```
% Group 96 19/12/2021
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% HW2 Q4 Part 1

clc;
clear;
close all;

% Period
T = 4;

% "N + 1" period is shown
N = 4;

% 200 samples per one period
samples = 200;

% Given function
f = @(t)(t-1).*(0<=t & t<=2) + (3-t).*(2<=t & t<=4);

% Generating samples in one period
x = linspace(0,T,samples);

% Interval to be shown
intvl = [-T, N*T];

% Copying the original function values to get multiple periods
periodic_fx = repmat(f(x),1,N+1);

% Copying the original input values to get multiple periods
periodic_x = linspace(intvl(1),intvl(2),length(periodic_fx));

% Plot multiple periods
plot(periodic_x, periodic_fx)
grid
title("5 Periods of the given function")

% For k = 7
fs = 51;
sum=0;

% Finding FS coefficients
for k=1:2:fs
    ak=(4)/(k*pi)^2*(-1+(-1)^k);
    sum=sum+(ak*cos(k*pi*x*1/2));

    % k=7
    if k == 7
    % Make output periodic
```
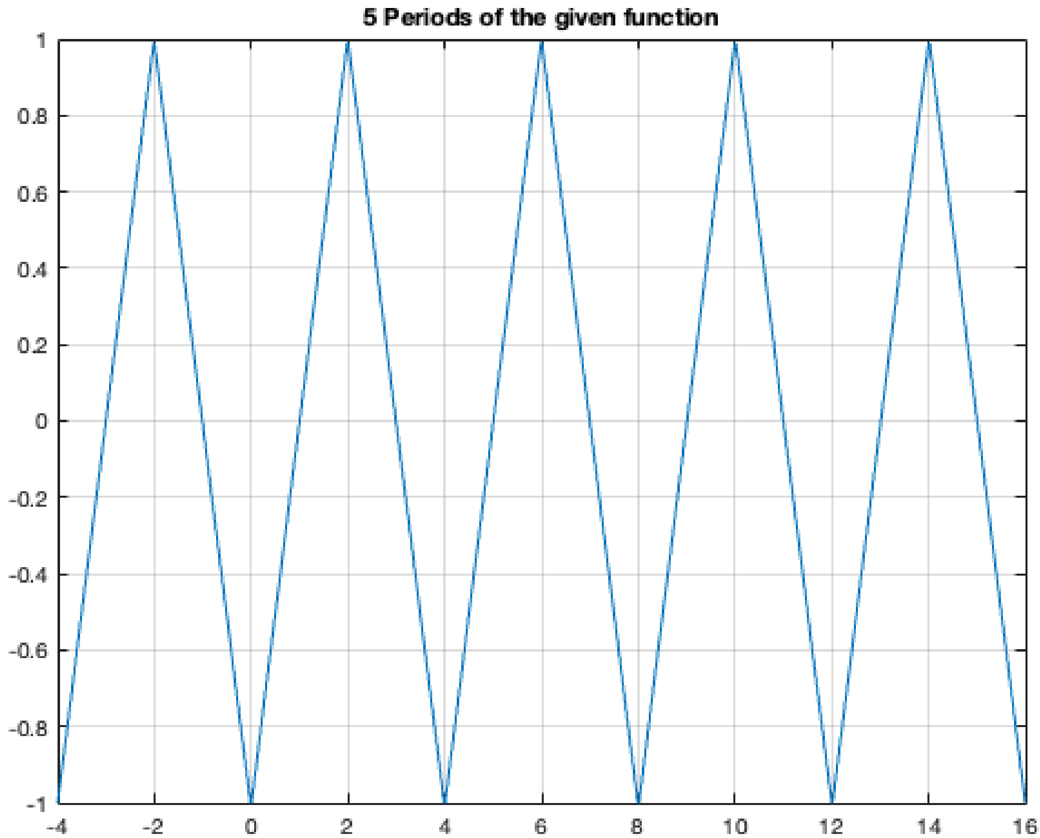
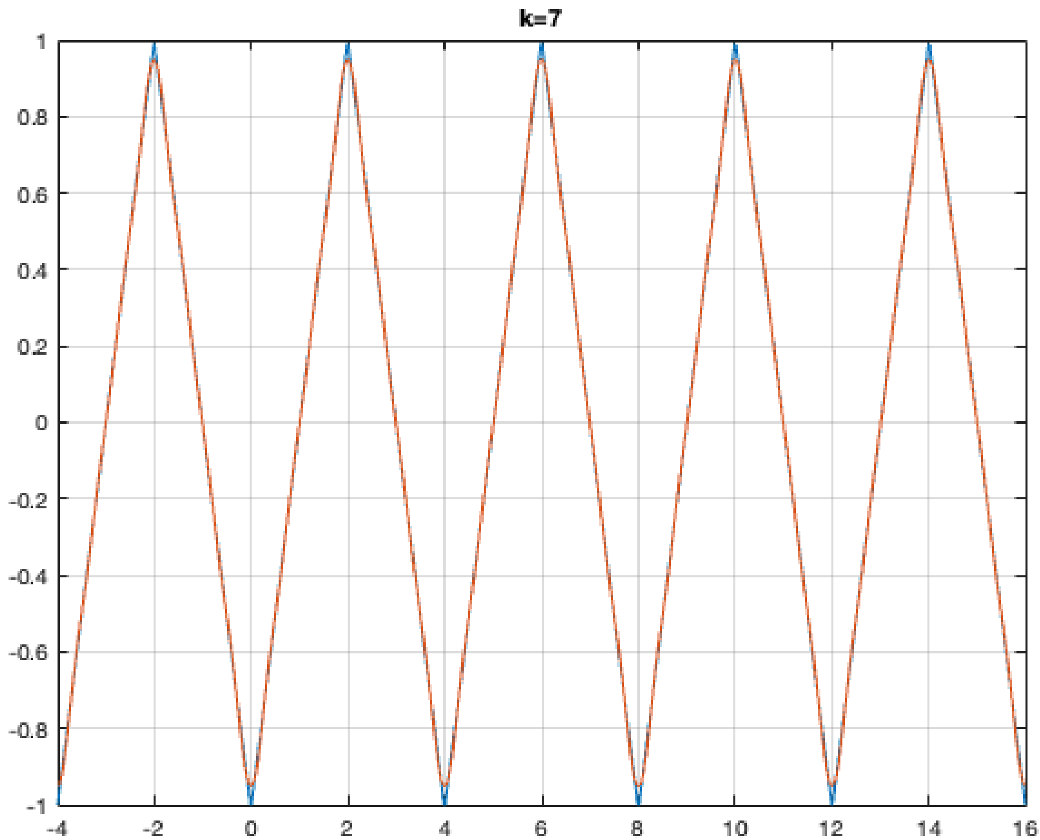

```matlab
    periodic_sum = repmat(sum,1,N+1);
    figure;

    % Plot original and reconstructed signal
    plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
    grid
    title('k=7')

    % k=9
    elseif k == 9
    % Make output periodic
    periodic_sum = repmat(sum,1,N+1);
    figure;

    % Plot original and reconstructed signal
    plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
    grid
    title('k=9')

    % k=11
    elseif k == 11
    % Make output periodic
    periodic_sum = repmat(sum,1,N+1);
    figure;

    % Plot original and reconstructed signal
    plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
    grid
    title('k=11')

    % k=21
    elseif k == 21
    % Make output periodic
    periodic_sum = repmat(sum,1,N+1);
    figure;

    % Plot original and reconstructed signal
    plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
    grid
    title('k=21')

    % k=51
    elseif k == 51
    % Make output periodic
    periodic_sum = repmat(sum,1,N+1);
    figure;

    % Plot original and reconstructed signal
    plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
    grid
    title('k=51')
    end
end
```

```
% We do not expect a significant improvement in the approximation because
% as you can see from results. After k=9, we got almost the original graph.
% This is happened because the first FS coefficients have more effect on
% the output. When we think about Parseval's equation, what Parseval's
% relation states is that the total average power in a periodic signal
% equals the sum of the average powers in all of its harmonic components.
% Therefore, the kth harmonic elements have less effect on the output that
% is shown by Parseval's equation as well.
```




k=7
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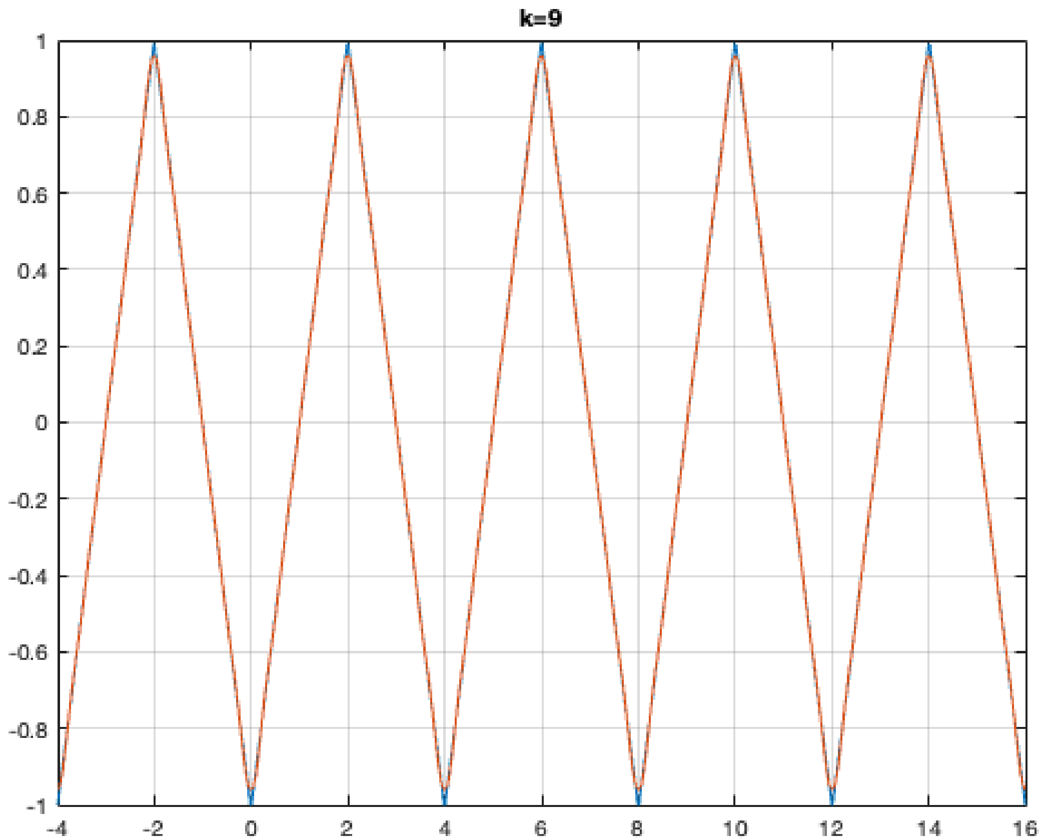
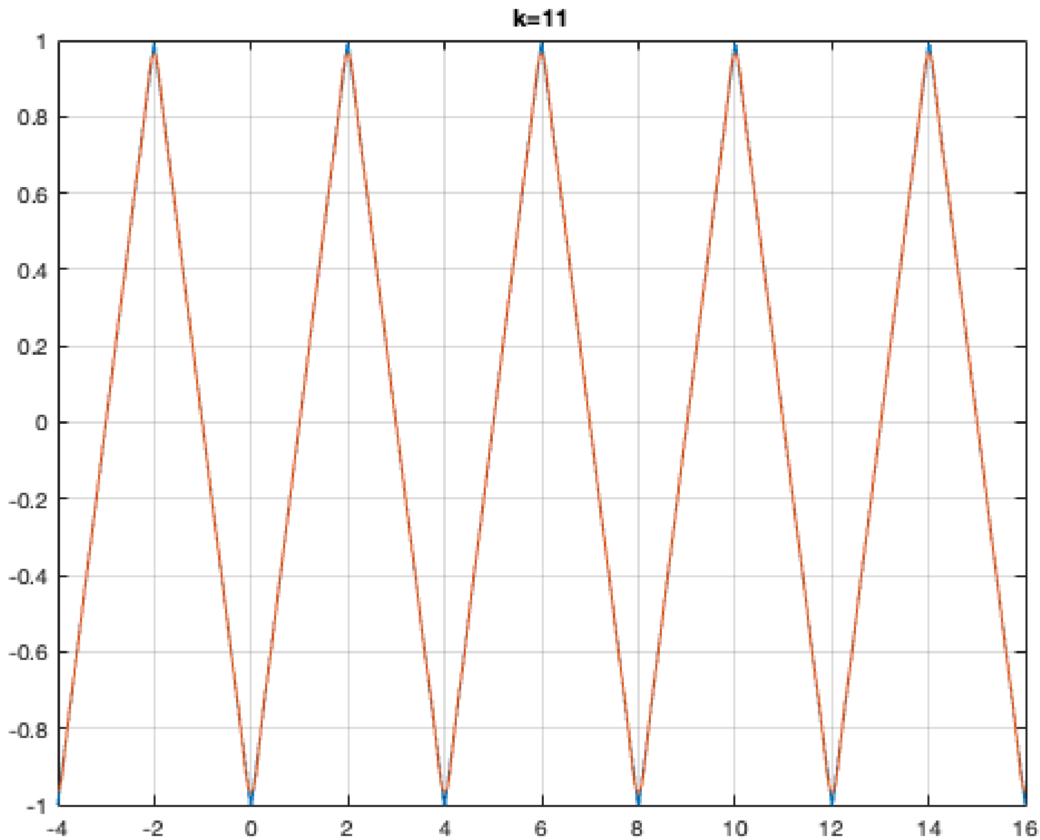
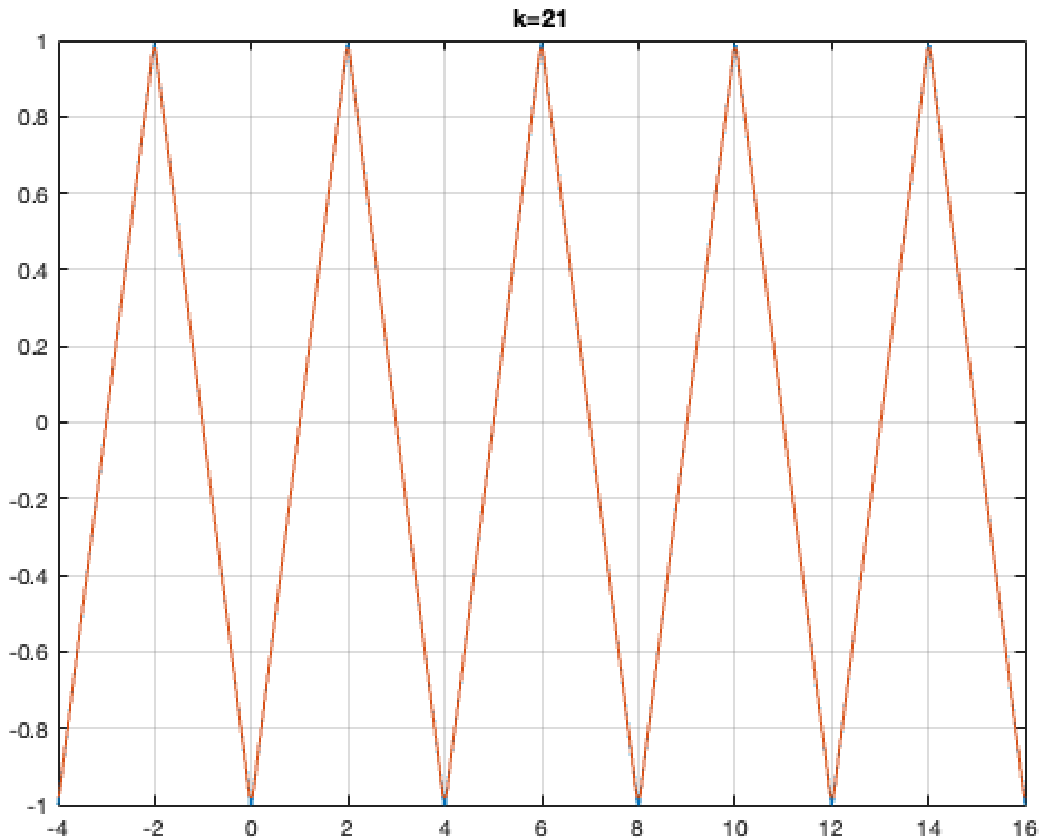
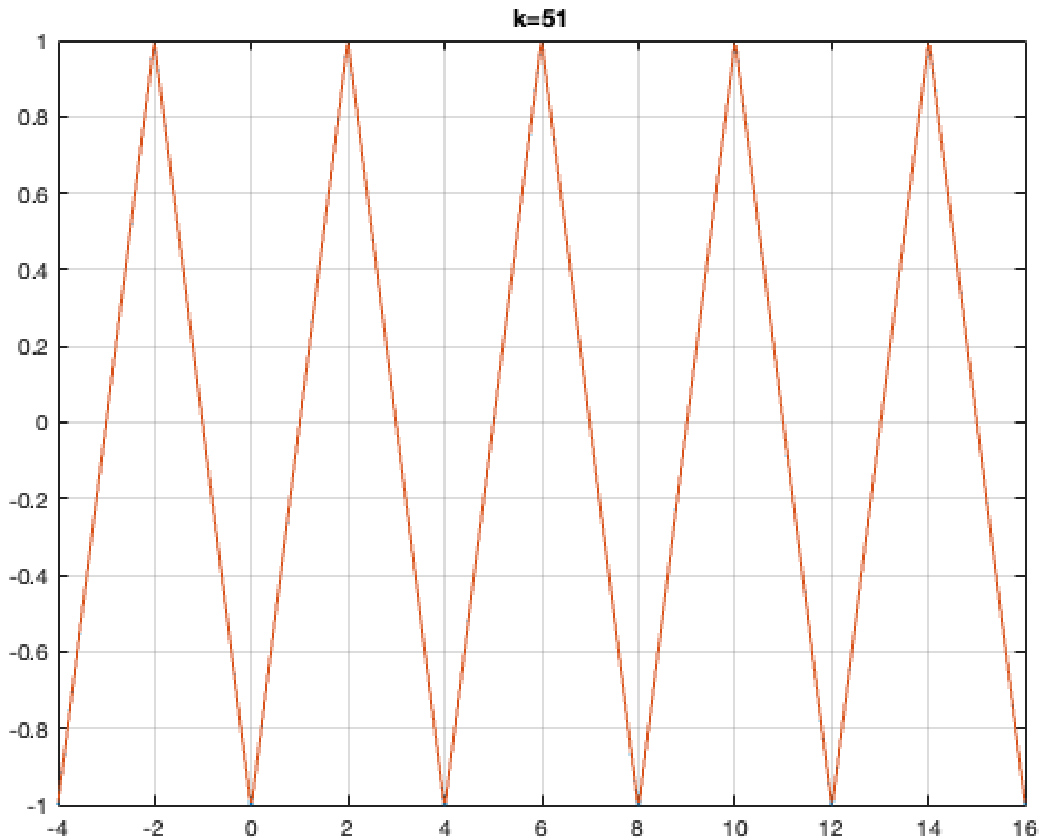
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-4
-2
0
2
4
6
8
10
12
14
16


k=9
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-4
-2
0
2
4
6
8
10
12
14
16


k=11
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-4
-2
0
2
4
6
8
10
12
14
16


k=21
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-4
-2
0
2
4
6
8
10
12
14
16



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```
% Group 96 19/12/2021
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% HW2 Q4 Part 2

clc;
clear;
close all;

% Period
T = 4;

% Delay
delay = 1;

% Fund Frequency
w0 = 2*pi/T;

% "N + 1" period is shown
N = 4;

% 200 samples per one period
samples = 200;

% Given function
f = @(t)(t-1).*(0<=t & t<=2) + (3-t).*(2<=t & t<=4);

% Generating samples in one period
x = linspace(0,T,samples);

% Interval to be shown
intvl = [-T, N*T];

% Copying the original function values to get multiple periods
periodic_fx = repmat(f(x),1,N+1);

% Copying the original input values to get multiple periods
periodic_x = linspace(intvl(1),intvl(2),length(periodic_fx));

% Get 51th Harmonic
fs=51;
sum=0;
for k=1:2:fs
    % Calculate FS coefficients
    ak =(4)/(k*pi)^2*(-1+(-1)^k);

    % Delay FS coefficients by 1
    ak = ak * exp(-1j*k*w0*delay);

    % Differentiate FS coefficients
```

```
    ak = ak *(1j*k*w0);

    % Calculate output function
    sum=sum+(ak*(cos(k*x*w0)));

    % k = 11
    if k == 11
        figure;

        % Make output periodic
        periodic_sum = repmat(sum,1,N+1);

        % Plot original and reconstructed signal
        plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
        grid
        title('k = 11')

    % k = 21
    elseif k == 21
        figure;

        % Make output periodic
        periodic_sum = repmat(sum,1,N+1);

        % Plot original and reconstructed signal
        plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
        grid
        title('k = 21')

    % k = 51
    elseif k == 51
        figure;

        % Make output periodic
        periodic_sum = repmat(sum,1,N+1);

        % Plot original and reconstructed signal
        plot(periodic_x, periodic_fx,periodic_x,periodic_sum)
        grid
        title('k = 51')
    end
end

% After reconstruction of the original signal by delayed and differentiated
% version, we observed the Gibbs phenomenon. If we further increase the
% number of FS coefficients to reconstruct the original signal, we can
% observe convergence to the delayed and differentiated waveform at the
% edges. However, as you can see from the results of k = 11, we do not need
% to zoom into the see the Gibbs effect. Therefore, increasing the number
% of FS coefficients allow us to converge our reconstructed signal to the
% original one.
```

Warning: Imaginary parts of complex X and/or Y arguments ignored.
Warning: Imaginary parts of complex X and/or Y arguments ignored.

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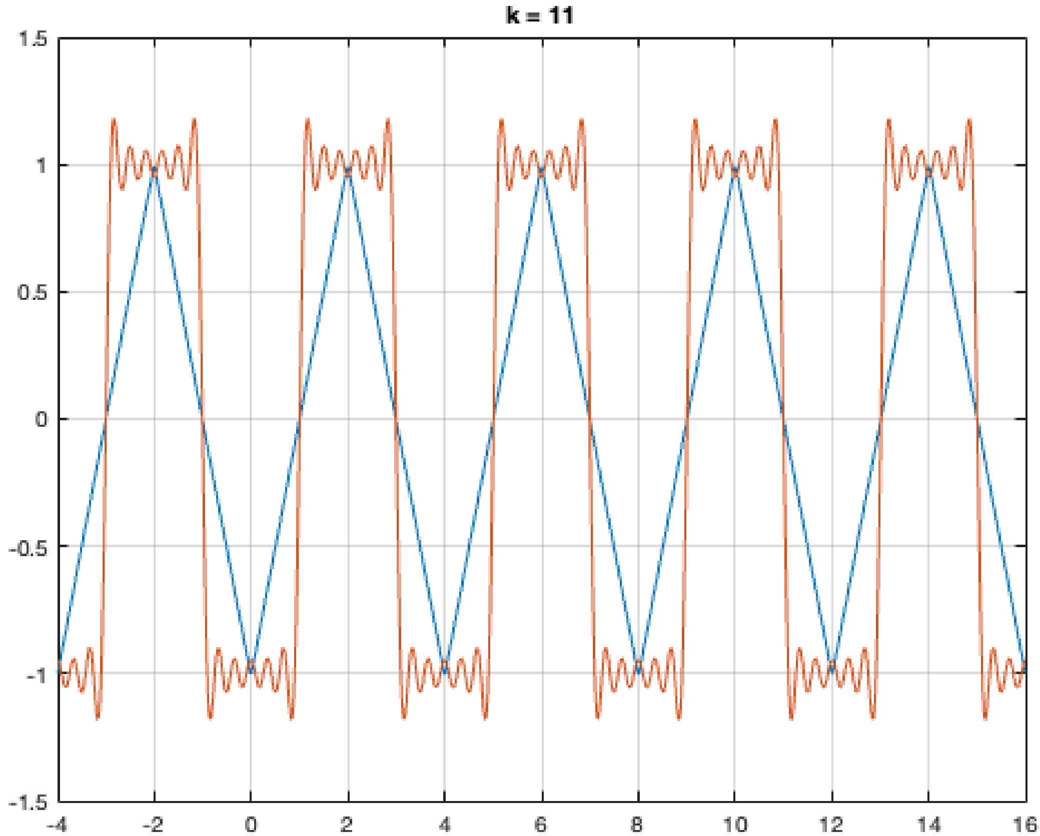
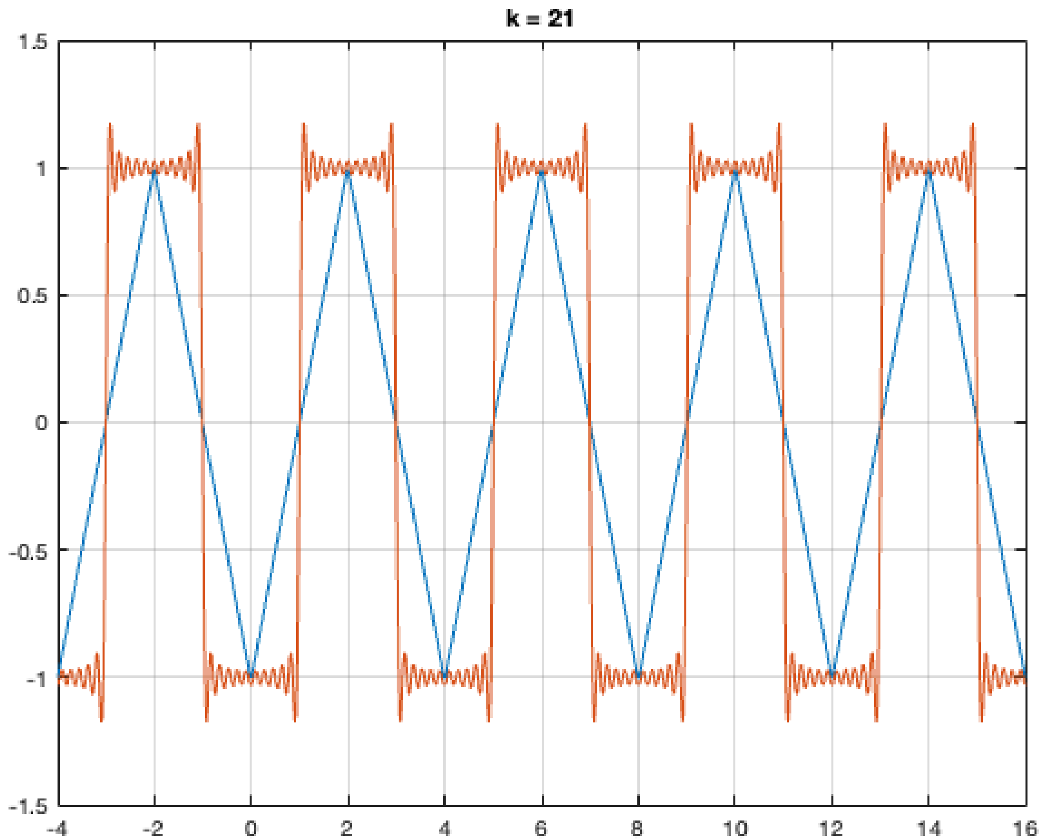
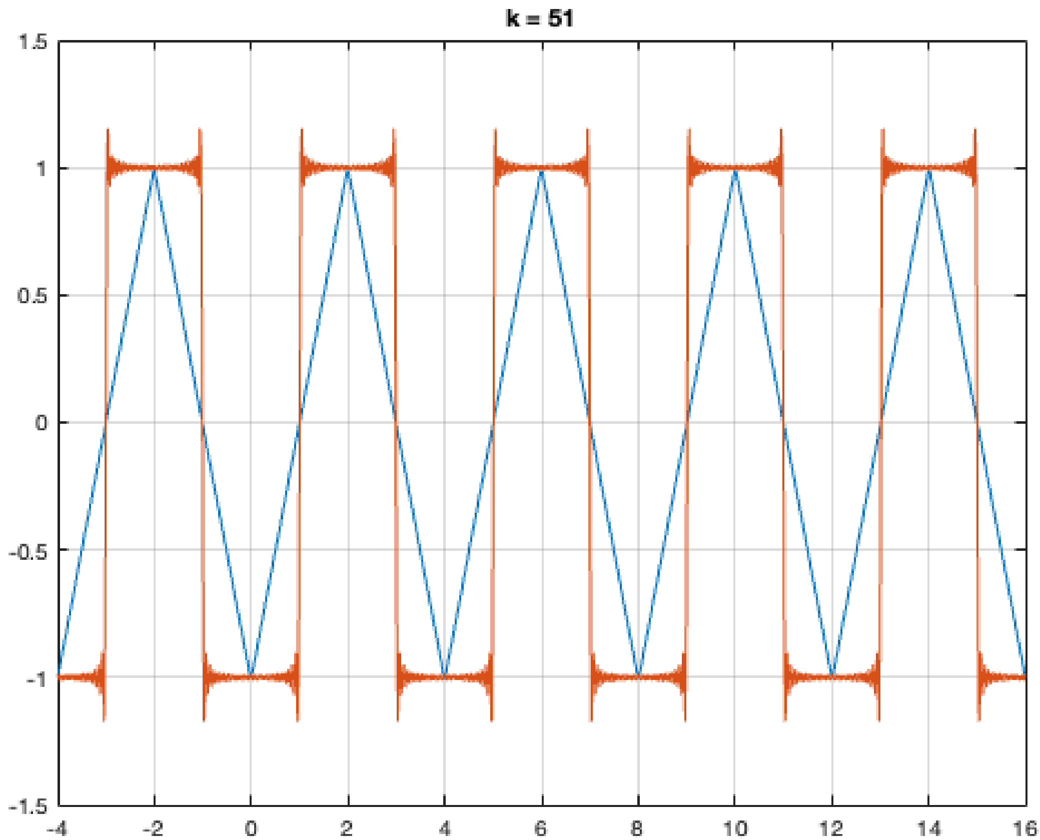



k = 21
1.5
1
0.5
0
-0.5
-1
-1.5
-4
-2
0
2
4
6
8
10
12
14
16



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