Digital Signal Processing Ⅱ

10^{th} EXPERIMENT

Report

(WEEK11 report of DSP2 course)

Subject	Digital Signal Processing Ⅱ
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Exercises

In this part, there are several exercise questions. Each exercise consists of code and its result. All documents including MATLAB code, result, and this report are uploaded in this website :

https://github.com/Gaon-Choi/ELE3077/tree/main/lab_experiment10

Exercise 1

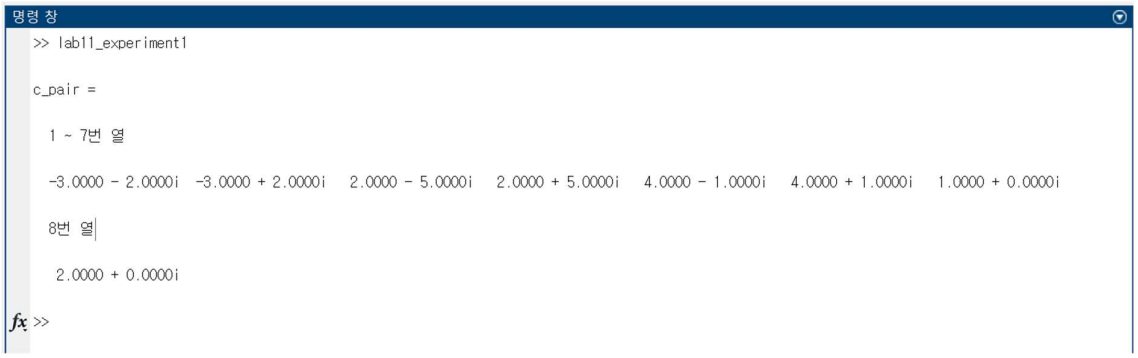
exercise1-a)

Group the complex conjugate pairs and sort them in increasing real part order for the following sequence by using 'cplxpair' which is a MATLAB built-in function.

(MATLAB Code) lab11_exercise1_a.m

```
% exercise1 - a
complex = [4-1j, -3-2j, 1, -3+2j, 2+5j, 2, 4+1j, 2-5j];
c_pair = cplxpair(complex)  % sort by real number in increasing order
```

(Results)



exercise1-b)

Given the coefficients $\{b_n\}$ and $\{a_n\}$ of the direct form filter, we have to obtain the coefficient b_0, $\{B_{k,i}\}$, and $\{A_{k,i}\}$. For doing this computation, make the function 'dir2cas'.

(MATLAB Code) dir2cas.m

```
function [b0, B, A] = dir2cas(b, a)
b0 = b(1); b = b/b0; a0 = a(1); a = a/a0; b0 = b0/a0;
M = length(b); N = length(a);

if N > M
    b = [b zeros(1, N-M)];
elseif M > N
    a = [a zeros(1, M-N)]; N = M;
else
    NM = 0;
end

K = floor(N/2); B = zeros(K, 3); A = zeros(K, 3);
if K*2 == N
    b = [b 0]; a = [a 0];
end

broots = cplxpair(roots(b));
aroots = cplxpair(roots(a));

for i = 1:2:2*K
    B_row = broots(i:1:i+1,:);
    B_row = real(poly(B_row));
    B(fix((i+1)/2),:) = B_row;

    A_row = aroots(i:1:i+1,:);
    A_row = real(poly(A_row));
    A(fix((i+1)/2),:) = A_row;
end
```

exercise1-c)

Make the function 'casfiltr' which will be used to implement digital filtering of the cascaded form.

(MATLAB Code) casfiltr.m

```
function y = casfiltr(b0, B, A, x)
[K, L] = size(B);
N = length(x);
w = zeros(K+1, N);
w(1,:) = x;

for i = 1:1:K
    w(i+1,:) = filter(B(i,:), A(i,:), w(i,:));
end

y = b0 * w(K+1, :);

end
```

Exercise 2

exercise2-a)

A filter is described by the following difference equation:

$$16y(n) + 12y(n-1) + 2y(n-2) - 4y(n-3) - y(n-4)$$
$$= x(n) + 3x(n-1) + 11x(n-2) - 27x(n-3) - 18x(n-4)$$

determine its cascaded form structure by using the function 'dir2cas' that you made in 'exercise1'.

(MATLAB Code) lab11_exercise2_a.m

```
coef_a = [16 12 2 -4 -1];
coef_b = [1 -3 11 -27 18];

[b0, coef_b, coef_a] = dir2cas(coef_b, coef_a)
```

(Result)

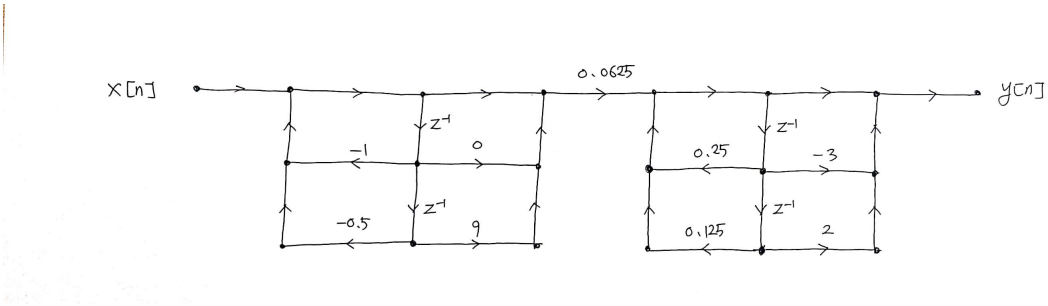
exercise2-b)

Draw the block diagram of Q2-a by using the signal-flow graph(SGF) with your own hands.

(MATLAB Code)

(No CODE)

(Result)



exercise2-c)

Generate an impulse response (the length of sequence = 8) and filter it by the cascaded form ('casfiltr') and the direct form ('filter') respectively. And check the result is same.

(MATLAB Code) lab11_exercise2_c.m

```
coef_a = [16 12 2 -4 -1];
coef_b = [1 -3 11 -27 18];

[b0, B, A] = dir2cas(coef_b, coef_a)

delta = [1 0 0 0 0 0 0 0];

hcas = casfiltr(b0, B, A, delta);
hdir = filter(coef_b, coef_a, delta);
err = abs(max(hcas-hdir))
```

(Result)

As the value of err is very small, it can be understood that they are the same.