Lab Report

(signal processing)

1.1 a)

Calculation Part:

(1)

(a) Given that

The function.

$$x(t) = 2\cos(2\pi t) + \cos(6\pi t)$$

and also

$T = 1$

$N = 5$

We need to find the fourier coefficients of $x(t)$

To find fourier coefficients

$$a_k = \frac{1}{T}\int x(t)\, e^{-jk\omega_0 t}\,dt \quad k \in Z$$

$\cancel{x(t) = \ldots + a_{-2}}$

$$\Rightarrow \quad x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$$

$$x(t) = \ldots + a_{-2}e^{4\pi jt} + a_{-1}e^{2\pi jt} + a_0 + a_1 e^{-2\pi jt} + a_2 e^{-4\pi jt} + \ldots$$

Here $x(t) = 2\cos(2\pi t) + \cos(6\pi t)$

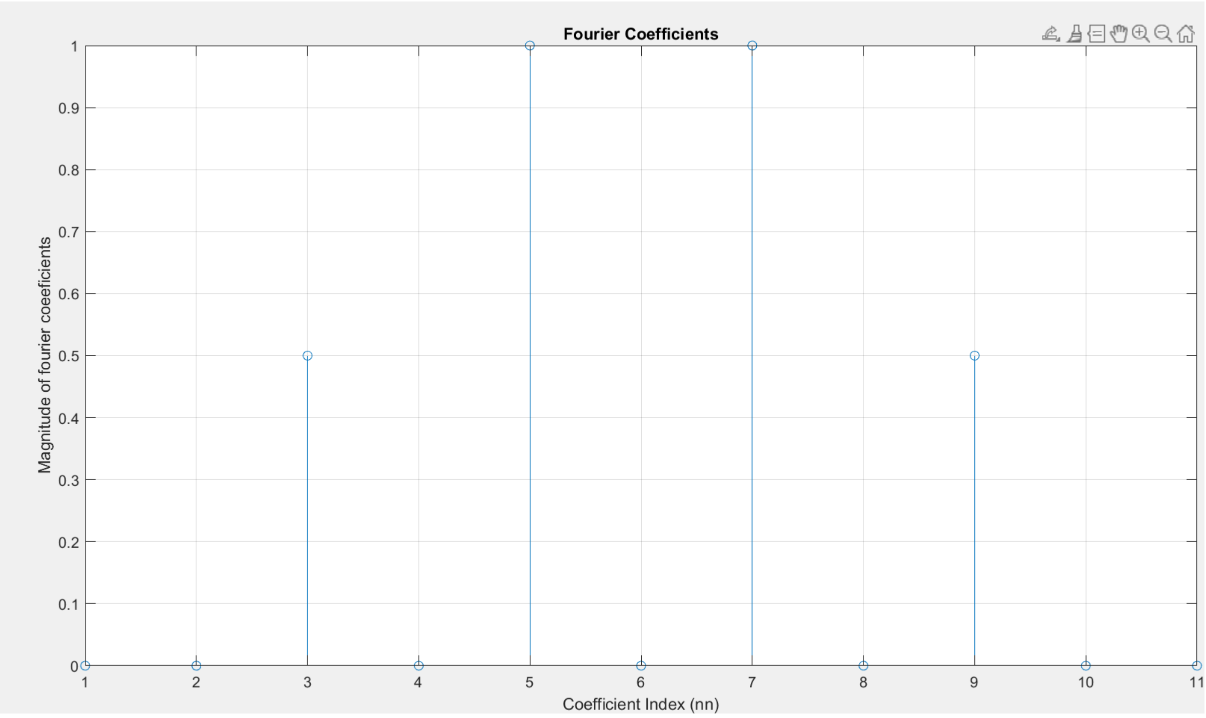
$$= \cancel{2}\left(\frac{e^{2\pi tj} + e^{-2\pi tj}}{\cancel{2}}\right) + \left(\frac{e^{6\pi jt} + e^{-6\pi jt}}{2}\right)$$

by comparing the both eq^{n}s of $x(t)$

$a_0 = 0$ $\quad a_1 = 1$ $\quad a_2 = 0$ $\quad a_3 = \frac{1}{2}$

$\quad a_{-1} = 1$ $\quad a_{-2} = 0$ $\quad a_{-3} = \frac{1}{2}$

MATLAB Plot:



Observation:

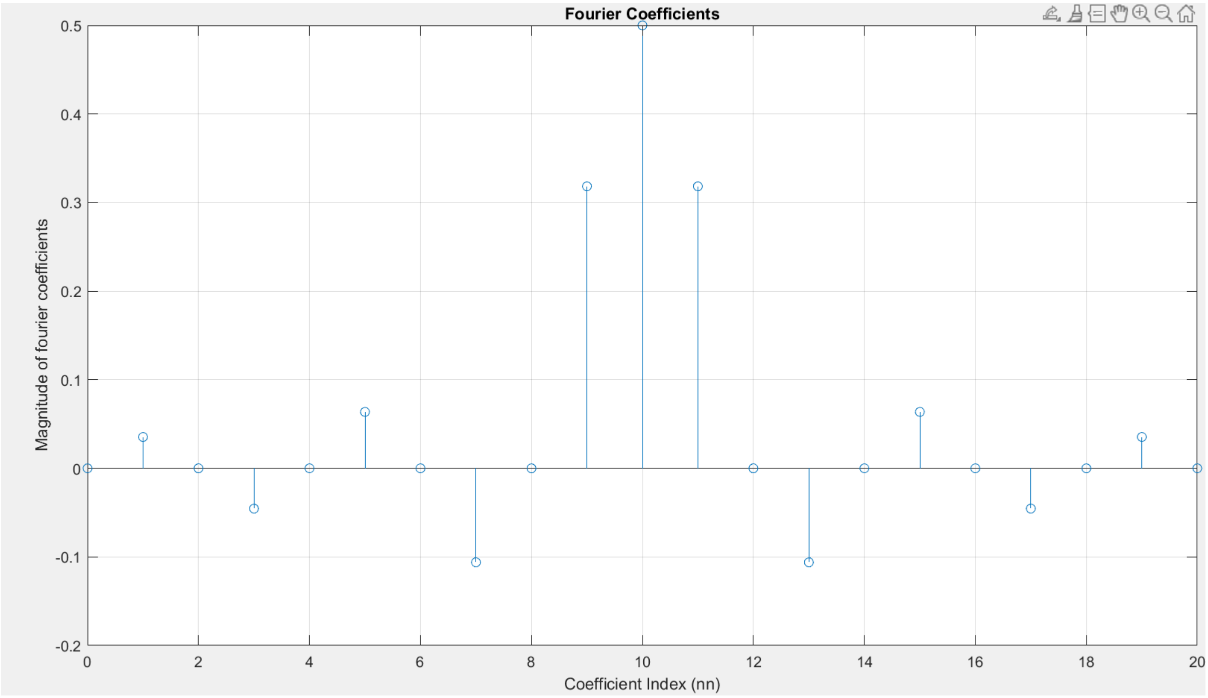
From the plot and the calculation part we are getting the same values.

1.1 b)

(It is a periodic square wave function)

Observation:

MATLAB plot :



From the plot we can say that it is a even symmetric function.

***every coefficient index nn is satisfying the f(-x)=f(x)**

So it is even function.

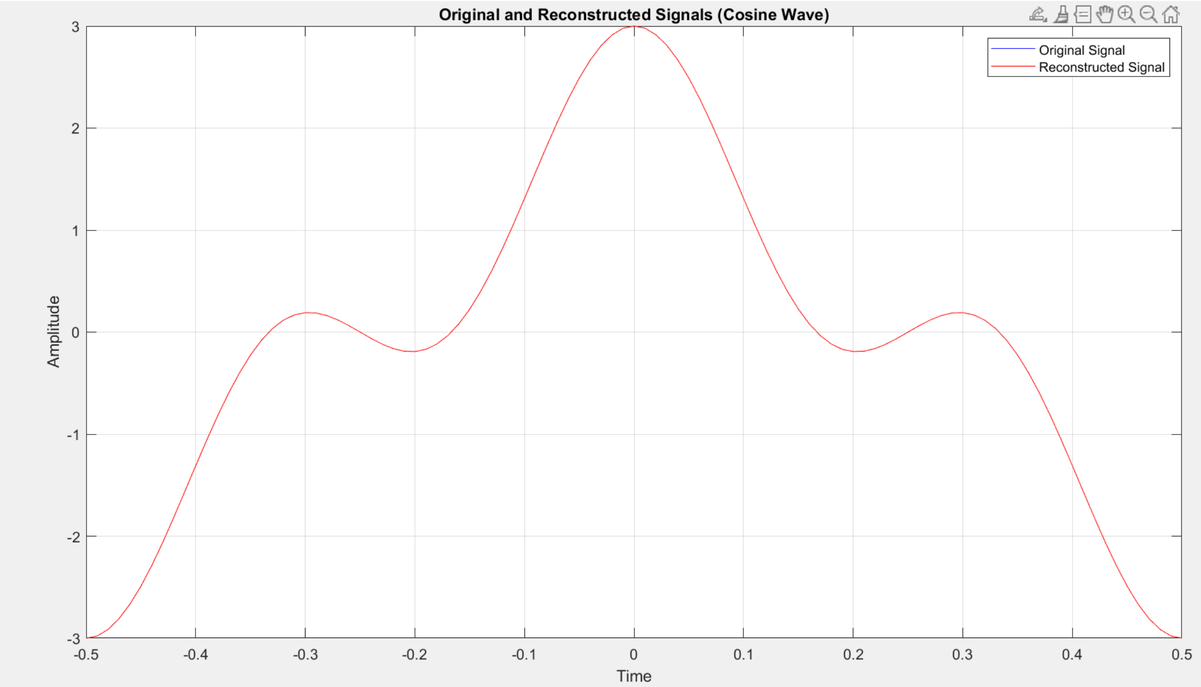
1.2

$\hat{x}(t) = \sum a_k * e^{(jk\omega 0t)}$ (where k is running from -N to N)

It is for finding the Partial Fourier sum of order N of the signal x(t).
If the N is increased to infinity then the partial sum approaches to the original signal i.e x(t).

b)

MATLAB PLOT:



Here with respect to plot the original and the reconstructed signal both are overlapping .

c)

There is small error .

****The value of Maximum absolute error (MAE) between original signal and reconstructed signal : 4.440892098500626e-16**

**** The Root mean squared (RMS) error between original signal and reconstructed signal : 8.768389183253862e-17**

(Or)

Max Absolute Error: 0.0000000000000004440892099

RMS Error: 0.0000000000000000876838918

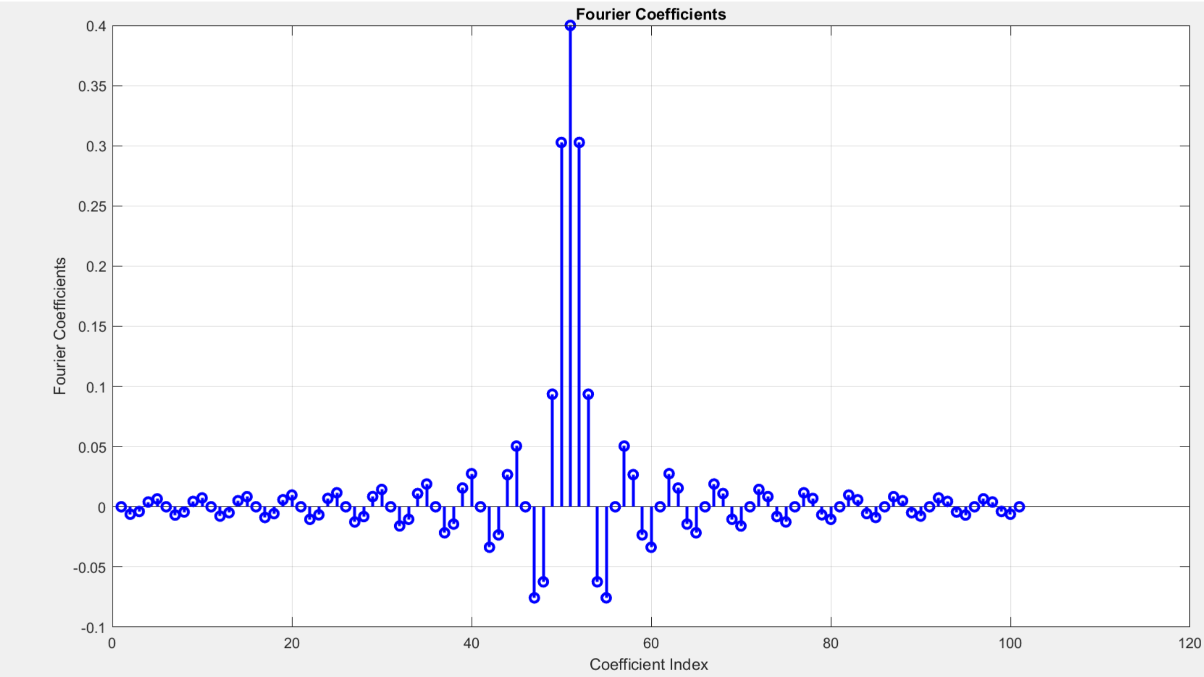
1.3)

a)

Here the Fourier series coefficients {a_k} for a real ,periodic square wave which have the amplitude as 1 in the interval [-T1,T1] and the period is T. (T1<T/2)

Observation:

MATLAB Plot:



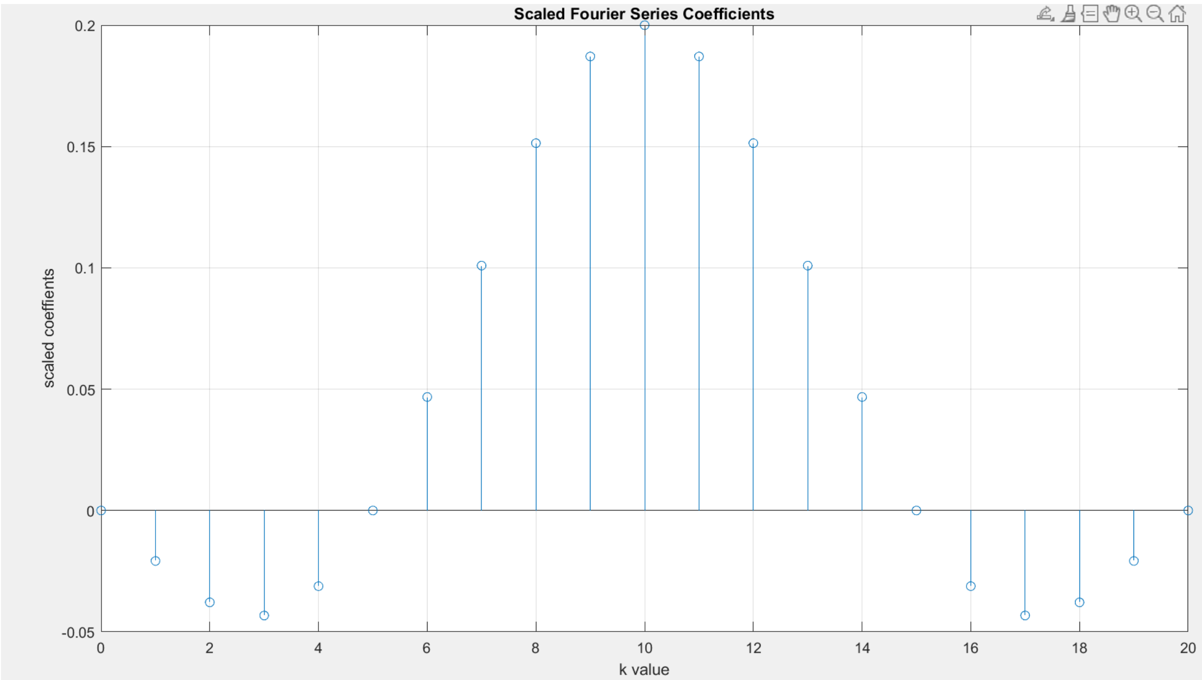
b)

Given T1=0.1

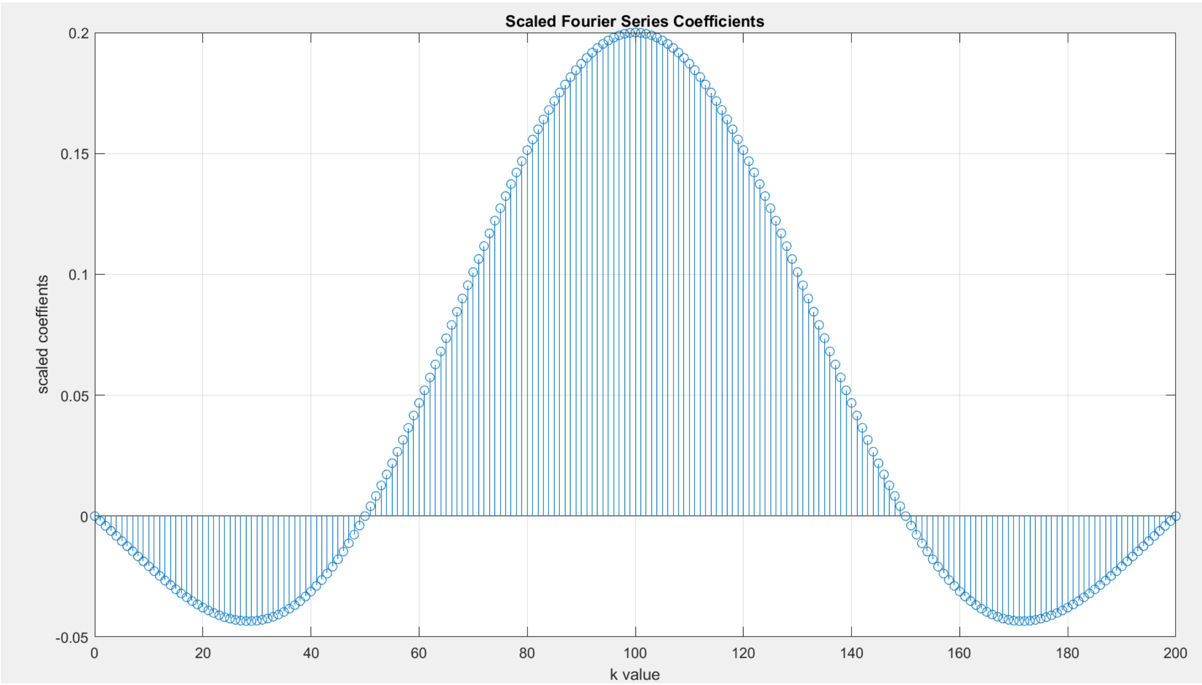
N=10*T

The plot of scaled coefficients T*a_K

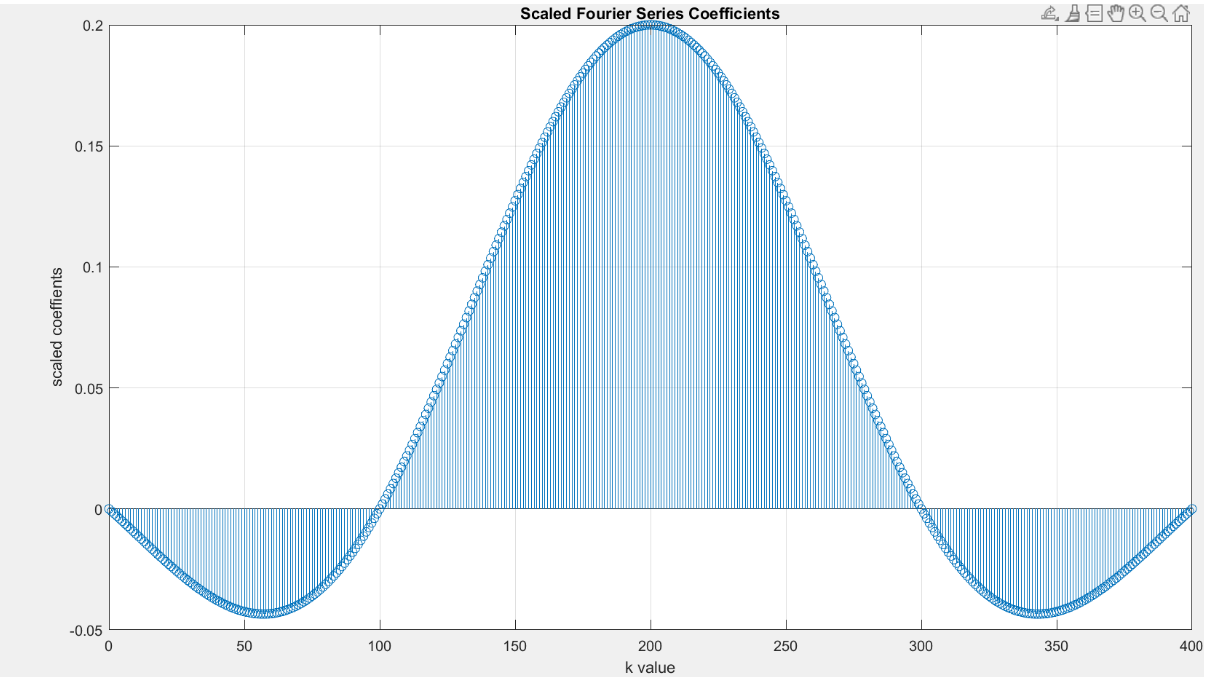
T=1


Scaled Fourier Series Coefficients
scaled coeffients
k value
0.2
0.15
0.1
0.05
0
-0.05
0
2
4
6
8
10
12
14
16
18
20

T=10


Scaled Fourier Series Coefficients
scaled coeffients
k value
0.2
0.15
0.1
0.05
0
-0.05
0
20
40
60
80
100
120
140
160
180
200

T=20



Observation:

The fourier series representation allows you to decompose a periodic signal into a sum of sinusoidal components (harmonics) . The coefficents represent the amplitudes of these sinusoidal components .

*As you increase the period T, that means stretching the signal .

*As you increase T the signal becomes smoother within each period.

As T approaches infinity , the signal becomes a continuous waveform without any abrupt changes .In this case , many of the fourier coefficients tend to zero , the a0 component which represents the mean value of the signal. This is related to the concept of the Dirac comb function, which is the limit of a periodic train of impulses as the period becomes infinite.

Conclusion:

By increasing the period T leads to a convergence of the Fourier series coefficients towards the true continuous Fourier transform of the signal.

c)

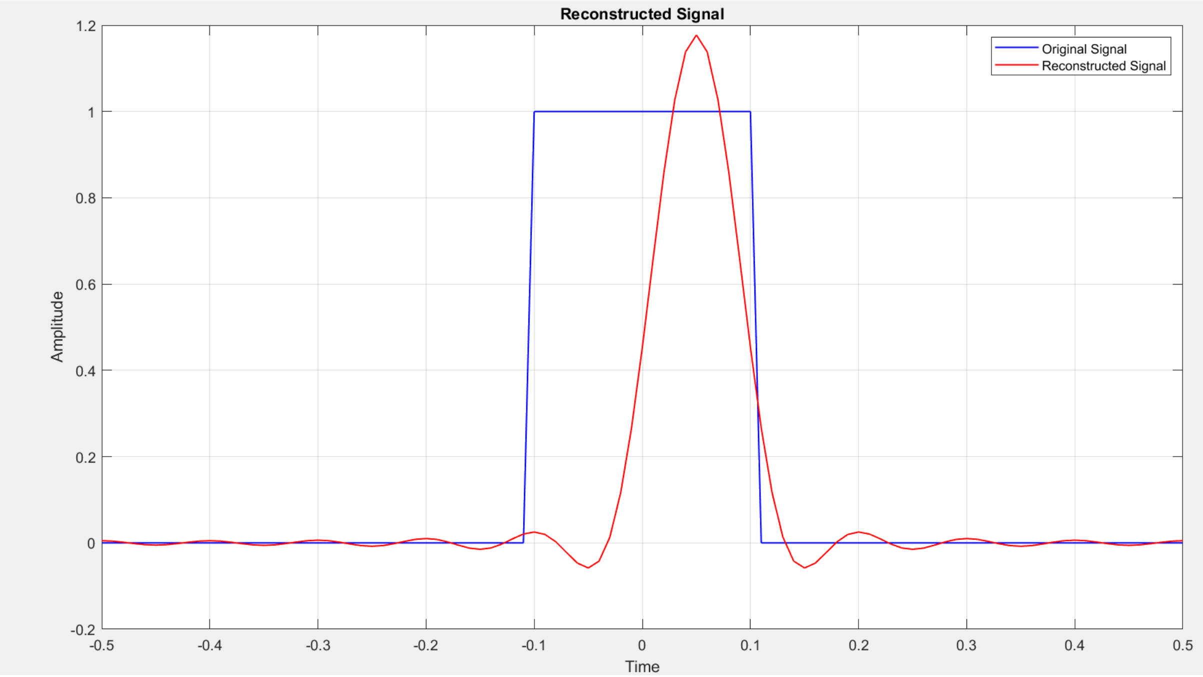
here the

N=10

T1=0.1

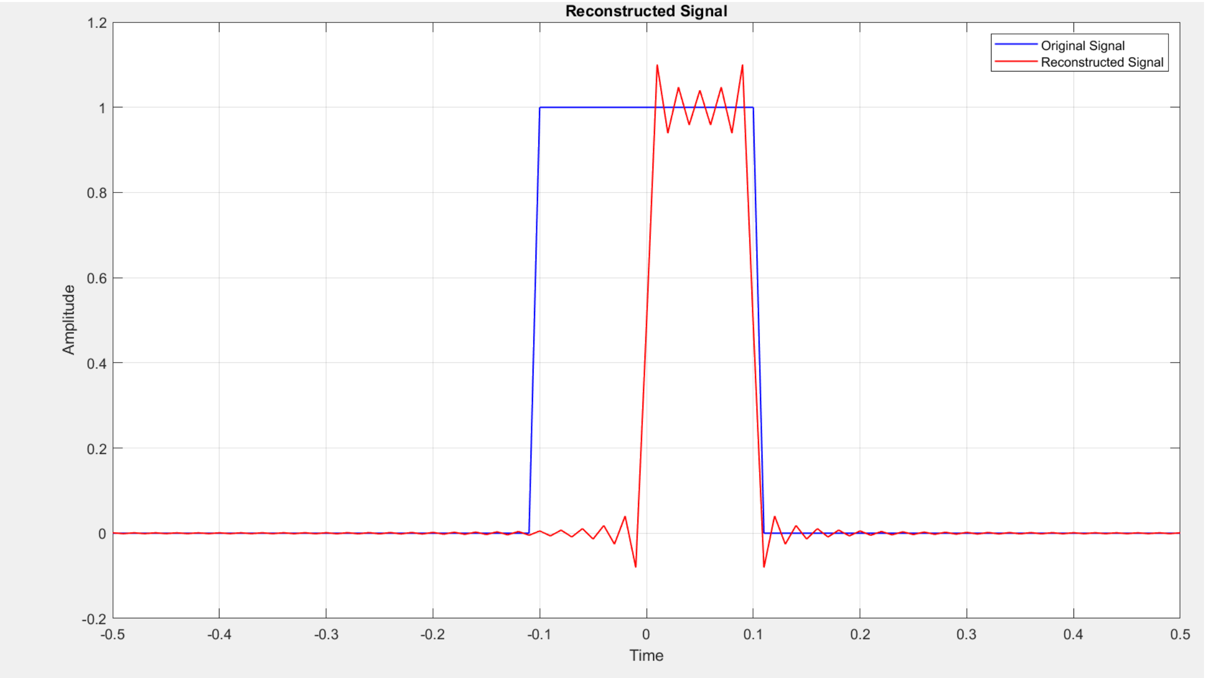
T=1

time_grid=-0.5:0.01:0.5



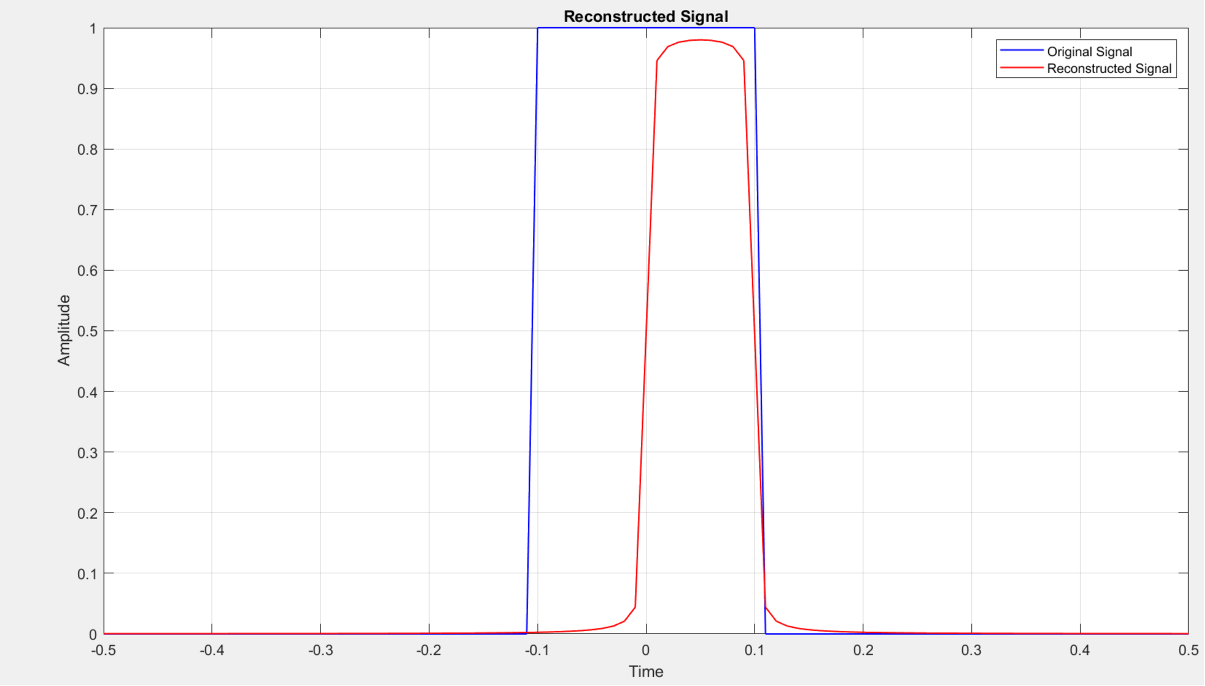
when

N=50



Reconstructed Signal
Original Signal
Reconstructed Signal
Amplitude
Time

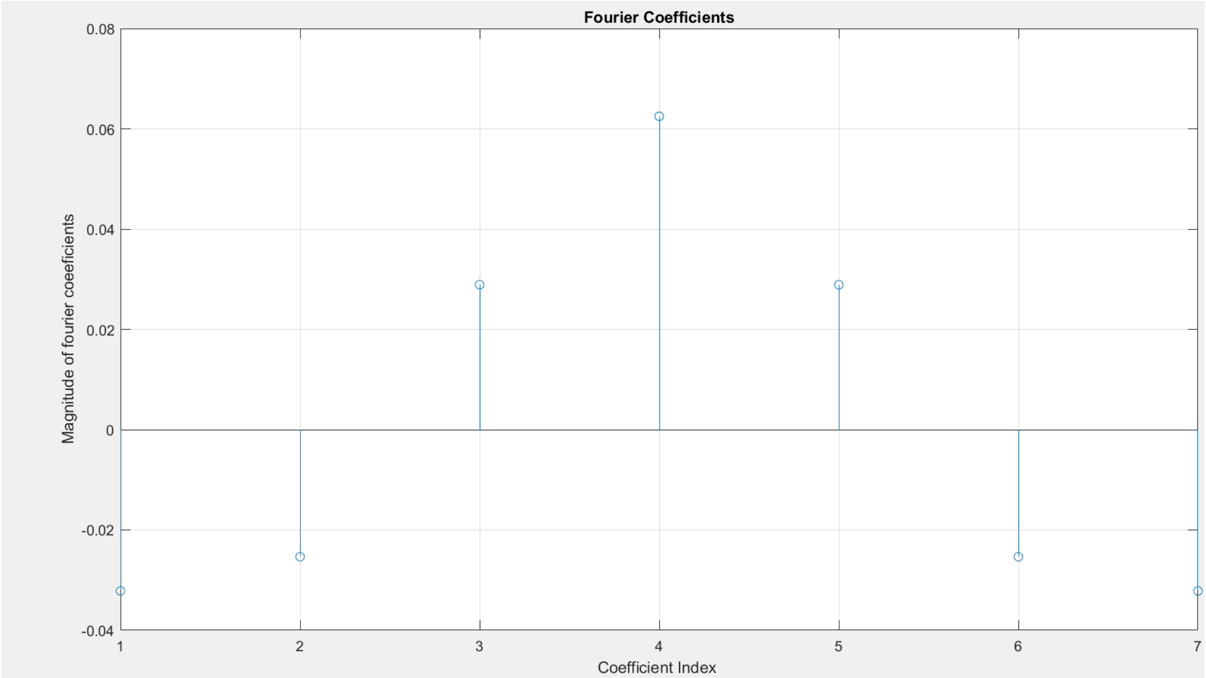
N=100



Reconstructed Signal
Original Signal
Reconstructed Signal
Amplitude
Time

1.4)

a)



c)

here from the a) and b)

we can say that part a has even symmetric

i.e

f(-t)=f(t)   for real part

and zero for imaginary part

in part b

we get the odd symmetry for the imaginary part

f(-t)=-f(t)

and all the values are zeros for real part.

Here we can observe the same for real and imaginary part of the both functions.