EE361

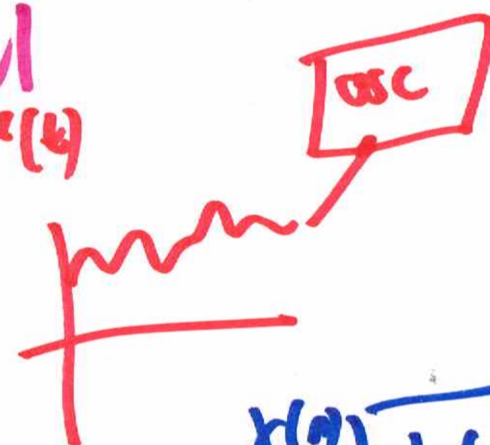
Stochastic Signals + Probability

April 25th, 2021

Random! Ex: noise

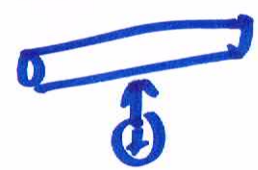
white $(N)^2$

$f^2(t)$



SNR = $\frac{\text{Signal}}{\text{Noise}}$

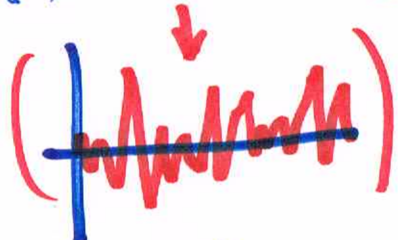
$\frac{X(n)^2}{\text{noise}^2}$



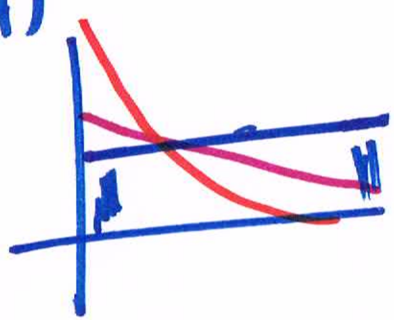
noise

f(t) noise!

$\left(\;\right)^2$

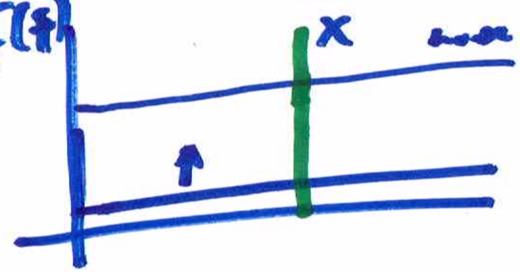


F(f)



f

x



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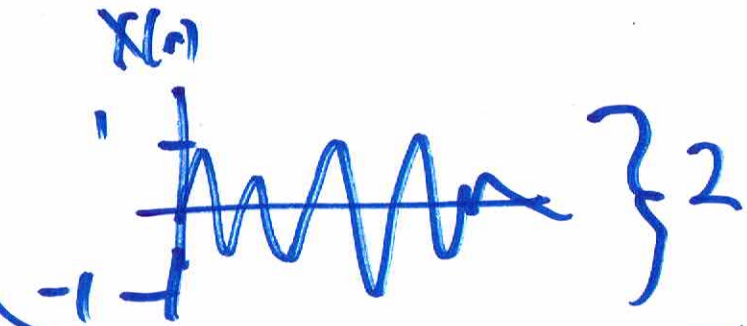
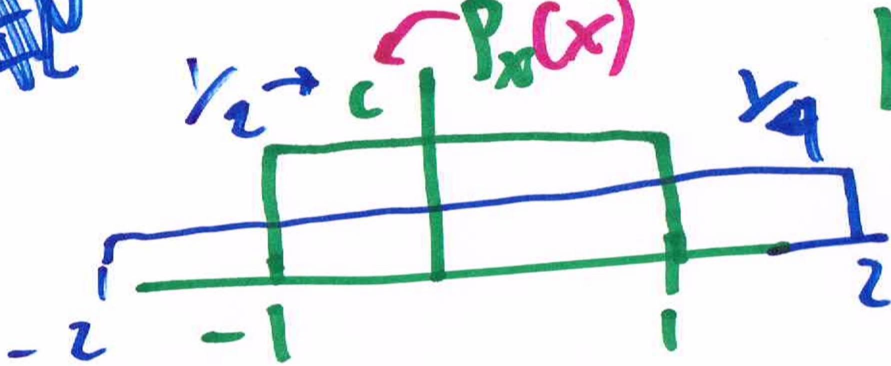
$$\sigma_x^2 = E(x^2) - [E(x)]^2$$

mean square − (mean)^2

$x(n) = 1 - 2\,\mathrm{rand}(N,1)$



Probability Density Function



Holy Rule of PDFs:

$$\int_{-\infty}^{\infty} p_x \, dx = 1$$

$$\int_{-1}^{1} c\,dx = 1$$

$$= c\,x\Big|_{-1}^{1} = c(1-(-1)) = 2c = 1$$

$$\boxed{c = \frac{1}{2}}$$

$$E(x) = \frac{1}{2}\int_{-1}^{1} x\,dx$$

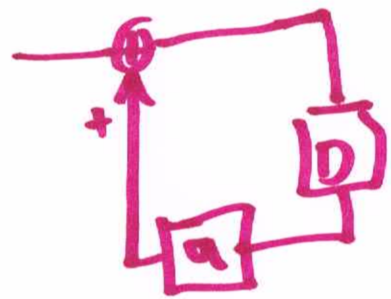
$$= \frac{1}{2}\left(\frac{x^2}{2}\right)\Big|_{-1}^{1} =$$

$$= \frac{1}{4}\left[1^2 - (-1)^2\right] = 0$$

2)

$$E(x^2) = \frac{1}{2}\int_{-1}^{1} x^2\,dx = \frac{1}{6}\,\frac{x^3}{3}\Big|_{-1}^{1} = \frac{1}{6}\left(\frac{1}{3} + \frac{(+1)^3}{3}\right) = \frac{2}{6} = \boxed{\frac{1}{3}}$$

$$\boxed{\sigma_x^2 = \frac{1}{3} - 0 = \frac{1}{3}}$$



$$H(z) = \frac{1}{1 - \frac{1}{2}z^{-1}}$$

$$\sigma_y^2 = \underbrace{\sigma_x^2}_{\frac{1}{3}} \sum_{-\infty}^{\infty} h^2(n)$$

$$h'(n) = \alpha^n u(n)$$

$$H'(z) = \frac{1}{1 - \alpha z^{-1}}$$

$$\boxed{h(n) = \left(\frac{1}{2}\right)^n u(n)}$$

σ_{xy}

$$\sigma_y^2 = \sigma_x^2 \sum_0^{\infty} \left(\left(\tfrac{1}{2}\right)^n\right)^2 = \sigma_x^2 \sum_0^{\infty} \left(\tfrac{1}{4}\right)^n = \sigma_x^2 \frac{1}{1-\frac{1}{4}}$$

$$\sum_0^{N-1} \alpha^n = \frac{1-\alpha^N}{1-\alpha}$$

$|\alpha|<1$

$$\sigma_y^2 = \sigma_x^2 \frac{1}{\cancel{3/4}\ 3/4}$$

$$= \frac{1}{3} \cdot \frac{4}{3} = \boxed{\frac{4}{9}}$$