HW#7 FIR Filter

#1 Square Wave

(a) Given a square wave:

$$s(t)=1 \quad \text{for} \quad 0 \le t \le 0.5\mathrm{T}_0$$
$$0 \quad \text{for} \quad 0.5\mathrm{T}_0 \le t \le T_0$$

The Fourier Series defined as below:

$$x(t)=\sum_{k=-\infty}^{+\infty} c_k \, e^{+j(2\pi/T_0)kt}$$

$$c_k = \frac{1}{T_o}\int_0^{T_0} x(t)\, e^{-j(2\pi/T_0)kt}\, dt$$

Show the FS coefficients are given by

$$c_k = \begin{cases} \frac{1}{j\pi k} & k = \pm 1, \pm 3, \pm 5, \cdots \\ 0 & k = \pm 2, \pm 4, \pm 6, \cdots \\ \frac{1}{2} & k = 0 \end{cases}$$

(b) Draw the spectrum plot ($|c_k|$, kf_0)

(c) Draw $x_5(t)=\sum_{k=-5}^{+5} c_k \, e^{+j(2\pi/T_0)kt}$, and $x_5(t)+n(t)$ (awgn)

(d) Let $x[n]$ denote the properly sampled signal of $x_5(t)+n(t)$,

and $h[n]=\frac{1}{11}\sum_{k=0}^{10}\delta[n-k]$,

find the convolution result $y[n] = x[n]*h[n]$

(i) convolution equation in matlab / octave

(ii) $y[n]=\frac{1}{11}\sum_{k=0}^{10} x[n-k]$ in matlab / octave

(iii) `ones(11, 1) / 11` and `conv(bb, xx)` in matlab / octave