Random Noise

Young W Lim

January 14, 2020

Based on
Probability, Random Variables and Random Signal Principles,
P.Z. Peebles,Jr. and B. Shi

Outline

Definition

$$R_{XX}(\tau) = \left(\frac{N_0}{2}\right)\delta(t)$$

$$R_{XX}(\tau) = \int_{-\infty}^{\infty}\left(\frac{N_0}{2}\right)\delta(t-\xi)h(\xi)d\xi$$

$$= \left(\frac{N_0}{2}\right)\delta(\tau)$$

$$h(\tau) \cong \left(\frac{2}{N_0}\right)R_{XX}(\tau)$$

Definition

$$h(\tau) \cong \left(\frac{2}{N_0}\right) R_{XX}(\tau)$$

$$\widetilde{h}(\tau) \cong \left(\frac{2}{N_0}\right) \widehat{R}_{XX}(\tau)$$

Definition

$$R_{YY} = \frac{1}{2\pi}\int_{-\infty}^{\infty}\left(\frac{N_0}{2}\right)|H(\omega)|^2 d\omega$$

$$R_{YY} = \frac{N_0}{2\pi}\int_{0}^{\infty}|H(\omega)|^2 d\omega$$

Definition

$$|H_I(\omega)|^2 = \begin{cases} |H(0)|^2 & |\omega| < W_N \\ 0 & |\omega| > W_N \end{cases}$$

$$\frac{N_0}{2\pi}\int_0^\infty |H(\omega)|^2 d\omega = \frac{N_0}{2\pi}\int_0^{W_N} |H(0)|^2 d\omega = \frac{N_0 |H(0)|^2 W_N}{2\pi}$$

$$W_N = \frac{\int_0^\infty |H(\omega)|^2 d\omega}{|H(0)|^2}$$

Definition

$$W_N = \frac{\int_0^\infty |H(\omega)|^2 d\omega}{|H(\omega_0)|^2}$$

$$P_{YY} = \frac{N_0 |H(\omega_0)|^2 W_N}{2\pi}$$

Definition

$$\overline{e_n^2(t)} = \frac{2kTRd\omega}{\pi}$$

$$\overline{i_n^2(t)} = \overline{e_n^2(t)/R^2} = \frac{2kTd\omega}{\pi R}$$

$$dN_L = \frac{\overline{e_n^2(t)}R_L}{(R+R_L)^2} = \frac{2kTRR_Ld\omega}{\pi(R+R_L)^2}$$

$$dN_{as} = \frac{\overline{e_n^2(t)}}{4R} = \frac{kTd\omega}{2\pi}$$

Definition

$$dN_{as} = \frac{\overline{e_n^2(t)}}{4R_o(\omega)}$$

$$\overline{e_n^2(t)} = 2kT_s R_o(\omega)\frac{d\omega}{\pi}$$

$$dN_{as} = kT_s \frac{d\omega}{2\pi}$$

Definition

$$dN_{as} = kT_d \frac{d\omega}{2\pi}$$

Definition

$$dN_{as} = \frac{\overline{e_n^2(t)}}{4R_s}$$

$$dN_{aos} = \frac{\overline{e_o^2(t)}}{4R_o}$$

$$G_a = \frac{dN_{aos}}{dN_{as}} = \frac{R_s \overline{e_o^2(t)}}{R_o \overline{e_s^2(t)}}$$

Definition

$$G_m = \frac{dN_{m,aos}}{dN_{m,as}} = \frac{R_{m,s}\overline{e^2_{m,o}(t)}}{R_{m,o}\overline{e^2_{m,s}(t)}}$$

$$G_a = \prod_{m=1}^{M} G_m$$

Definition

$$dN_{aos} = G_a dN_{as} = G_a k T_s \frac{d\omega}{2\pi}$$

$$\Delta N_{as} = G_a k T_e \frac{d\omega}{2\pi}$$

$$T_e = T_{c1} + \frac{T_{c2}}{G_1} + \frac{T_{c3}}{G_1 G_2} + \cdots + \frac{T_{cM}}{G_1 G_2 \cdots G_{M-1}}$$