# Theory Answers for Lab0

ARAVIND - 2019102014
HEMANT - 2019102016

Q1.3

a) $$a_k = \frac{1}{T}\int_{\langle T\rangle} x(t)\, e^{-jk\omega_0 t}\, dt$$

$$a_k = \frac{2\sin(k\omega_0 T_1)}{k\omega_0 T} = \frac{2\sin(k\omega_0 T_1)}{k\left[\frac{2\pi}{T}\right][T]} = \frac{\sin(k\omega_0 T_1)}{k\pi} \quad \forall\, k \neq 0$$

$$a_0 = \frac{1}{T}\int_{\langle T\rangle} x(t)\,dt = \frac{1}{T}\int_{-T_1}^{T_1} 1\,dt = \frac{2T_1}{T}$$

Ans: $a_0 = \frac{2T_1}{T}$, $a_k = \frac{\sin(k\omega_0 T_1)}{k\pi}\ \forall\, k \neq 0$

b) With increasing T value
1) the number of samples is more
2) Range of k value increases i.e. graph is more spread having a larger domain
3) Amplitude ~~scale~~ is inversely proportional to the T value i.e. the amplitude decreases for increase in T value

c) As N increases, the oscillations ~~will~~ increases near the points of discontinuity of the signal i.e. the edges of the square wave. Although the overshoot area between original and reconstructed wave reduces, there will always be an overshoot of around 9-10% atleast. ~~which~~ which can be seen as N increases from 10 to 1000. This ~~phenomenon~~ is known as Gibbs phenomenon.

1.1. a) We try to find the FS coefficients analytically then compare the values.

$$a_k = \frac{1}{T}\int_{\langle T\rangle} x(t)e^{-jk\omega_0 t}\,dt$$

$$a_k = \frac{1}{T}\int_{\langle T\rangle}\left(\frac{1}{4}-|t|\right)e^{-jk\omega_0 t}\,dt = \frac{1}{T}\int_{-1/4}^{1/4}\left[\frac{1}{4}-|t|\right]e^{-jk\omega_0 t}\,dt$$

After simplication we obtain,

$$a_k = \frac{1-\cos\left(\frac{\pi k}{2}\right)}{2k^2\pi^2}$$

$$a_0 = \frac{1}{T}\int_{-1/4}^{1/4}\left[\frac{1}{4}-|t|\right]dt = \frac{1}{4}\left[\frac{1}{2}\right] - \left[\left[\frac{-t^2}{2}\right]_{-1/4}^{0} + \left[\frac{t^2}{2}\right]_{0}^{1/4}\right]$$

$$a_0 = \frac{1}{8} - \frac{1}{16} = \frac{1}{16} = 0.0625$$

So,

Analytically Calculated Values:

$a_0 = 0.0625$

$a_1 = a_{-1} = 0.05066$

$a_2 = a_{-2} = 0.02533$

$a_3 = a_{-3} = 0.005629$

These values matchs exactly as obtained in the graph.