* $x(t) \longrightarrow X(f)$

$x(t-t_0) \longrightarrow e^{-j2\pi f t_0} X(f)$

$x(t+t_0) \longrightarrow e^{j2\pi f t_0} X(f)$

* $x(t)\, e^{j2\pi f_0 t} \longrightarrow X(f-f_0)$

$x(t)\, e^{-j2\pi f_0 t} \longrightarrow X(f+f_0)$

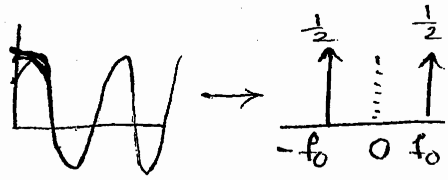
* $1 \longrightarrow \delta(f)$

* $1 \cdot e^{j2\pi f_0 t} \longrightarrow \delta(f-f_0)$

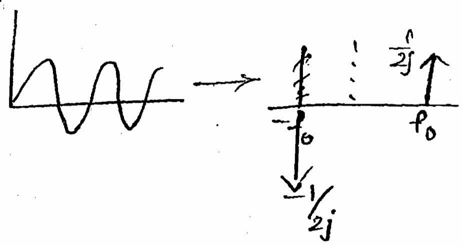
* $1 \cdot e^{-j2\pi f_0 t} \longrightarrow \delta(f+f_0)$

$\cos 2\pi f_0 t = \frac{1}{2}\left[e^{j2\pi f_0 t} + e^{-j2\pi f_0 t} \right]$

* $\cos 2\pi f_0 t \longrightarrow \frac{1}{2}\left[\delta(f-f_0) + \delta(f+f_0) \right]$



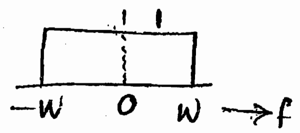
* $\sin 2\pi f_0 t \longrightarrow \frac{1}{2j}\left[\delta(f-f_0) - \delta(f+f_0) \right]$



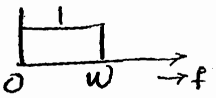
LTI

Filters

Ideal LPF



practical filter



$h(t) \xrightarrow{FT} H(f)$

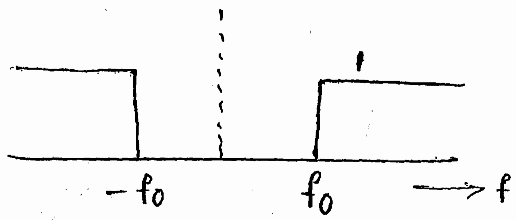
$h(t)$ ↓ impulse response

$H(f)$ ↓ Transfer function

$H(f) = 1 \quad -W \le f \le W$

$f_H = W$, $f_L = 0$ } $BW = f_H - f_L = W$

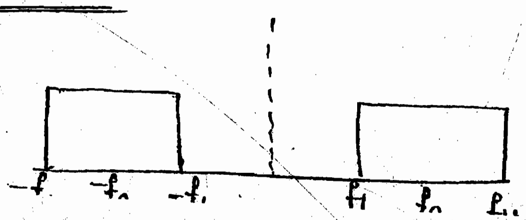
Ideal HPF



$H(f) = 1 \Rightarrow |f| \ge f_0$

$BW = \infty$

Ideal BPF



$BW = f_H - f_L$

$H(f) = 1 \quad f_L \le |f_0| \le f_H$

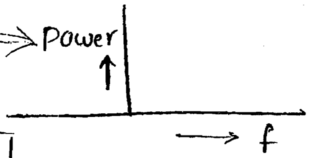
$x(t) \rightarrow \boxed{h(t)} \rightarrow y(t)$

$$\boxed{y(t) = x(t) * h(t)}$$

$$Y(f) = X(f) \cdot H(f)$$

$$H(f) = \frac{Y(f)}{X(f)}$$

Power spectrum $\Rightarrow$



$$\boxed{PSD = \frac{Power}{BW}}$$

$X(f) \rightarrow \boxed{H(f)} \rightarrow Y(f) = H(f) \cdot X(f)$

PSD

$$\boxed{PSD_i \rightarrow \boxed{H(f)} \rightarrow PSD_o = |H(f)|^2 \cdot PSD_i}$$

Power = Area under PSD

$$P = \int_{-\infty}^{\infty} PSD \cdot df$$

$x(t)$ Signal

$$Power = \frac{1}{T}\int_0^T x^2(t)\,dt$$

Proporties of $\delta(t)$

$$x(t)\,\delta(t) = x(0)\,\delta(t)$$

$$x(t)\,\delta(t-t_0) = x(t_0)\,\delta(t-t_0)$$

$$\int_{-\infty}^{\infty} \delta(t)\,dt = 1$$

$$\int_{-\infty}^{\infty} x(t)\,\delta(t) = x(0)$$

$$\int_{-\infty}^{\infty} x(t)\,\delta(t-t_0) = x(t_0)$$

$$\delta(at) = \frac{1}{|a|}\cdot\delta(t)$$

$$\delta(at \pm \beta) = \frac{1}{|a|}\cdot\delta(t \pm \beta/a)$$

$$\delta(-t) = \delta(t)$$

$$x(t) * \delta(t) = x(t)$$

$$x(t) \longrightarrow X(f)$$

$$\frac{d}{dt}x(t) \xrightarrow{FT} j2\pi f \cdot X(f)$$

$$\int x(t) \longrightarrow \frac{1}{j2\pi f}\cdot X(f) + \frac{x(0)}{2}\cdot\delta(f)$$

$$u(t) \longrightarrow \frac{1}{j2\pi f} + \frac{\delta(f)}{2}$$

Trigonmetry :-

$$\cos A \cos B = \frac{1}{2}\left[\cos(A+B) + \cos(A-B)\right]$$

$$\sin A \sin B = \frac{1}{2}\left[\cos(A-B) - \cos(A+B)\right].$$

$$\sin A \cos B = \frac{1}{2}\left[\sin(A+B) + \sin(A+B)\right]$$

$$\cos A \sin B = \frac{1}{2}\left[\sin(A+B) - \sin(A-B)\right]$$

$$\sin A \cdot \cos A = \frac{1}{2}\sin 2A$$

$$\cos^2\theta = \frac{1+\cos 2\theta}{2}, \quad \sin^2\theta = \frac{1-\cos 2\theta}{2}$$

* Bandwidth $= f_H - f_L$

Power $= \frac{1}{T}\int x^2(t)dt$

If $x = 5\cos 2\pi 3000t$ Power $= \frac{\left(\frac{5}{\sqrt{2}}\right)^2}{R}$

~~Pow~~

If R is given then we should put otherwise if hen not given then we can Replace R by 1

So Power $= \frac{\left(\frac{5}{\sqrt{2}}\right)^2}{1} = \frac{25}{2} = 12.5W$

$$x(t) = 5 + 10\cos 2\pi \times 2000t$$

$$P = (5)^2 + \left(\frac{10}{\sqrt{2}}\right)^2 = 25 + \frac{100}{2}$$

$$= 75W$$

* $x(t) = 5 \cdot (10 \cos 2\pi \times 200t)$

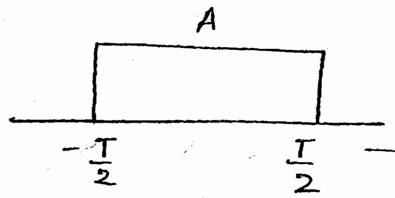
one way : $\left(\frac{50}{\sqrt{2}}\right)^2 = 1250W$

another way $= 5^2 \left(\frac{10}{\sqrt{2}}\right)^2 = 1250W$

$x(t) \xrightarrow{Power} P$

$K \cdot x(t) \xrightarrow{Power} K^2 P$

* $x(t) =$

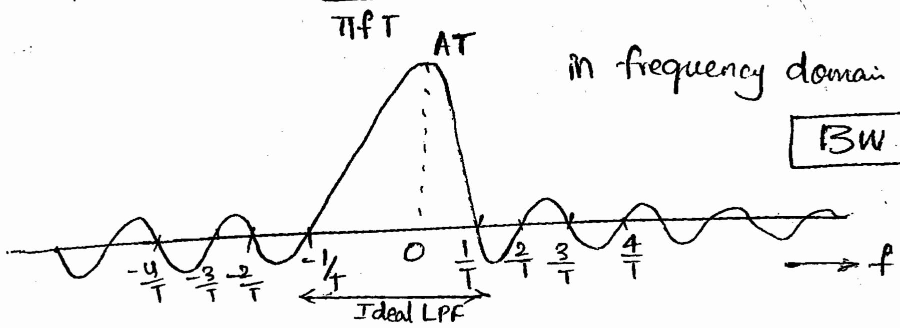


Signal in Time domain
→ oibitary signal

$X(f) = AT\text{Sinc}(fT)$

$$\text{Sinc}(x) = \frac{\sin \pi x}{\pi x}$$

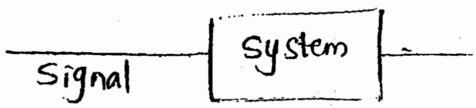
$= AT \frac{\sin \pi f T}{\pi f T}$

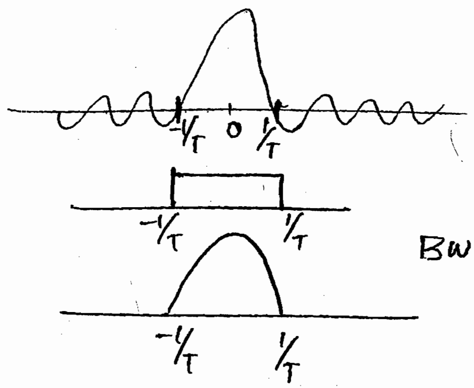


in frequency domain

BW = ∞

For proper transfer of signal in Communication system Signal BW is ~~small~~ con less compared with channel BW





Signal BW ______ channel ______

BW = $\frac{1}{T}$

$$BW \propto \frac{1}{PW}$$

Minimum BW $= \frac{1}{PW}$

* Orbitary Signals ~~co~~ has Contmetion
* multi Tone Signals has impulses