Efe

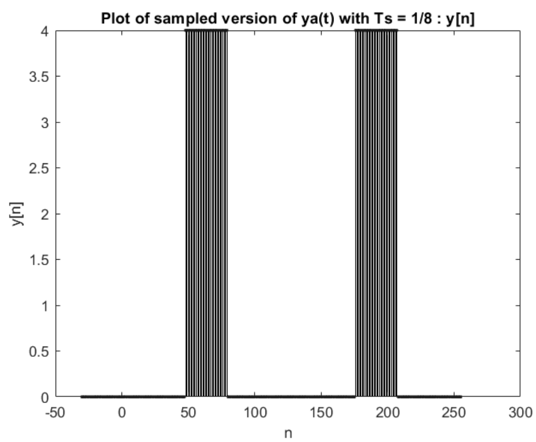
Tarhan

22002840

EEE321 Signals and Systems Lab 4

1-

a) Plot of discretized $y_a(t)$ with sampling period 1/8 seconds, y[n] is the following:



b) Fourier series expansion of $y_a(t)$ can be found with the following calculations:

$$y_a(t) = \begin{cases} 0, & 6 > t \geq 0 \\ 4, & 10 > t \geq 6 \\ 0, & 16 > t \geq 10 \end{cases}$$

Then;

$$a_0 = \frac{1}{T} \cdot \int_0^T x(t)\, dt = \frac{1}{16} \int_0^{16} y_a(t)\, dt = \frac{1}{16} \int_6^{10} 4\, dt = 1$$

Other coefficients of the FSE can be found with the generalized formula:

$$a_k = \frac{1}{16} \int_0^{16} y_a(t) \cdot e^{-j \cdot \frac{2\pi}{16} \cdot k \cdot t}\, dt = \frac{1}{16} \int_6^{10} 4 \cdot e^{-j \cdot \frac{2\pi}{16} \cdot k \cdot t}\, dt$$

$$= -\frac{1}{4} \cdot \frac{16}{j \cdot 2\pi \cdot k} \cdot \left(e^{-j \cdot \frac{20\pi}{16} \cdot k} - e^{-j \cdot \frac{12\pi}{16} \cdot k} \right)$$

$$= \frac{4}{2j \cdot \pi \cdot k} \cdot \left(e^{j \cdot \frac{20\pi}{16} \cdot k} - e^{-j \cdot \frac{20\pi}{16} \cdot k} \right) = \boxed{\frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k}}$$

Then Fourier series expansion of $y_a(t)$ becomes:

$$\boxed{FSE[y_a(t)] = 1 + \sum_{\substack{k=-\infty,\\ k\neq 0}}^{\infty} \frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \cdot e^{j \cdot \frac{\pi}{8} \cdot k \cdot t}}$$

$$= 1 + \sum_{k=-\infty}^{-1} \frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \cdot e^{j \cdot \frac{\pi}{8} \cdot k \cdot t} + \sum_{k=1}^{\infty} \frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \cdot e^{j \cdot \frac{\pi}{8} \cdot k \cdot t}$$

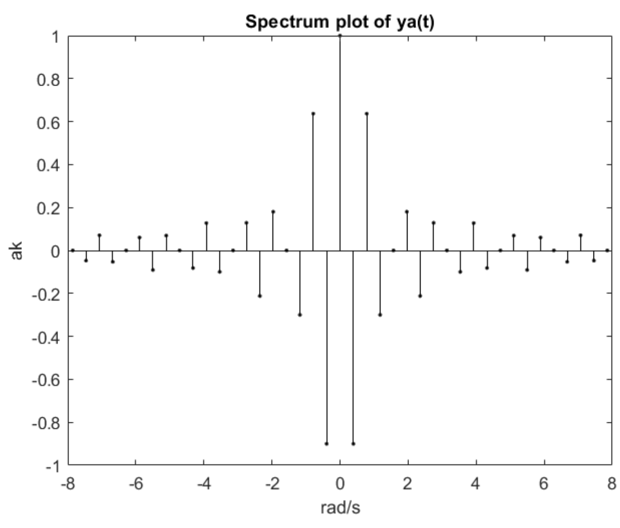
$$= 1 + \sum_{k=1}^{\infty} \frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \left(e^{j \cdot \frac{\pi}{8} \cdot k \cdot t} + e^{-j \cdot \frac{\pi}{8} \cdot k \cdot t}\right)$$

$$= \boxed{1 + \sum_{k=1}^{\infty} 8 \cdot \frac{\sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \cdot \cos\left(\frac{\pi}{8} \cdot k \cdot t\right)}$$

c) Spectrum of the complex amplitudes can be found by using the Fourier series expansion coefficients:

$$a_k = \begin{cases} 1, & k = 0 \\ \frac{4 \cdot \sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k}, & k \neq 0 \end{cases}$$

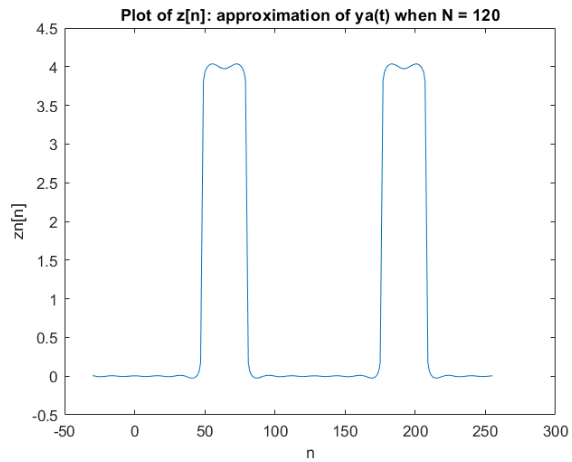
Then the plot of the spectrum of amplitudes with MATLAB is the following:



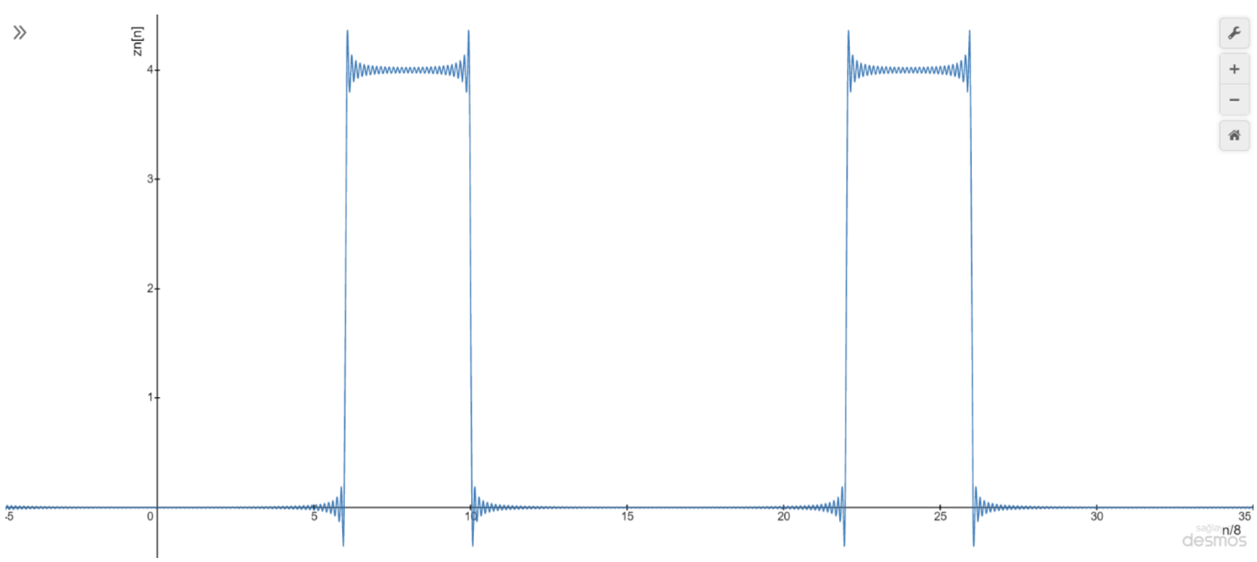
Because the signal is even and real $a_k = a_{-k}'s$. And there are no imaginary components of the FSE coefficients.

d) By the result obtained from part b, the FSE approximations $z_N[n]$ can be written as the following:

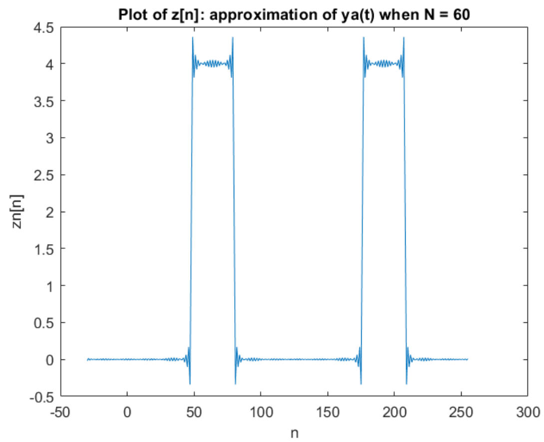
$$z[n] = 1 + \sum_{k=1}^{N} 8 \cdot \frac{\sin\left(\frac{5\pi}{4} \cdot k\right)}{\pi \cdot k} \cdot \cos\left(\frac{\pi}{8} \cdot k \cdot \frac{n}{8}\right) \; for \; n \in [-30,255]$$



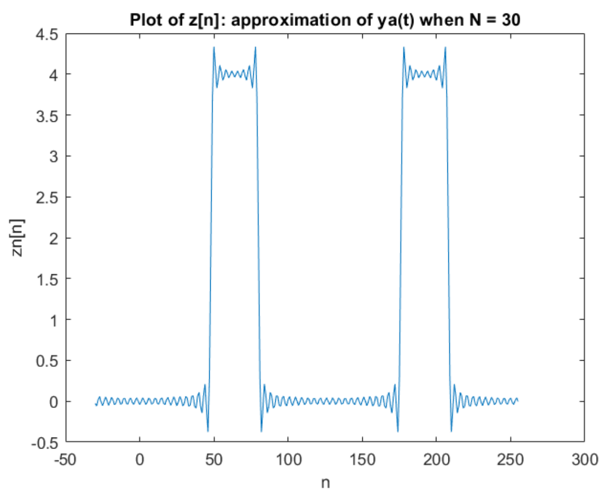
Because of the automatic line fitting function of the MATLAB, Gibbs effect cannot be seen clearly from the plot generated using MATLAB. Because of this, a plot has been created using Desmos graphing calculator, to see the actual graph of the approximation.



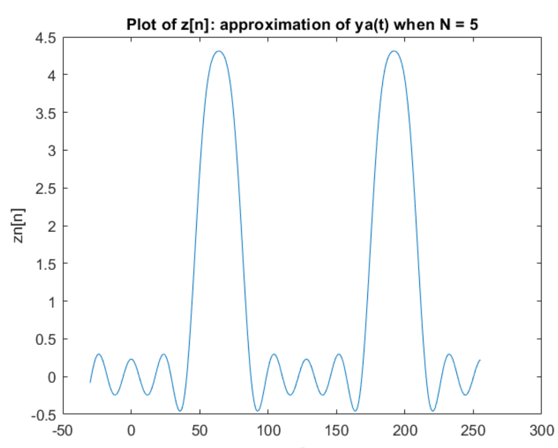
e) For N = 60:



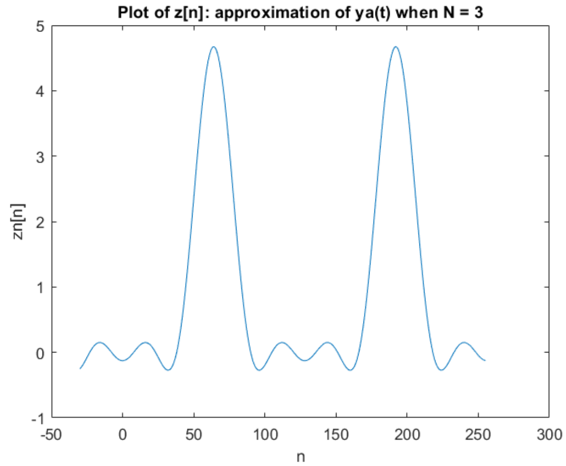
f) For N = 30:



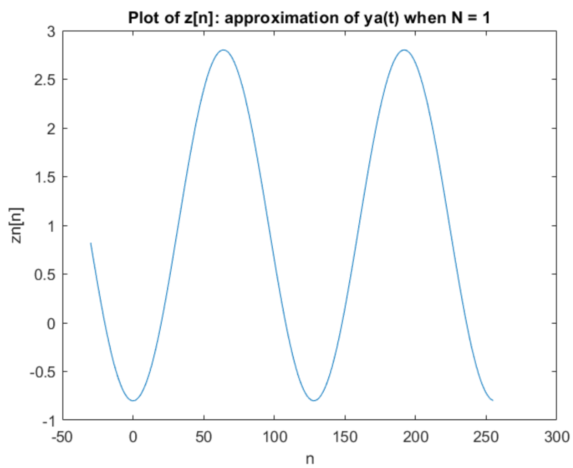
g) For N = 5:



h) For N = 3:



i) For N = 1:



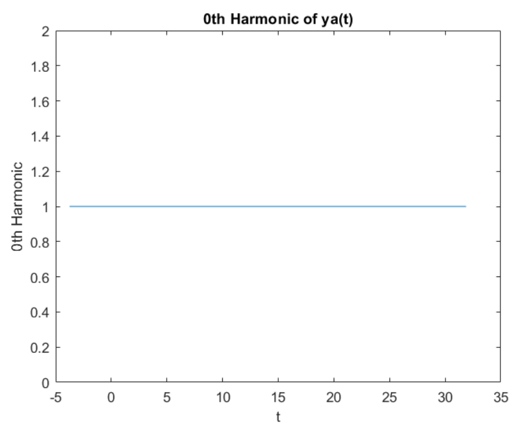
As it can be seen quality of the approximation increases with the number of components used for z[n]. The reason is that the Fourier series expansion of this function is equal to the function in a weak sense. This indicates that every component that we don't add to the approximation function become a source of error.

Therefore, the value of the absolute error decreases with the increasing N, i.e., increasing number of components of the FSE added to z[n]. Also, it can be seen from the spectrum of $y_a(t)$ that the $a_k's$ with larger k's also has a comparably effective contribution to the approximation as k increases.

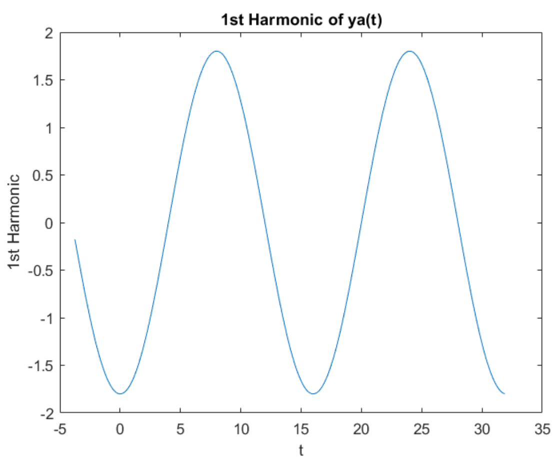
Also, according to the Gibbs phenomena, the jump discontinuity can't die with increasing number of components added to the approximation function but the problem that the graph for N= 120 has a smoother curve compared with the N = 60 is because MATLAB fits the points to the lines smoothly when they become really close to each other in a situation like this. Therefore, the first approximation graph should not look like as it is. The jump discontinuity and the lines must be straighter than the plot of the approximation for N = 60. To show the actual plot of the approximation, the online graph calculator Desmos has been used.

j)

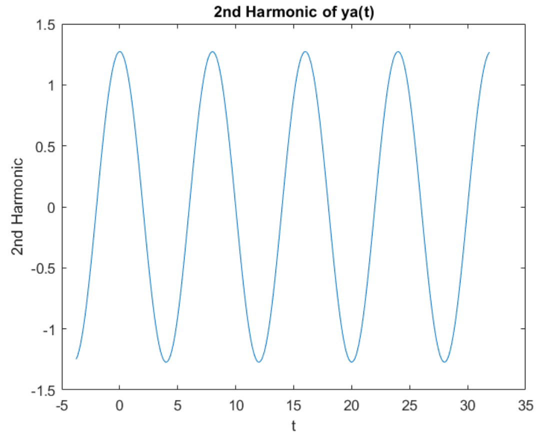
0^{th} Harmonic:



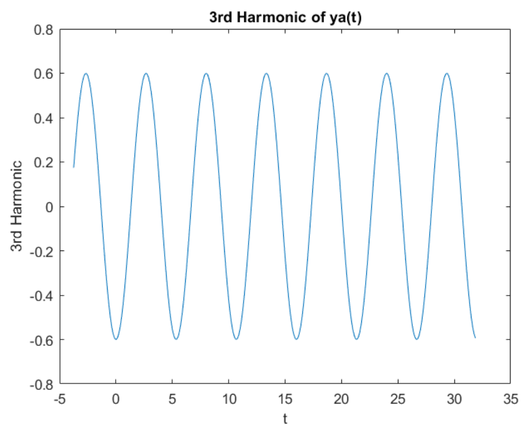
1^{st} Harmonic:



2nd Harmonic:

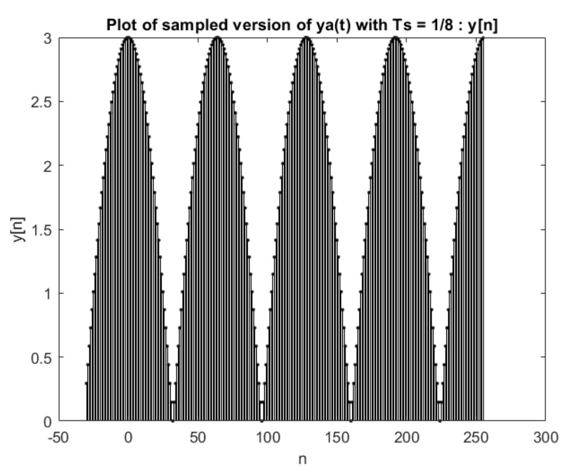


3rd Harmonic:



2-

a) Plot of discretized $y_a(t)$ with sampling period 1/8 seconds, y[n] is the following:



b) Fourier series expansion of $y_a(t)$ can be found with the following calculations:

$$y_a(t) = \left|3 \cdot \cos\left(\frac{\pi}{8} \cdot t\right)\right| = 3 \cdot \cos\left(\frac{\pi}{8} \cdot t\right) \; for\ t \in [-4,4] \; and\ periodic\ with\ T = 8$$

Then;

$$a_0 = \frac{1}{T} \cdot \int_0^T x(t)\, dt = \frac{1}{8}\int_{-4}^{4} y_a(t)\, dt = \frac{1}{8}\int_{-4}^{4} 3 \cdot \cos\left(\frac{\pi}{8}t\right)\, dt = \frac{3}{\pi}\left(\sin\left(\frac{\pi}{2}\right) - \sin\left(-\frac{\pi}{2}\right)\right) = \frac{6}{\pi}$$

Other coefficients of the FSE can be found with the generalized formula:

$$\begin{aligned}
a_k &= \frac{1}{8}\int_{-4}^{4} y_a(t) \cdot e^{-j\cdot\frac{2\pi}{8}\cdot k\cdot t}\, dt = \frac{1}{8}\int_{-4}^{4} 3 \cdot \cos\left(\frac{\pi}{8}t\right) \cdot e^{-j\cdot\frac{2\pi}{8}\cdot k\cdot t}\, dt \\
&= \frac{3}{16}\int_{-4}^{4} \left(e^{-j\cdot\frac{2\pi}{8}\cdot k\cdot t} \cdot e^{j\cdot\frac{\pi}{8}\cdot t} + e^{-j\cdot\frac{2\pi}{8}\cdot k\cdot t} \cdot e^{-j\cdot\frac{\pi}{8}\cdot t}\right) dt \\
&= \frac{3}{16}\int_{-4}^{4} \left(e^{j\cdot\frac{\pi}{8}\cdot t(1-2k)} + e^{-j\cdot\frac{\pi}{8}\cdot t(1+2k)}\right) dt \\
&= \frac{3}{2}\left(\frac{\left(e^{j\cdot\frac{\pi}{2}(1-2k)} - e^{-j\cdot\frac{\pi}{2}(1-2k)}\right)}{j\pi(1-2k)} + \frac{\left(e^{j\cdot\frac{\pi}{2}\cdot t(1+2k)} - e^{-j\cdot\frac{\pi}{2}(1+2k)}\right)}{j\pi(1+2k)}\right)
\end{aligned}$$

$$= \boxed{3\left(\frac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \frac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right)}$$

Then Fourier series expansion of $y_a(t)$ becomes:

$$\boxed{FSE[y_a(t)] = \frac{6}{\pi} + \sum_{\substack{k=-\infty,\\ k\neq 0}}^{\infty} 3\left(\frac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \frac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right) \cdot e^{j\cdot\frac{2\pi}{8}\cdot k\cdot t}}$$

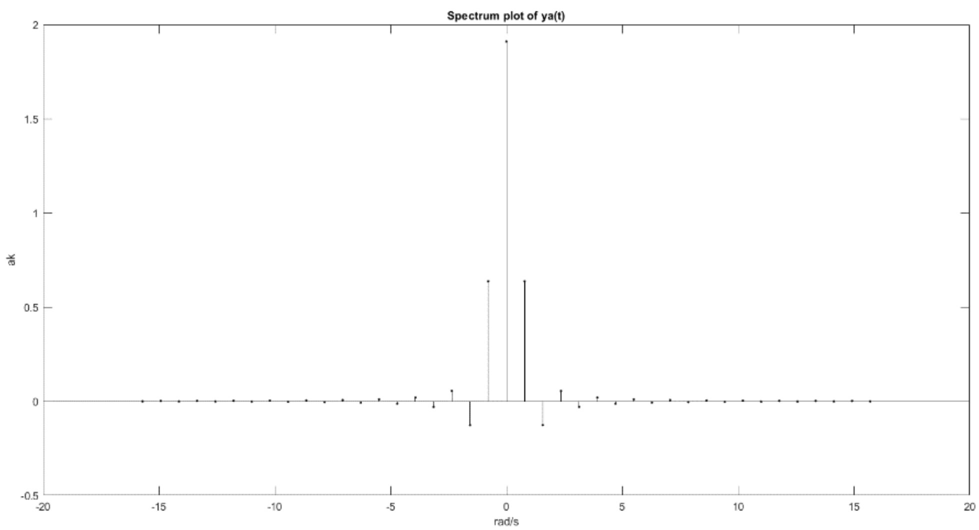
$$\begin{aligned}
&= 1 + \sum_{k=-\infty}^{-1} a_k \cdot e^{j\cdot\frac{2\pi}{8}\cdot k\cdot t} + \sum_{k=1}^{\infty} a_k \cdot e^{j\cdot\frac{2\pi}{8}\cdot k\cdot t} \\
&= 1 + \sum_{k=1}^{\infty} a_k \left(e^{j\cdot\frac{\pi}{4}\cdot k\cdot t} + e^{-j\cdot\frac{\pi}{4}\cdot k\cdot t}\right)
\end{aligned}$$

$$= \boxed{\frac{6}{\pi} + \sum_{k=1}^{\infty} 6\left(\frac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \frac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right) \cdot \cos\left(\frac{\pi}{4} \cdot k \cdot t\right)}$$

c) Spectrum of the complex amplitudes can be found by using the Fourier series expansion coefficients:

$$a_k = \begin{cases} \dfrac{6}{\pi}, & k = 0 \\ 3\left(\dfrac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \dfrac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right), & k \neq 0 \end{cases}$$

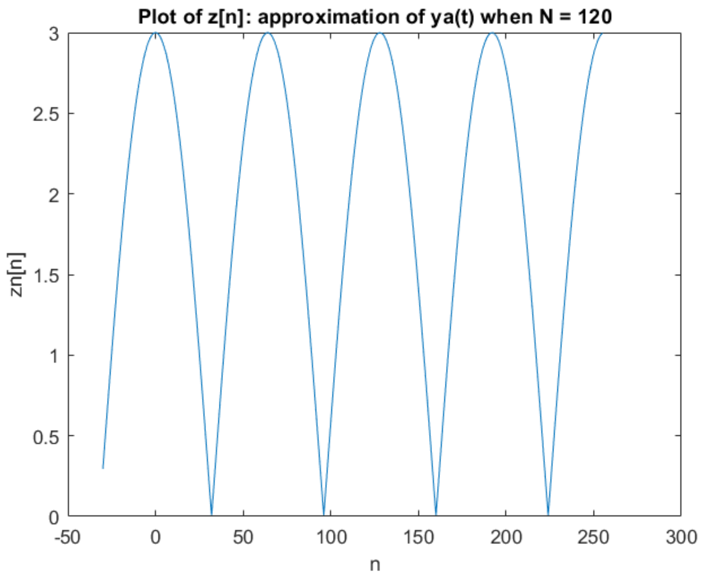
Then the plot of the spectrum of amplitudes with MATLAB is the following:



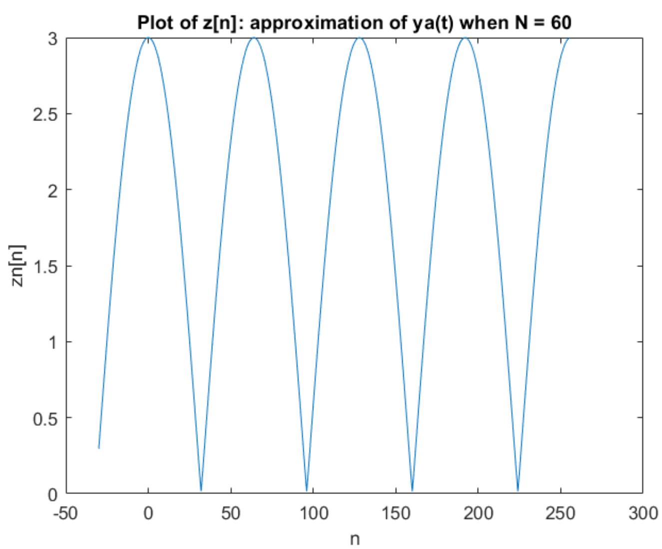
Since the function is even and real $a_k = a_{-k}$. Therefore, there are no imaginary components of the FSE coefficients.

d) By the result obtained from part b, the FSE approximations $z_N[n]$ can be written as the following:

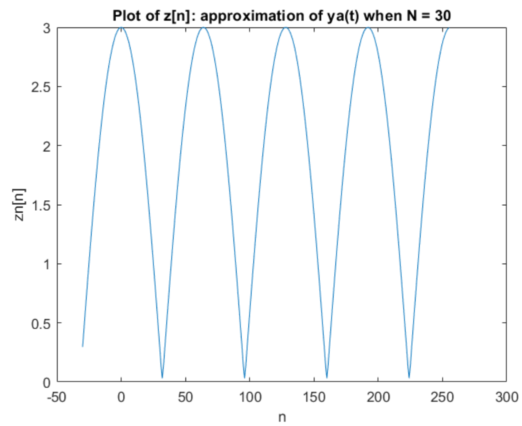
$$z[n] = \frac{6}{\pi} + \sum_{k=1}^{N} 6\left(\frac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \frac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right) \cdot \cos\left(\frac{\pi}{4} \cdot k \cdot \frac{n}{8}\right) \ for\ n \in [-30,255]$$



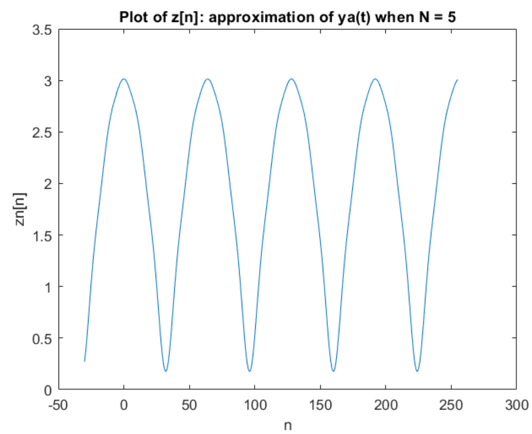
e) For N = 60:



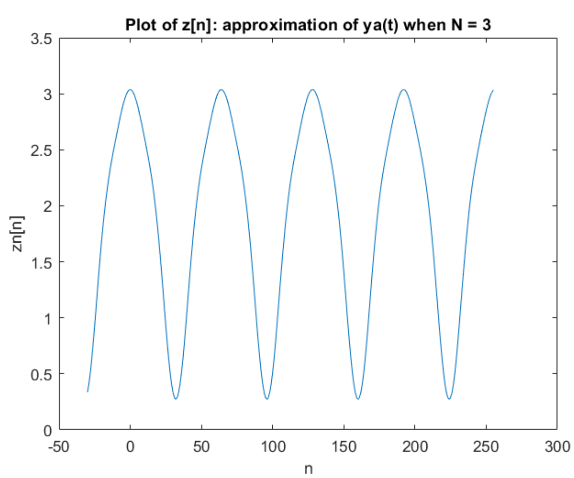
f) For N = 30:



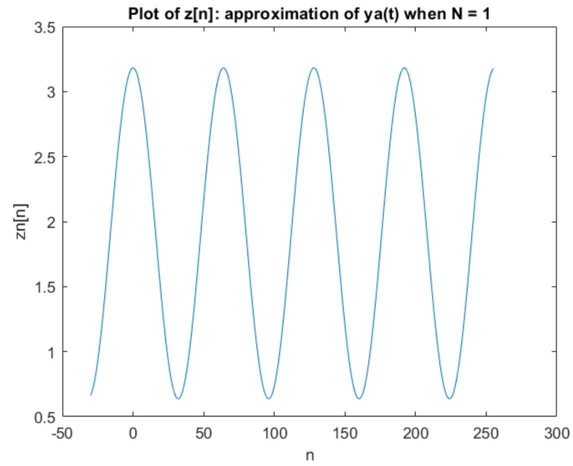
g) For N = 5:



h) For N = 3:



i) For N = 1:



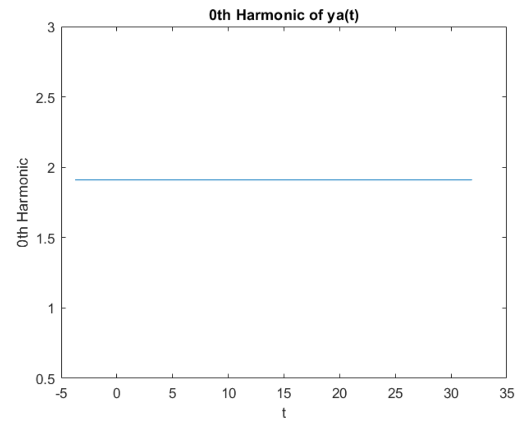
As it can be seen quality of the approximation increases with the number of components used for z[n]. The reason is that the Fourier series expansion of this function is equal to the function in a weak sense. This indicates that every component that we don't add to the approximation function become a source of error.

Therefore, the value of the absolute error decreases with the increasing N, i.e., increasing number of components of the FSE added to z[n]. But the plot of this function looks more alike to the original function compared with the 1st part of the lab. This is due to the contribution of larger harmonics to the approximation. In the plot of the spectrum of FSE of the signal it can be seen that the after the 3rd harmonic contribution of harmonics decrease significantly.

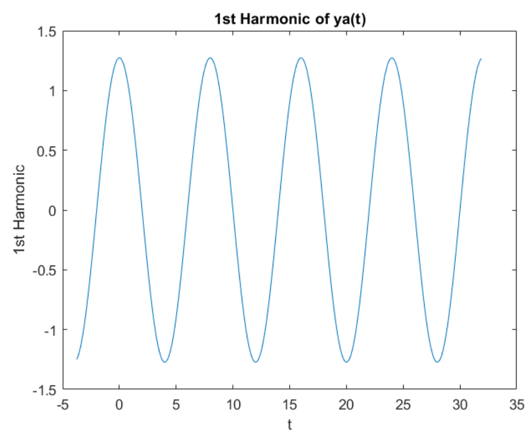
Since there are not any sharp edges or jumps in the original function, Gibbs effect can not be seen in this part of the lab.

j)

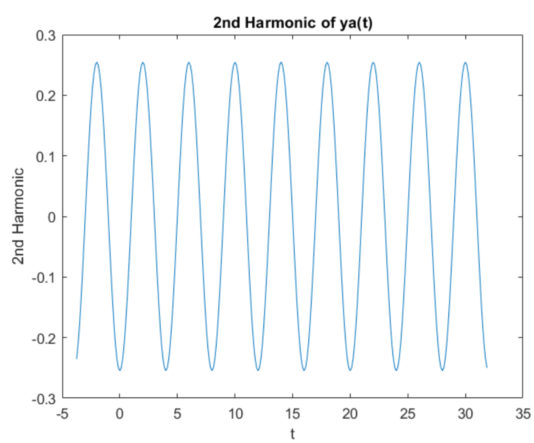
0^{th} Harmonic:



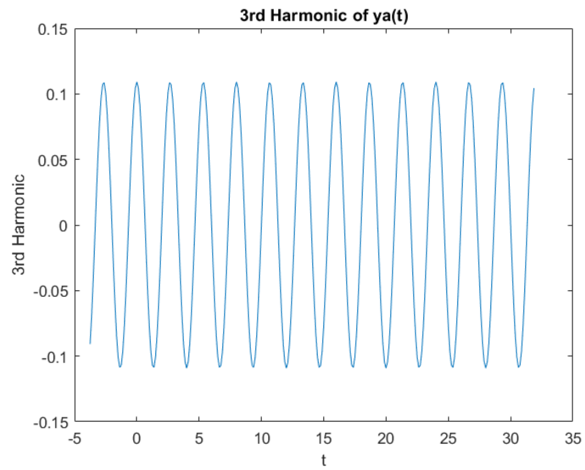
1^{st} Harmonic:



2^{nd} Harmonic:

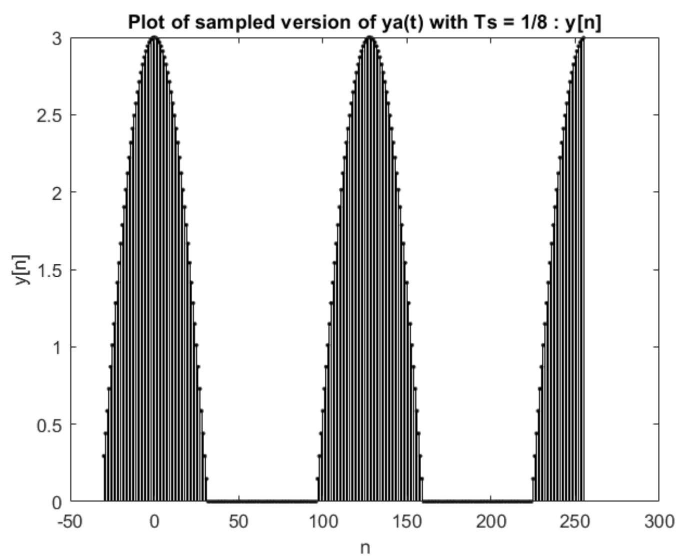


3rd Harmonic:



3-

a) Plot of discretized $y_a(t)$ with sampling period 1/8 seconds, y[n] is the following:



b) Fourier series expansion of $y_a(t)$ can be found with the following calculations:

This signal can be represented with the linear relation of signal in part 2 and

$$m(t) = 3 \cdot \cos\left(\frac{\pi}{8} \cdot t\right).$$

$$y_{a3}(t) = \frac{y_{a2}(t) + m(t)}{2}$$

Then the FSE coefficients of $y_{a3}(t)$ can be represented as the half of the summation of the FSE coefficients of two signals above because of its linearity property. FSE coefficients of $y_{a2}(t)$ was found in part 2.

$$m(t) = 3\cos\left(\frac{2\pi}{16}t\right) = 3\frac{e^{\frac{j2\pi}{16}t} + e^{-\frac{j2\pi}{16}t}}{2} = \frac{3}{2}\cdot e^{\frac{j2\pi}{16}t} + \frac{3}{2}\cdot e^{\frac{-j2\pi}{16}t}$$

is the FSE of the signal. The FSE of the given signal is also the linear combination of the FSE of the signals above, therefore FSE of $y_{a3}(t)$ can be written as the following:

$$y_{a3}(t) = \frac{\frac{6}{\pi} + \left[\sum_{\substack{k=-\infty,\\ k\neq 0}}^{\infty} 3\left(\frac{\sin\left(\frac{\pi}{2}(1-2k)\right)}{\pi(1-2k)} + \frac{\sin\left(\frac{\pi}{2}(1+2k)\right)}{\pi(1+2k)}\right)\cdot e^{j\cdot\frac{2\pi}{8}\cdot k\cdot t}\right] + \frac{3}{2}\cdot e^{\frac{j2\pi}{16}t} + \frac{3}{2}\cdot e^{\frac{-j2\pi}{16}t}}{2}$$

Let $k' = 2k$.

$$= \frac{2}{\pi} + \left[\sum_{\substack{k'=-\infty,\\ k'\neq 0}}^{\infty} \frac{3}{2}\left(\frac{\sin\left(\frac{\pi}{2}(1-k')\right)}{\pi(1-k')} + \frac{\sin\left(\frac{\pi}{2}(1+k')\right)}{\pi(1+k')}\right)\cdot e^{j\cdot\frac{\pi}{8}\cdot k'\cdot t}\right] + \frac{3}{4}\cdot e^{\frac{j2\pi}{16}t} + \frac{3}{4}\cdot e^{\frac{-j2\pi}{16}t}$$

Since for k = 1 and k = -1 the identity is ambiguous they must be found by using a different method which is the following. Also, it must be noted that $a_k = a_{-k}$, because the signal is real.

$$a_{-1} = a_1 = \frac{1}{16}\int_{-4}^{12}\left(\frac{y_{a2}(t) + 3\cdot\cos\left(\frac{2\pi}{16}\cdot t\right)}{2}\right)\cdot e^{-\frac{j2\pi}{16}t}dt =$$

$$= \frac{3}{16}\int_{-4}^{4}\cos\left(\frac{2\pi}{16}\cdot t\right)\cdot e^{-\frac{j2\pi}{16}t}dt = \frac{3}{16}\int_{-4}^{4}\frac{1 + e^{-\frac{j2\pi}{8}t}}{2}dt = \frac{3}{16}\left(\frac{4 + \frac{4j}{\pi}}{2} - \frac{-4 + \frac{4j}{\pi}}{2}\right) = \frac{3}{4}$$

$$= \boxed{FSE\left[y_{a3}(t)\right] = \frac{3}{\pi} + \frac{3}{4} \cdot e^{\frac{j2\pi}{16}t} + \frac{3}{4} \cdot e^{\frac{-j2\pi}{16}t} + \left[\sum_{\substack{k=-\infty,\\ k\neq -1,0,1}}^{\infty} \frac{3}{2}\left(\frac{\sin\left(\frac{\pi}{2}(1-k^{'})\right)}{\pi(1-k^{'})} + \frac{\sin\left(\frac{\pi}{2}(1+k^{'})\right)}{\pi(1+k^{'})}\right) \cdot e^{j\cdot\frac{2\pi}{16}\cdot k\cdot t}\right]}$$

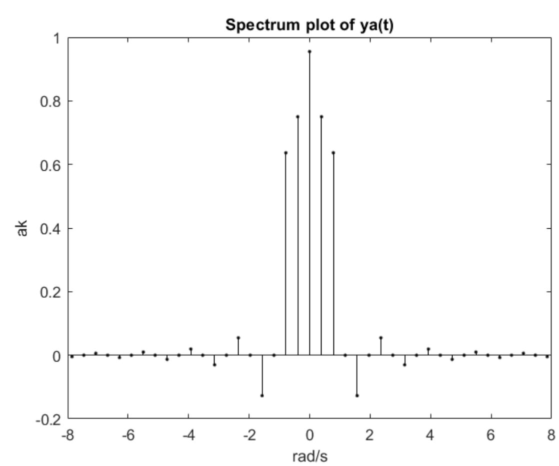
$$= \boxed{\frac{3}{\pi} + \frac{3}{2} \cdot cos\left(\frac{2\pi}{16}t\right) + \left[\sum_{k=2}^{\infty} 3\left(\frac{\sin\left(\frac{\pi}{2}(1-k')\right)}{\pi(1-k')} + \frac{\sin\left(\frac{\pi}{2}(1+k')\right)}{\pi(1+k')}\right) \cdot cos\left(\frac{2\pi}{16}t\right)\right]}$$

During this calculation period of the $y_{a2}(t)$ has been chosen as 16s which is the double of the fundamental period to make the calculation.

c) Spectrum of the complex amplitudes can be found by using the Fourier series expansion coefficients:

$$a_k = \begin{cases} \frac{3}{4}, & k = -1 \\ \frac{3}{\pi}, & k = 0 \\ \frac{3}{4}, & k = 1 \\ \frac{3}{2}\left(\frac{\sin\left(\frac{\pi}{2}(1-k)\right)}{\pi(1-k)} + \frac{\sin\left(\frac{\pi}{2}(1+k)\right)}{\pi(1+k)}\right), & k \neq -1,0,1 \end{cases}$$

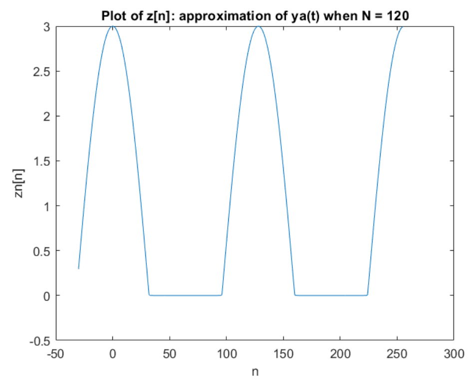
Then the plot of the spectrum of amplitudes with MATLAB is the following:



Since the signal is even and real $a_k = a_{-k}$. And there are no imaginary components of the FSE coefficients.

d) By the result obtained from part b, the FSE approximations $z_N[n]$ can be written as the following:

$$z[n] = \frac{3}{\pi} + \frac{3}{2} \cdot cos\left(\frac{2\pi}{16} \cdot \frac{n}{8}\right) + \left[\sum_{k=2}^{N} 3\left(\frac{\sin\left(\frac{\pi}{2}(1-k')\right)}{\pi(1-k')} + \frac{\sin\left(\frac{\pi}{2}(1+k')\right)}{\pi(1+k')}\right) \cdot cos\left(\frac{2\pi}{16} \cdot n \cdot \frac{1}{8}\right)\right] \; for\, n \in [-30,255]$$



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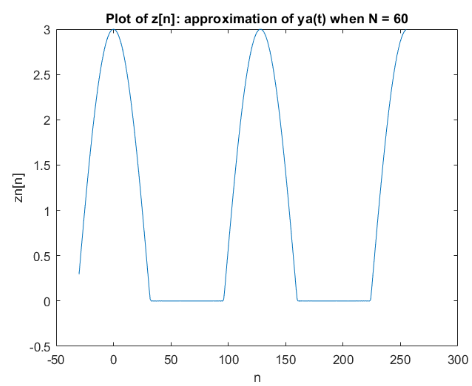

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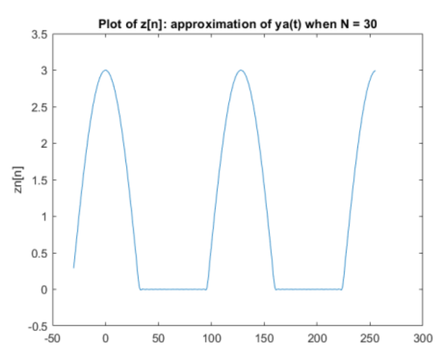
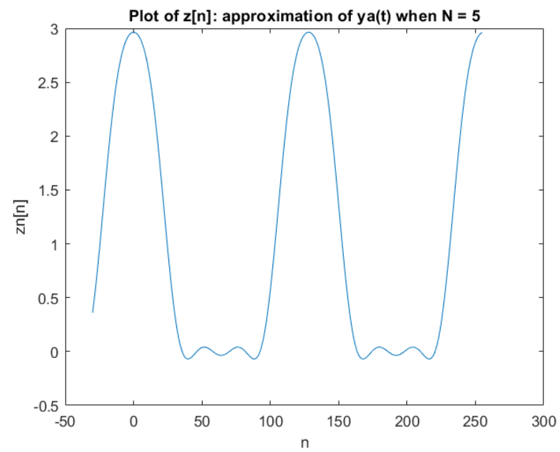
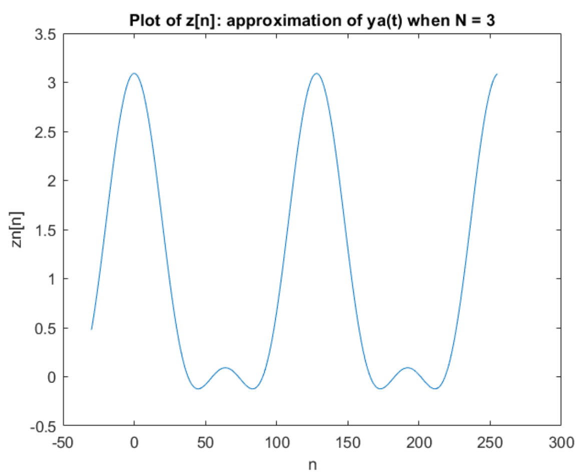


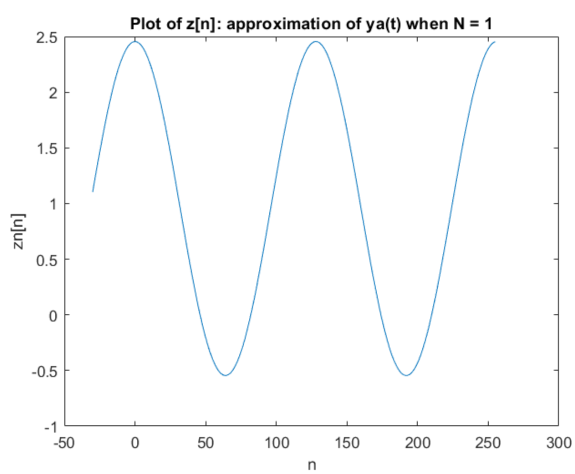
g) For N = 5:



h) For N = 3:



i) For N = 1:



As it can be seen quality of the approximation increases with the number of components used for z[n]. The reason is that the Fourier series expansion of this function is equal to the function in a weak sense. This indicates that every component that we don't add to the approximation function become a source of error. This can be summarized with the following equality:

$$\int_{-\infty}^{\infty} y_a(t)dt = \int_{-\infty}^{\infty}\left(\sum_{k=-\infty}^{\infty} a_k \cdot e^{j\omega_0 kt}\right)dt$$

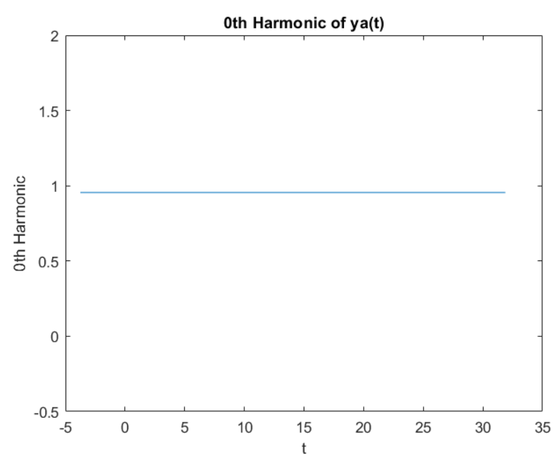
$$\epsilon(t) = \left|\int_{-\infty}^{\infty} y_a(t)dt - \int_{-\infty}^{\infty} z_N(n)dt\right|$$

$$= \left|\int_{-\infty}^{\infty}\left(\sum_{k=N+1}^{\infty} 3\left(\frac{\sin\left(\frac{\pi}{2}(1-k)\right)}{\pi(1-k)} + \frac{\sin\left(\frac{\pi}{2}(1+k)\right)}{\pi(1+k)}\right)\cdot\cos\left(\frac{\pi}{8}\cdot k\cdot t\right)\right)dt\right|$$

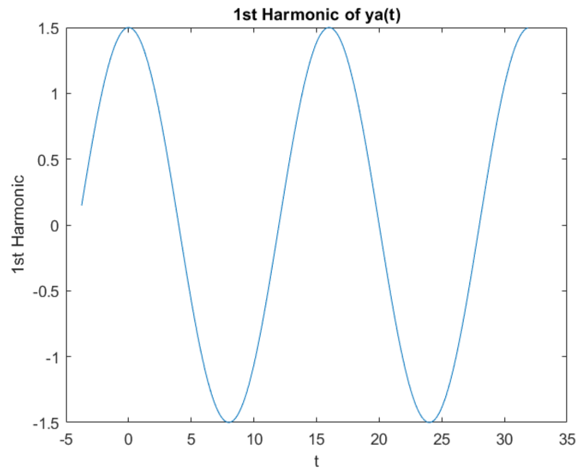
Therefore, the value of the absolute error decreases with the increasing N, i.e., increasing number of components of the FSE added to z[n]. But the plot of this function looks more alike to the original function compared with the 1st part of the lab. This is due to the contribution of larger harmonics to the approximation. In the plot of the spectrum of FSE of the signal it can be seen that the after the 5th harmonic, contribution of harmonics decrease significantly.

j)

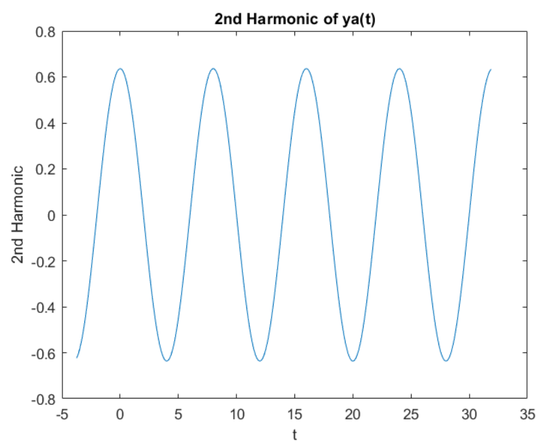
0th Harmonic:



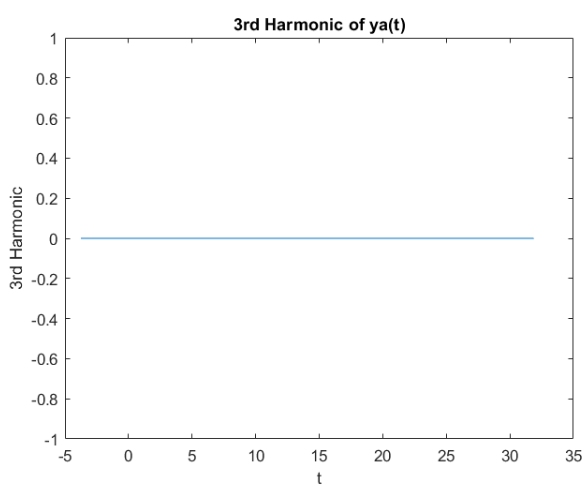
1st Harmonic:



2nd Harmonic:



3rd Harmonic:



Code of Part 1:

```
n = -30:1:255;
ya = zeros(size(n));
for i = n
   dum = mod(i/8,16);
   if (dum >= 6)&&(dum < 10)
        ya(i+31) = 4;
   end
end

stem(n/8,ya,'.k');
xlabel('n/8')
ylabel('z[n]')
title('Plot of sampled version of ya(t) with Ts = 1/8 : y[n]')

m = -20:1:20;
a = 4.*(sin(5*pi/4.*m))./(pi.*m);
a(21) = 1;
stem(m*2*pi/16,a,'filled','k.');
xlabel('rad/s');
ylabel('ak');
title('Spectrum plot of ya(t)');

syms k
f(k) = 8*sin(5*pi/4*k)/(pi*k)*cos(pi/8*k*n/8);
%zn120 = 1 + symsum(f,k,[1 120]);
%zn60 = 1 + symsum(f,k,[1 60]);
%zn30 = 1 + symsum(f,k,[1 30]);
%zn5 = 1 + symsum(f,k,[1 5]);
%zn3 = 1 + symsum(f,k,[1 3]);
%zn1 = 1 + symsum(f,k,[1 1]);


%plot(n/8,zn120);title('Plot of z[n]: approximation of ya(t) when N = 120');
%plot(n/8,zn60);title('Plot of z[n]: approximation of ya(t) when N = 60');
%plot(n/8,zn30);title('Plot of z[n]: approximation of ya(t) when N = 30');
%plot(n/8,zn5);title('Plot of z[n]: approximation of ya(t) when N = 5');
%plot(n/8,zn3);title('Plot of z[n]: approximation of ya(t) when N = 3');
%plot(n/8,zn1);title('Plot of z[n]: approximation of ya(t) when N = 1');
xlabel('n/8')
ylabel('zn[n]')


%plot(n/8,ones(size(n)));title('0th Harmonic of ya(t)');ylabel('0th Harmonic')
%plot(n/8,f(1)); title('1st Harmonic of ya(t)');ylabel('1st Harmonic')
%plot(n/8,f(2)); title('2nd Harmonic of ya(t)');ylabel('2nd Harmonic')
plot(n/8,f(3)); title('3rd Harmonic of ya(t)');ylabel('3rd Harmonic')

xlabel('n/8');
```

Code of Part 2:

```
n = -30:1:255;
ya = zeros(size(n));
for i = n
   dum = mod(i/8,8);
   ya(i+31) = abs(3*cos(pi/8*dum));
end

stem(n/8,ya,'.k');
xlabel('n/8')
ylabel('y[n]')
title('Plot of sampled version of ya(t) with Ts = 1/8 : y[n]')
%{
m = -20:1:20;
a = 3*((sin(pi/2*(1-2*m))./(pi.*(1-2*m)))+(sin(pi/2*(1+2*m))./(pi*(1+2*m))));
a(21) = 6/pi;
stem(m.*pi/4,a,'filled','k.');
xlabel('rad/s');
ylabel('ak');
title('Spectrum plot of ya(t)');


%syms k
%f(k) = 6*((sin(pi/2*(1-2*k))./(pi.*(1-2*k)))+(sin(pi/2*(1+2*k))./(pi*(1+2*k))))*cos(pi/4*k*n/8);
%zn120 = 6/pi + symsum(f,k,[1 120]);
%zn60 = 6/pi + symsum(f,k,[1 60]);
%zn30 = 6/pi + symsum(f,k,[1 30]);
%zn5 = 6/pi + symsum(f,k,[1 5]);
%zn3 = 6/pi + symsum(f,k,[1 3]);
%zn1 = 6/pi + symsum(f,k,[1 1]);


%plot(n/8,zn120);title('Plot of z[n]: approximation of ya(t) when N = 120');
%plot(n/8,zn60);title('Plot of z[n]: approximation of ya(t) when N = 60');
%plot(n/8,zn30);title('Plot of z[n]: approximation of ya(t) when N = 30');
%plot(n/8,zn5);title('Plot of z[n]: approximation of ya(t) when N = 5');
%plot(n/8,zn3);title('Plot of z[n]: approximation of ya(t) when N = 3');
%plot(n/8,zn1);title('Plot of z[n]: approximation of ya(t) when N = 1');
xlabel('n/8')
ylabel('zn[n]')

%plot(n/8,ones(size(n))*6/pi);title('0th Harmonic of ya(t)');ylabel('0th Harmonic')
%plot(n/8,f(1)); title('1st Harmonic of ya(t)');ylabel('1st Harmonic')
plot(n/8,f(2)); title('2nd Harmonic of ya(t)');ylabel('2nd Harmonic')
%plot(n/8,f(3)); title('3rd Harmonic of ya(t)');ylabel('3rd Harmonic')

xlabel('n/8');
%}
```

<u>Code of Part 3:</u>

```
n = -30:1:255;
ya = zeros(size(n));
for i = n
   dum = mod(i/8+4,16);
   if (dum >= 0)&&(dum < 8)
        ya(i+31) = abs(3*cos(pi/8*(dum+4)));
   end
end

stem(n/8,ya,'.k');
xlabel('n/8')
ylabel('y[n]')
title('Plot of sampled version of ya(t) with Ts = 1/8 : y[n]')
%{
m = -20:1:20;
a = 3*((sin(pi/2*(1-m))./(pi.*(1-m)))+(sin(pi/2*(1+m))./(pi*(1+m))));
a(20) = 3/4;
a(21) = 3/pi;
a(22) = 3/4;
stem(m.*pi/8,a,'filled','k.');
xlabel('rad/s');
ylabel('ak');
title('Spectrum plot of ya(t)');


%syms k
%f(k) = 3*((sin(pi/2*(1-k))./(pi.*(1-k)))+(sin(pi/2*(1+k))./(pi*(1+k))))*cos(pi/8*k*n/8);
%zn120 = 3/pi + 3/2*cos(pi/8*n/8)+ symsum(f,k,[2 120]);
%zn60 = 3/pi + 3/2*cos(pi/8*n/8)+ symsum(f,k,[2 60]);
%zn30 = 3/pi + 3/2*cos(pi/8*n/8)+ symsum(f,k,[2 30]);
%zn5 = 3/pi + 3/2*cos(pi/8*n/8)+ symsum(f,k,[2 5]);
%zn3 = 3/pi + 3/2*cos(pi/8*n/8)+ symsum(f,k,[2 3]);
%zn1 = 3/pi + 3/2*cos(pi/8*n/8) ;


%plot(n/8,zn120);title('Plot of z[n]: approximation of ya(t) when N = 120');
%plot(n/8,zn60);title('Plot of z[n]: approximation of ya(t) when N = 60');
%plot(n/8,zn30);title('Plot of z[n]: approximation of ya(t) when N = 30');
%plot(n/8,zn5);title('Plot of z[n]: approximation of ya(t) when N = 5');
%plot(n/8,zn3);title('Plot of z[n]: approximation of ya(t) when N = 3');
%plot(n/8,zn1);title('Plot of z[n]: approximation of ya(t) when N = 1');
xlabel('n/8')
ylabel('zn[n]')

%plot(n/8,ones(size(n))*3/pi);title('0th Harmonic of ya(t)');ylabel('0th Harmonic')
%plot(n/8,3/2*cos(pi/8*n/8)); title('1st Harmonic of ya(t)');ylabel('1st Harmonic')
%plot(n/8,f(2)); title('2nd Harmonic of ya(t)');ylabel('2nd Harmonic')
plot(n/8,f(3)); title('3rd Harmonic of ya(t)');ylabel('3rd Harmonic')

xlabel('n/8');
```