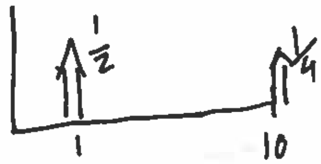
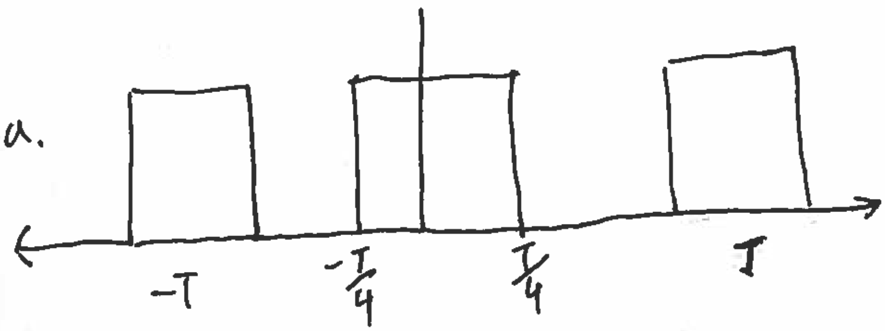
1. A gun shot is similar to an impulse because it has a very short period and some amount of energy. Because the sound in the shooting range is a linear time invariant system then we can see how the violin's sound would be affected by convolving the gun shot in the range with the violin recording

2. $h(t) = \frac{1}{2}\delta(t-1) + \frac{1}{4}\delta(t-10)$



this is an echo channel as the input signal is reduced in amplitude and occurs twice in time

3.a.



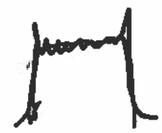
$$\frac{1}{T}\left(\frac{x(t)}{-j\frac{2\pi}{T}k}e^{-j\frac{2\pi}{T}kt}\Bigg|_{-T/2}^{T/2}\right) - \underbrace{\int_{-\frac{T}{2}}^{\frac{T}{2}} x'(t)\, e^{-j\frac{2\pi}{T}kt}\,dt}_{0}$$

$$\frac{1}{\cancel{T}}\; \frac{x(\frac{T}{4})}{-j\frac{2\pi}{\cancel{T}}k} e^{-j\frac{\pi}{2}k} + \frac{x(\frac{-T}{4})}{j\frac{2\pi}{\cancel{T}}k} e^{j\frac{\pi}{2}k}$$

$$\boxed{\frac{1}{\pi k}\sin\left(\frac{\pi}{2}k\right)}$$

b. $\tilde{x}_K(t) = \sum_{k=-K}^{K} c_k e^{j\frac{2\pi}{T}kt}$ $\quad K = 5,\ 17,\ 257$

c. eq (10) states that the difference between the fourier series representation and the actual function squared decreases as $K \to \infty$ from our graphs that appears to be true. However at the points of discontinuity the error is high



4a. $c_{ky} = \frac{1}{T}\int_{-T/2}^{T/2} x(t-T_1)\, e^{-j\frac{2\pi}{T}kt}\, dt$ $\qquad u = t - T_1$

$du = dt$

$$c_{ky} = \frac{1}{T}\int_{-T/2-T_1}^{T/2-T_1} x(u)\, e^{-j\frac{2\pi}{T}k(u+T_1)}\, dt = \frac{1}{T}\int_{-\frac{T}{2}-T_1}^{\frac{T}{2}-T_1} x(u)\, e^{-j\frac{2\pi}{T}ku}\, e^{-j\frac{2\pi}{T}kT_1}\, dt$$

$$c_{kx} = \frac{1}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} x(t)\, e^{-j\frac{2\pi}{T}k(t)}\, dt$$

$$c_{ky} = \frac{1}{T} e^{-j\frac{2\pi}{T}kT_1} \int_{-\frac{T}{2}-T_1}^{\frac{T}{2}-T_1} x(u)\, e^{-j\frac{2\pi}{T}ku}\, du$$

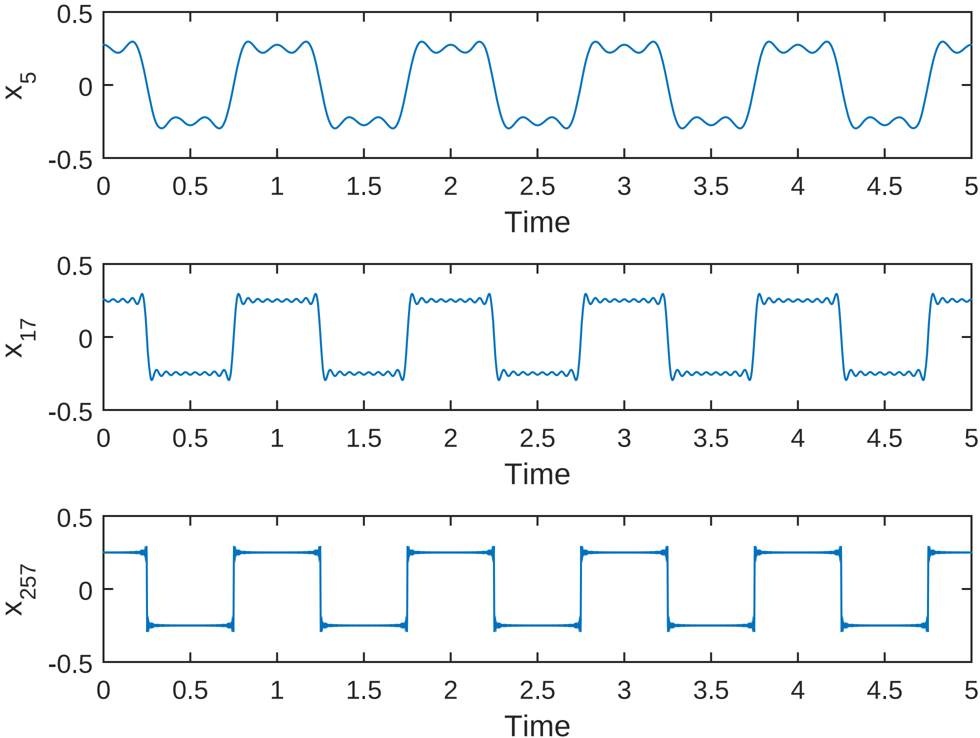
$$\boxed{c_{ky} = e^{-j\frac{2\pi}{T}kT_1}\, c_{kx}}$$

b. $T_1 = \frac{T}{2}$

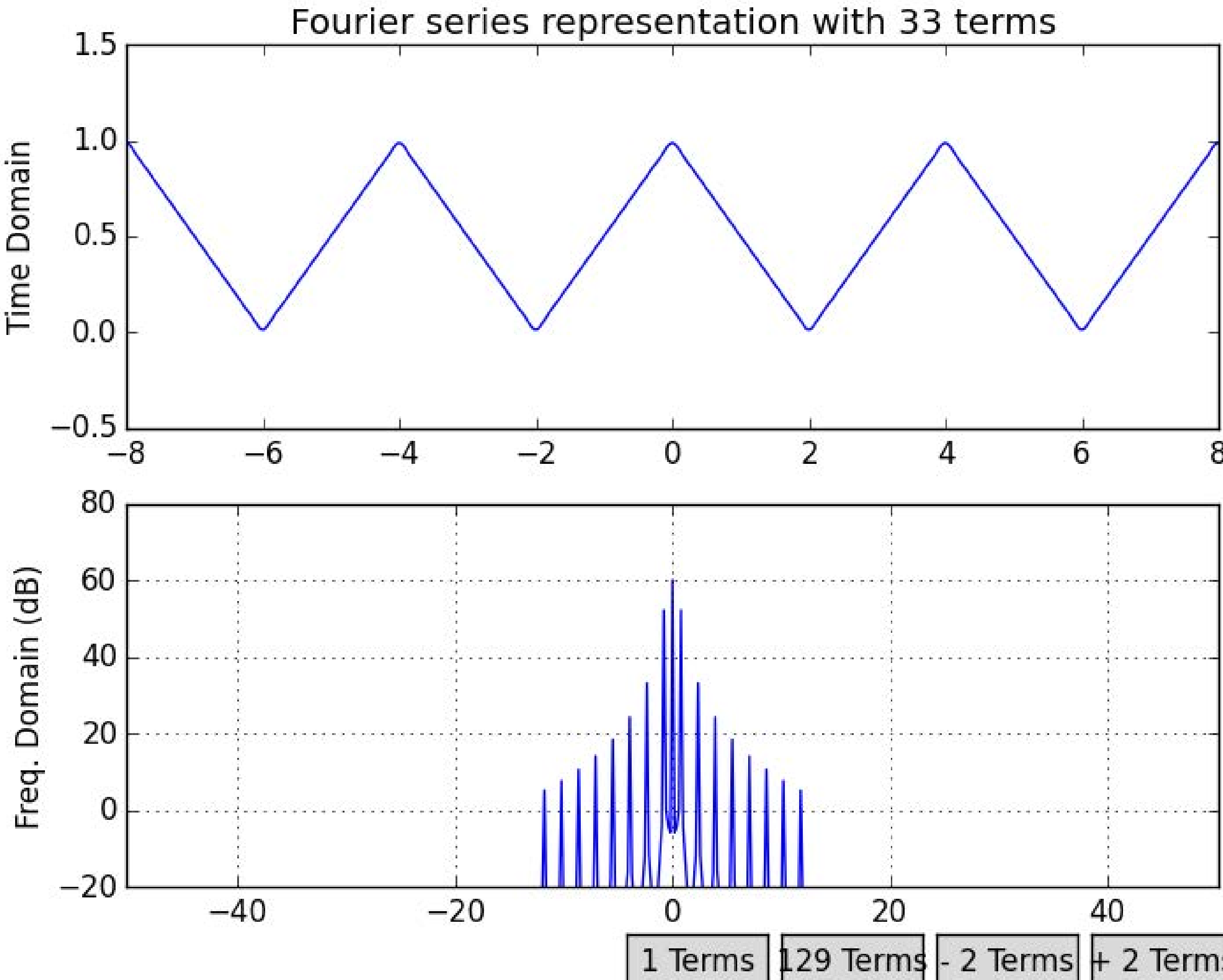
$$c_{ky} = e^{-j\frac{2\pi}{\cancel{T}}k\frac{\cancel{T}}{2}} c_{kx}$$

$$c_{kx} = \begin{cases} \frac{-2}{\pi^2 k^2} & \text{if } k \text{ is odd} \\ \frac{1}{2} & k = 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\boxed{c_{ky} = e^{-j\pi k} c_{kx}}$$



0.5
0
-0.5
x_5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time
0.5
0
-0.5
x_{17}
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time
0.5
0
-0.5
x_{257}
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Time



Fourier series representation with 33 terms
Time Domain
1.5
1.0
0.5
0.0
−0.5
−8
−6
−4
−2
0
2
4
6
8
Freq. Domain (dB)
80
60
40
20
0
−20
−40
−20
0
20
40
1 Terms
129 Terms
- 2 Terms
+ 2 Terms

Line edited in SigSys2015:

In function fs_triangle:

```
x = x + Coeff*np.exp(1j*2*np.pi/T*k*ts)*np.exp(-1j*np.pi*k)
```