Digital communication

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$$x(t) = \begin{cases} t & t \in [0, \frac{1}{2}) \\ t-1 & , t \in [\frac{1}{2}, 1] \end{cases}$$

$$x(t) = \sum_{n=-\infty}^{\infty}$$

$$= \sum_{n=0}^{\infty} \langle x(t), \phi_n(t) \rangle \, \phi_n(t)$$

a)

$$* \; \hat{x}(n) = \langle x(t), \phi_n(t) \rangle$$

$$= \frac{1}{1} \int_{-\infty}^{\infty} x(t) \cdot \overline{\phi_n(t)} \, . \, dt$$

$$= 1 \int_0^1 x(t) \cdot \phi_n(t) \, dt$$

~~We can observe~~
~~for odd coefficients of n.~~

$$\cancel{\hat{x}(n) = \int_0^{1/2} x(t) \cdot \phi_n(t) + \int_{1/2}^{1} x(t) \phi_n(t) \, . \, dt}$$

$$\cancel{=}$$

$$\hat{x}(0) = \int_0^{1/2} t \cdot dt + \int_{1/2}^{1} (t-1)\, dt$$

$$= \left[\frac{t^2}{2}\right]_0^{1/2} + \left[\frac{t^2}{2} - t\right]_{1/2}^{1}$$

$$= \frac{1}{8} + \frac{1}{2} - 1 - \frac{1}{8} + \frac{1}{2} = 0$$

$$\hat{x}(1) = \int_0^{1/2} t \cdot dt + \int_{1/2}^{1} -t+1 \cdot dt$$

$$= \left[\frac{t^2}{2}\right]_0^{1/2} + \left[-\frac{t^2}{2} + t\right]_{1/2}^{1}$$

$$= \frac{1}{8} - \frac{1}{2} + 1 + \frac{1}{8} - \frac{1}{2} = \frac{1}{4}$$

observably

$$\phi_{k+1}(t) = \begin{cases} \phi_k(2t) & , \quad t \in [0, \frac{1}{2}) \\ -\phi_k(2t-1) & , \quad t \in [\frac{1}{2}, 1] \end{cases}$$

$$x(t) = \begin{cases} t & , \quad t \in [0, \frac{1}{2}) \\ t-1 & , \quad t \in [\frac{1}{2}, 1] \end{cases}$$

$$\hat{x}(0) = \int_0^{1/2} x(t)\, \phi_0(t)\, dt + \int_{1/2}^{1} x(t) \cdot \phi_0(t) \cdot dt$$

$$= 0$$

$$\hat{x}(1) = \int_0^{1/2} x(t)\, \phi_1(t) \cdot dt + \int_{1/2}^{1} x(t) \cdot \phi_1(t) \cdot dt$$

$$= 1/4$$