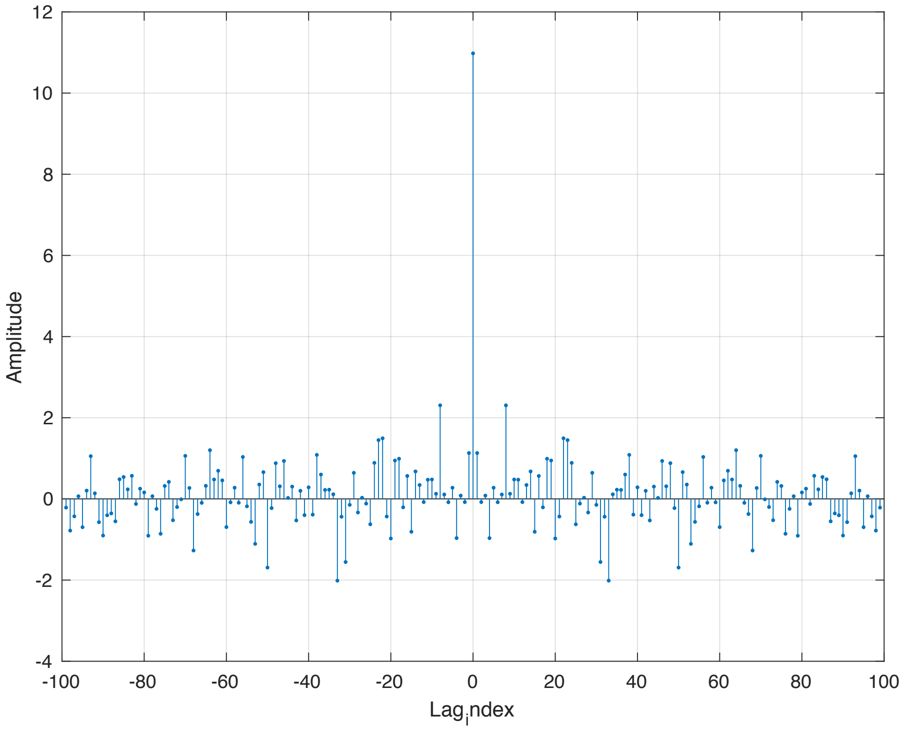


Figure 5: The autocorrelation function

```
N = input('Length of sequence = ');
n = 0:N-1;
x = exp(-0.8*n);
y = rand(1,N)-0.5+x;
n1 = length(x)-1;
r = conv(y,fliplr(y));
k = (-n1):n1;
stem(k,r,'.');
xlabel('Lag_index'); ylabel('Amplitude');
grid on;
```

4 SUMMARY

For this Homework, I understand more about Digital Signal Processing, as well as how to use the MATLAb to plot and analysis them. I also know more about the sampling theorem and the autocorrelation between signals.

REFERENCES

[1] 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

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