Table of Contents

lab4_2024.m

```
clear
delete(allchild(0));
w = linspace(-pi, pi, 11);
x.data = [1 6 3 -4 2];
x.offset = -1;
```

Problem #1: Even, Odd

```
test_lab3_2024('even(x)');
test_lab3_2024('odd(x)');
test_lab3_2024('trimit(addit(even(x), odd(x)))');
```

```
_____________
even(x): sequence O.K.
Your answer:

z =

  struct with fields:

      data: [1 -2 2 6 2 -2 1]
    offset: -3


y =

  struct with fields:

      data: [-2 4 -2 0 2 -4 2]
    offset: -3


_____________
odd(x): sequence O.K.
Your answer:

z =
```

```
  struct with fields:

      data: [-1 2 -1 0 1 -2 1]
    offset: -3


y =

  struct with fields:

      data: [-2 4 -2 0 2 -4 2]
    offset: -3

_____________
trimit(addit(even(x), odd(x))): sequence O.K.
Your answer:

z =

  struct with fields:

      data: [1 6 3 -4 2]
    offset: -1
```

Problem #1: Conjugate

```
x.data = [1+1j 6j 3 1j-4 2j];
x.offset = -2;
test_lab3_2024('conjit(x)')
test_lab3_2024('addit(x, conjit(x))')
```

```
_____________
conjit(x): sequence O.K.
Your answer:

z =

  struct with fields:

      data: [1.0000 - 1.0000i 0.0000 - 6.0000i … ] (1×5 double)
    offset: -2

_____________
addit(x, conjit(x)): sequence O.K.
Your answer:

z =

  struct with fields:

      data: [2 0 6 -8]
```

```
    offset: -2
```

Problem #2: DTFT

```
x.data = [1 1 1];
x.offset = -1;
test_lab3_2024('dtft(x, w)');

% Simple impulse Caution! check your answer for this.
% It should be a sequence.
x.data = 1;
x.offset = 0;
test_lab3_2024('dtft(x, w)');

x.data = [1 3 -1 -4 1];
x.offset = -2;
test_lab3_2024('dtft(x, w)');

x.data = [1+1j 0 1-1j];
x.offset = -1;
test_lab3_2024('dtft(x, w)-dtft(conjit(flipit(x)), w)');
```

```
_____________
dtft(x, w): data O.K.
Your answer:

z =

  Columns 1 through 7

   -1.0000   -0.6180    0.3820    1.6180    2.6180    3.0000    2.6180

  Columns 8 through 11

    1.6180    0.3820   -0.6180   -1.0000

_____________
dtft(x, w): data O.K.
Your answer:

z =

     1     1     1     1     1     1     1     1     1     1     1

_____________
dtft(x, w): data O.K.
Your answer:

z =

  Columns 1 through 4
```

```
   2.0000 - 0.0000i   0.4271 - 4.1145i  -2.3090 - 6.6574i  -2.9271 - 6.6574i

  Columns 5 through 8

  -1.1910 - 4.1145i   0.0000 + 0.0000i  -1.1910 + 4.1145i  -2.9271 + 6.6574i

  Columns 9 through 11

  -2.3090 + 6.6574i   0.4271 + 4.1145i   2.0000 + 0.0000i
```

```
dtft(x, w)-dtft(conjit(flipit(x)), w): data O.K.
Your answer:

z =

     0     0     0     0     0     0     0     0     0     0     0
```

Problem #3: Real and Imaginary

```
x.data = [1 1 1 1 1];
x.offset = -1;
test_lab3_2024('dtft2(x, w)');

x.data = [1 2 2 -1 2 1];
x.offset = -2;
test_lab3_2024('dtft2(x, w)');
```

```
dtft2(x, w): data O.K.
Your answer:

z =

  struct with fields:

    real: [-1 2.7756e-16 0.3820 1.1102e-16 2.6180 5 2.6180 … ] (1×11 double)
    imag: [1.2246e-16 -1.1102e-16 -1.1756 2.2204e-16 1.9021 0 … ] (1×11
double)
```

```
dtft2(x, w): data O.K.
Your answer:

z =

  struct with fields:

    real: [3 2.4271 0.0729 -0.9271 3.4271 7 3.4271 -0.9271 0.0729 2.4271 3]
    imag: [-2.4493e-16 -1.7634 -4.0287 -2.8532 0.1388 0 … ] (1×11 double)
```

Problem #4: Magnitude and Phase

```
test_lab3_2024('mag_phase(dtft2(x, w))');
```

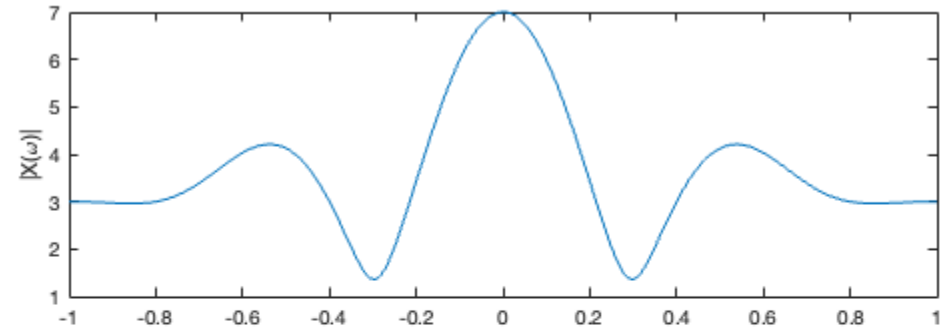
```
_____________
mag_phase(dtft2(x, w)): data O.K.
Your answer:

z =

  struct with fields:

      mag: [3 3.0000 4.0294 3.0000 3.4299 7 3.4299 3.0000 4.0294 3.0000 3]
    phase: [-8.1643e-17 -0.6283 -1.5527 -1.8850 0.0405 0 … ] (1×11 double)
```

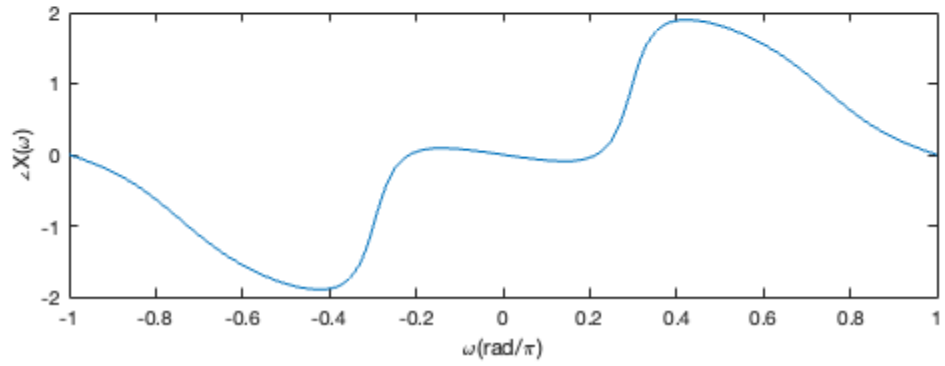
Problem #5 Plotting

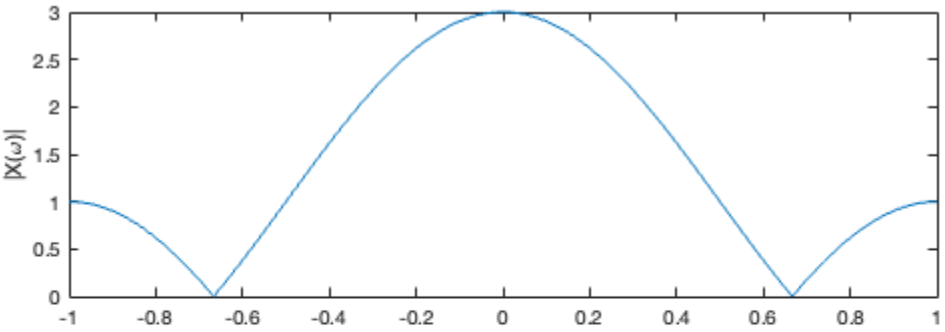
```
w = linspace(-pi, pi, 1001);
plot_magph(x, w);

% This is a purely real and even function.
% What can you say about the phase?
% Specifically why is it either 0 or pi?
x.data = [1 1 1];
x.offset = -1;
set(figure, 'Color', 'w');
plot_magph(x, w);

% This is a purely real and odd function.
% What can you say about the phase?
% Specifically why is it either +pi/2 or -pi/2?
x.data = [-1 0 1];
x.offset = -2;
set(figure, 'Color', 'w');
plot_magph(x, w);

% Here are a series of pulse functions.
% What happens to the magnitude of the transform as the pulse gets broader?
% You may note that the phase 'chatters' between +pi and -pi at some values
of w.
% This doesn't look nice and it's confusing. How could you fix this in your
plot_magph
% program so that the phase doesn't chatter? No biggie if you can't.
% (Hint: it has something to do with a very small imaginary part...).

x.data = ones(1, 5);
x.offset = -2;
set(figure, 'Color', 'w');
plot_magph(x, w)

x.data = ones(1, 21);
x.offset = -10;
```

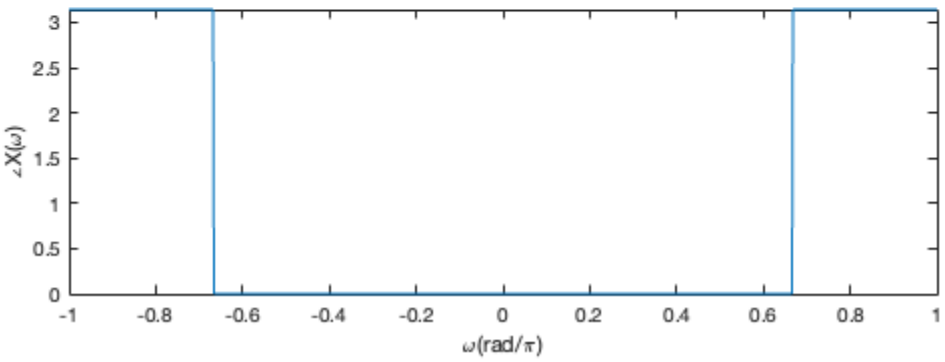
```
set(figure, 'Color', 'w');
plot_magph(x, w)

x.data = ones(1, 101);
x.offset = -50;
set(figure, 'Color', 'w');
plot_magph(x, w)
```

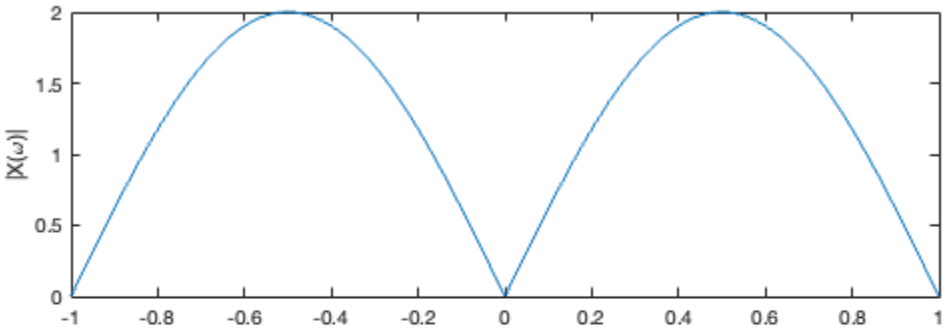
```
ans =

  struct with fields:

      mag: [1 0.9999 0.9995 0.9989 0.9981 0.9970 0.9957 … ] (1×1001 double)
    phase: [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 … ] (1×1001
double)


ans =

  struct with fields:

      mag: [1 0.9978 0.9913 0.9805 0.9655 0.9462 0.9228 … ] (1×1001 double)
    phase: [-1.9722e-31 -2.7816e-17 0 2.8307e-17 … ] (1×1001 double)


ans =

  struct with fields:

      mag: [1 0.9501 0.8053 0.5802 0.2971 0.0157 0.3269 … ] (1×1001 double)
    phase: [9.8608e-31 5.8428e-17 -1.3786e-16 0 0 3.1416 … ] (1×1001 double)
```

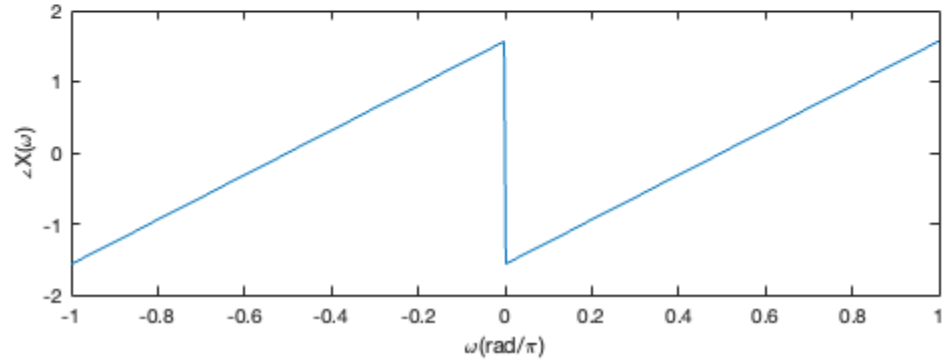

|X(ω)|
7
6
5
4
3
2
1
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

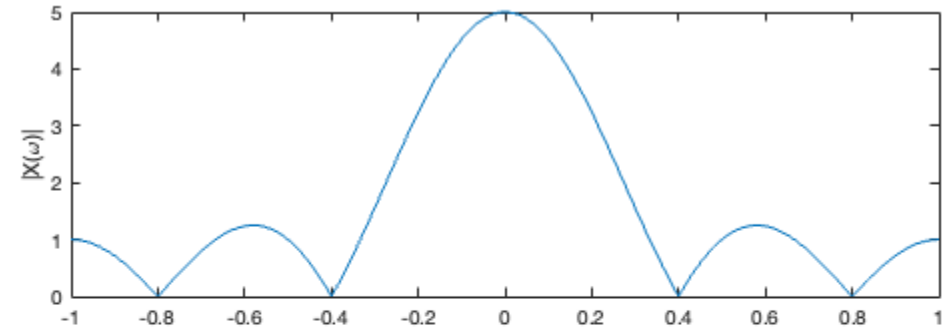

∠X(ω)
2
1
0
-1
-2
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)

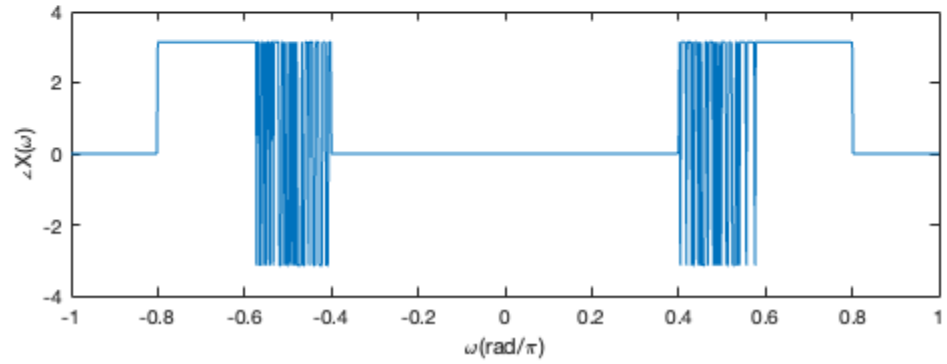

|X(ω)|
3
2.5
2
1.5
1
0.5
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

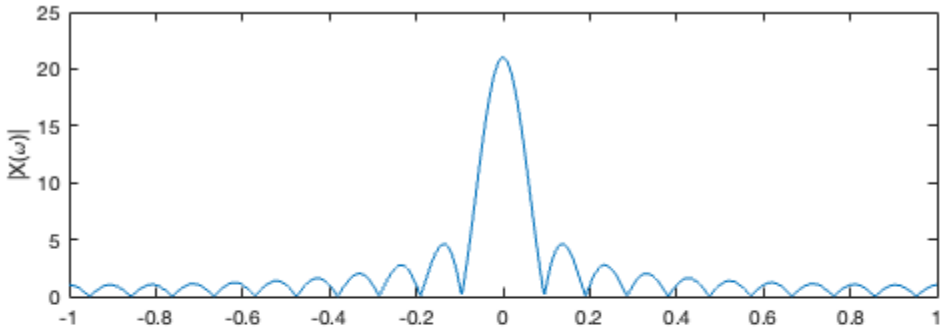

∠X(ω)
3
2.5
2
1.5
1
0.5
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)

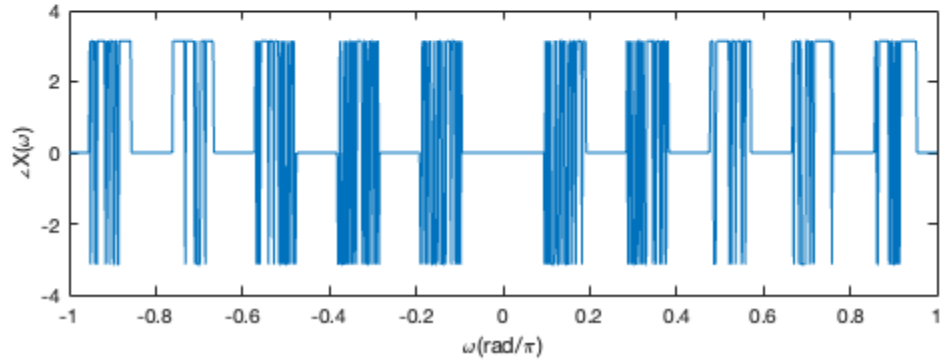

|X(ω)|
2
1.5
1
0.5
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

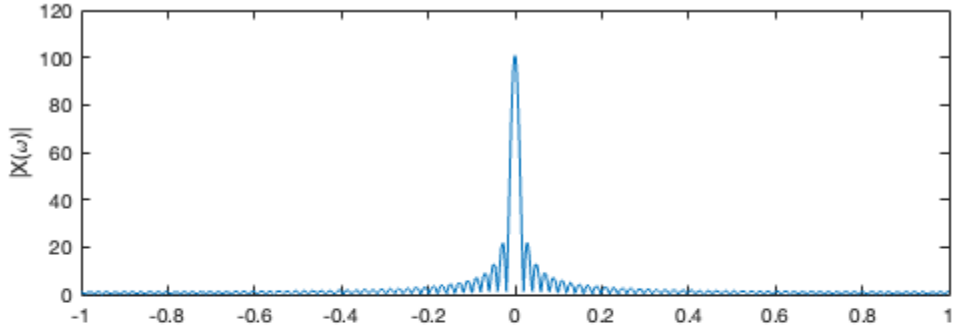

∠X(ω)
2
1
0
-1
-2
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)

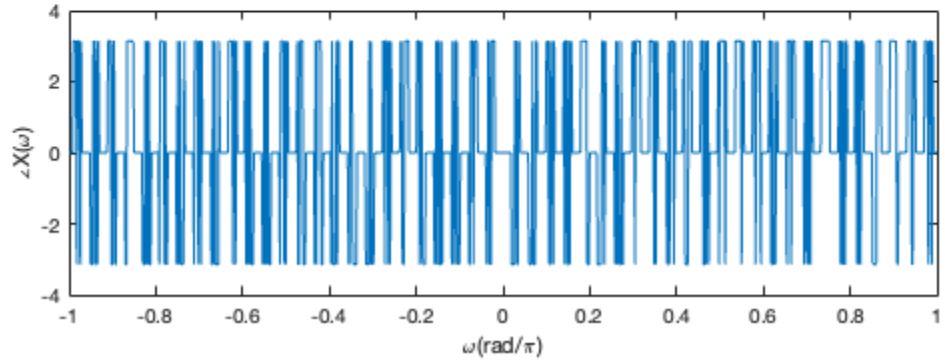

|X(ω)|
5
4
3
2
1
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


∠X(ω)
4
2
0
-2
-4
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)


25
20
15
10
5
0
|X(ω)|
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


4
2
0
-2
-4
∠X(ω)
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)


120
100
80
60
40
20
0
|X(ω)|
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1


4
2
0
-2
-4
∠X(ω)
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
ω(rad/π)

Print programs

```
disp(' ')
disp('--- dtft.m -------------------------------')
type('dtft')
disp(' ')
disp('--- dtft2.m ------------------------------')
type('dtft2')
disp(' ')
disp('--- mag_phase.m --------------------------')
type('mag_phase')
disp(' ')
disp('--- plot_magph.m -------------------------')
type('plot_magph')


--- dtft.m -------------------------------

function y = dtft(x, w)
    y = x.data * exp(-1j * ([x.offset:length(x.data)+x.offset-1]' * w));

--- dtft2.m ------------------------------

function y = dtft2(x, w)
    y.real = zeros(1, length(w));
    y.imag = zeros(1, length(w));
    for i = 1:length(w)
        for n = 1:length(x.data)
            y.real(i) = y.real(i) + x.data(n) * cos(-w(i) * (x.offset+n-1));
            y.imag(i) = y.imag(i) + x.data(n) * sin(-w(i) * (x.offset+n-1));
        end
    end

--- mag_phase.m --------------------------

function y = mag_phase(x)
    y.mag = sqrt(x.real.^2 + x.imag.^2);
    y.phase = atan2(x.imag, x.real);

--- plot_magph.m -------------------------

function y = plot_magph(x, w)
    y = mag_phase(dtft2(x, w));

    tiledlayout(2,1);

    nexttile
    plot(w ./ pi, y.mag);
    ylabel('|X(\omega)|');

    nexttile
    plot(w ./ pi, y.phase);
```

```
    ylabel('\angleX(\omega)');
    xlabel('\omega(rad/\pi)');
```

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