

$$E\{x(t)x(t+\tau)\} = R_{xx}(\tau)$$

$$= \frac{P_d}{T} \cdot R_{P_T P_T}(\tau)$$

$\frac{P_d}{T}$: Power of Data Symbols.
 T : Symbol Duration.
 $R_{P_T P_T}(\tau)$: autocorrelation of pulse $P_T(t)$.

$$R_{PP}(\tau) = \int_{-\infty}^{\infty} p(t)p(t-\tau) dt$$

$$S_{PP}(f) = \int_{-\infty}^{\infty} R_{PP}(\tau) e^{-j2\pi f\tau} d\tau$$

Fourier Transform of $R_{PP}(\tau)$

$$S_{PP}(f) = |P(f)|^2$$

Energy Spectral Density (ESD).

Fourier Transform of pulse $p(t)$.

$$P(f) = \int_{-\infty}^{\infty} p(t) e^{-j2\pi ft} dt$$

$$R_{xx}(\tau) = \frac{P_d}{T} \cdot R_{pp}(\tau)$$

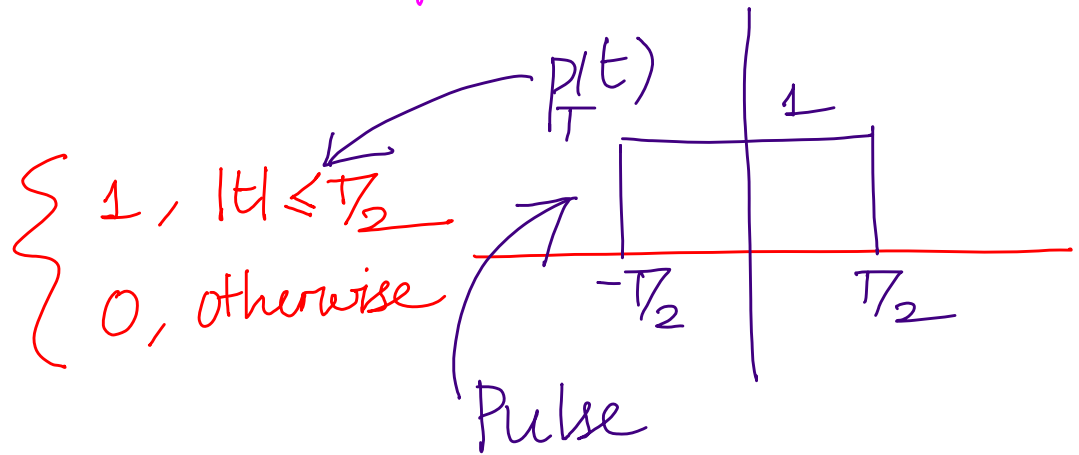
$$S_{xx}(f) = \int_{-\infty}^{\infty} R_{xx}(\tau) e^{-j2\pi f\tau} d\tau$$

For a wide Sense Stationary process, PSD is given by Fourier Transform of auto-correlation.

$$\begin{aligned} S_{xx}(f) &= \frac{P_d}{T} \cdot S_{pp}(f) \\ &= \frac{P_d}{T} \cdot |P(f)|^2 \end{aligned}$$

Power Spectral density of Transmitted signal is proportional to Energy Spectral Density of Pulse.

Consider $p(t) = P_T(t)$



$$P_T(f) = \int_{-\infty}^{\infty} P_T(t) e^{-j2\pi ft} dt$$

$$= T \text{sinc}(fT)$$

$$= T \frac{\sin(\pi fT)}{\pi fT}$$

$$|P_T(f)|^2 = T^2 \text{sinc}^2 fT$$

$$\text{PSD} = \frac{P_d}{T} |P_T(f)|^2$$

$$= \frac{P_d}{T} T^2 \text{sinc}^2 fT$$

$$\boxed{S_{xx}(f) = P_d T \text{sinc}^2 fT}$$

PSD of Transmitted signal.

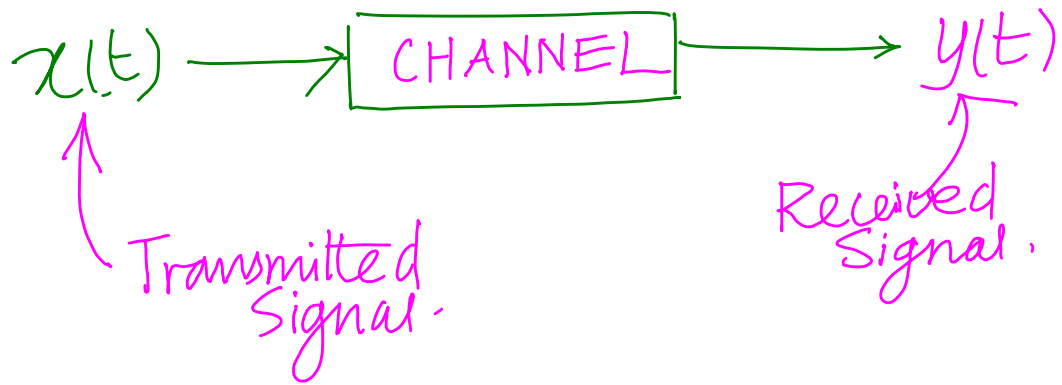
DIGITAL COMMUNICATION CHANNEL

Medium through which signal propagates from transmitter to receiver in a comm. system.

Telephone Lines, Coaxial Cables
Wireless Channel.

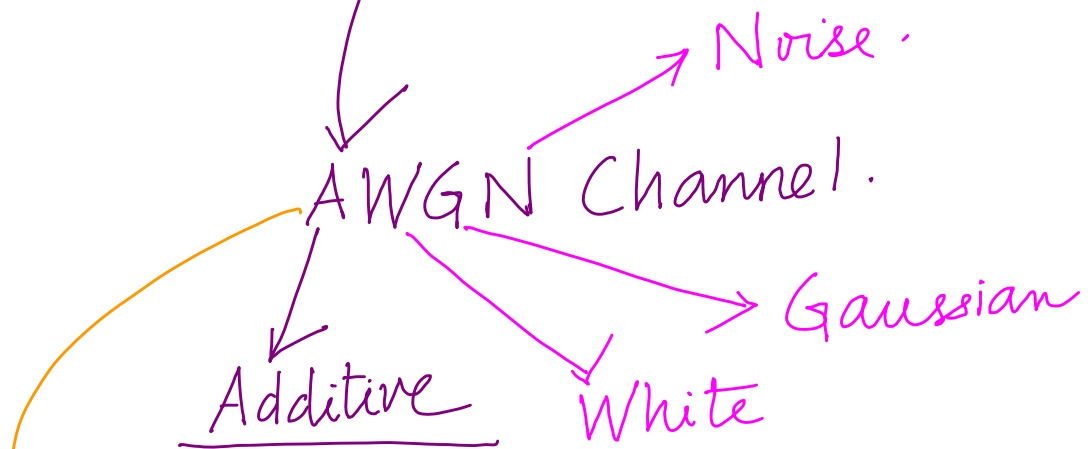
Ex: AM, FM, Cellular, WiFi, Bluetooth.

$$x(t) = \sum_{k=-\infty}^{\infty} a_k p(t - kT)$$



SIMPLE CHANNEL

MODEL



Additive White Gaussian Noise Channel..

$$y(t) = x(t) + n(t)$$

Received Signal. Transmitted Signal. Noise.

Diagram description: The equation $y(t) = x(t) + n(t)$ is written in blue. A blue arrow points from the text 'Received Signal.' to $y(t)$. Another blue arrow points from 'Transmitted Signal.' to $x(t)$. A third blue arrow points from 'Noise.' to $n(t)$. A pink circle is drawn around the plus sign (+). A pink arrow points from the word 'Additive' to this circle. A long pink arrow originates from the circle and points down towards the explanatory text below.

Noise Adds to signal.
This is termed as
Additive Noise.