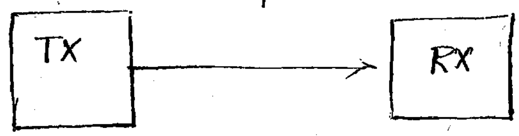
Communication Systems

Communication:- Exchange of information b/w 2 points

Simplex

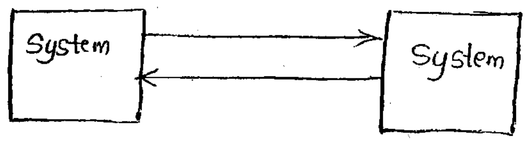


Source Sink

Eg :- Radio, TV

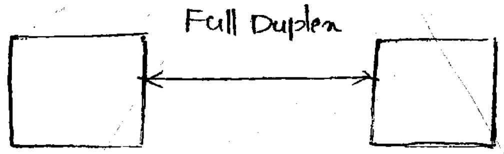
Duplex
- HD
- FD

Half Duplex



Eg :- Walkie Talkie

Full Duplex



Eg :- Telephone

1) Analog Communication → * Basics
2) Digital "

* Modulation
* AM → DSBFC, DSB, SSB, ~~V~~SB, ISB, QAM
  - → different message signals
  - ⇒ Equation
  - → Spectrum
  - → BW
  - → Power calculations
  - → Generation
  - → demodulation
  - ISB, QAM: objective, eqns, Spectrum, BW.

* Angle modulation
  - FM
    - NBFM
    - WBFM
  - PM
    - NBPM
    - WBPM
  - → Eqns
  - → Time domain
  - → spectrum
  - → BW
  - → Power calculations
  - → Relation b/w FM & PM
    - → Generation
    - → demodulation

* Noise
  - → Superheterodyne recievers
  - → SNR Calculations for FOM
    - → AM
    - → DSB
    - SSB
    - → ~~VSB~~ AM

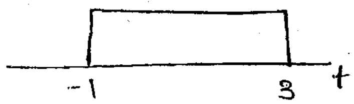
FM → preemphasis, Deemphasis

FDM

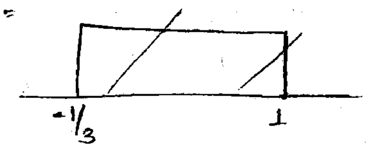
$x(at) \longrightarrow$ $a > 1$ Compression

$a < 1$ Expansion

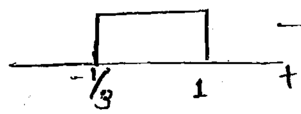
$x(t)$



$x(3t) =$ $-1 \le t \le 3$



$x(3t)$

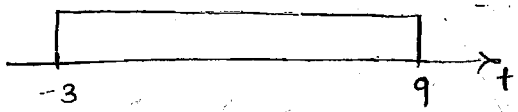


$\longrightarrow$ Compression

$-1 \le 3t \le 3$

$-\frac{1}{3} \le t \le 1$

$x\left(\frac{t}{3}\right)$



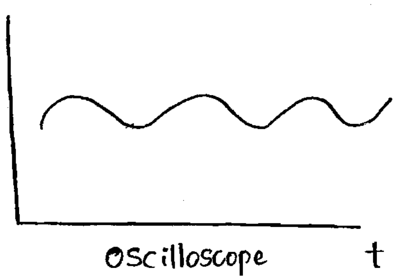
$\longrightarrow$ Expansion

$-1 \le \frac{t}{3} \le 3$

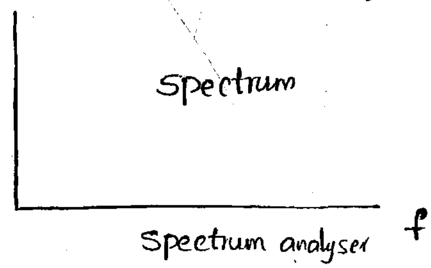
$-3 \le t \le 9$

Signal can be represented in two domains — Time domain / Frequency

Amp



$\xleftrightarrow{FT}$ amp



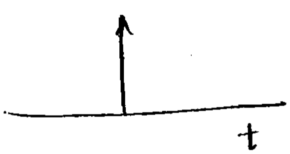
FT convers one form to anothe form

$x(t) \longrightarrow$ Signal

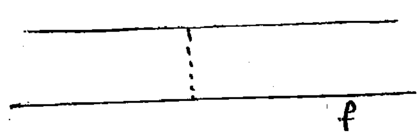
$$X(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi ft} \cdot dt$$

$$\boxed{X(f) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi f t}\, dt}$$

$$\delta(t) \xleftrightarrow{FT} 1$$



$\xleftrightarrow{FT}$



$$x(t) = \int_{-\infty}^{\infty} X(f)\, e^{j2\pi ft}\, df$$

$\omega = 2\pi f$

$d\omega = 2\pi\, df$

$df = \frac{d\omega}{2\pi}$

$$\boxed{x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(\omega)\, e^{j\omega t}\, d\omega}$$

$g(t) = 1$

$$G(f) = \int_{-\infty}^{\infty} e^{-j2\pi ft} \cdot dt = \delta(f)$$

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

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

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

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

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

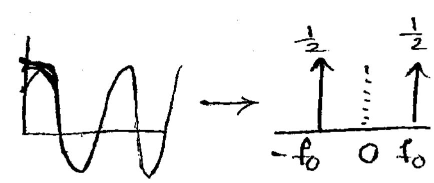
* $1 \longrightarrow \delta(f)$

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

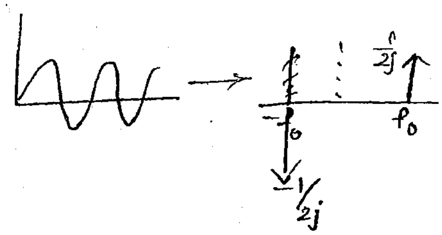
* $1 \cdot e^{-j2\pi f_0 t} \longrightarrow \delta(f+f_0)$

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

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



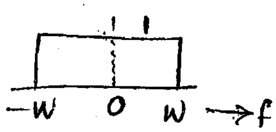
* $\sin 2\pi f_0 t \longrightarrow \frac{1}{2j}\left[\delta(f-f_0) - \delta(f+f_0) \right]$



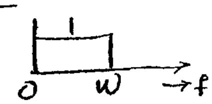
LTI

Filters

Ideal LPF



practical filter



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

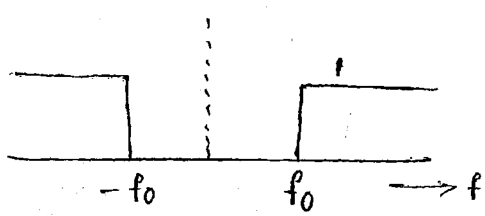
$h(t)$ ↓ impulse response

$H(f)$ ↓ Transfer function

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

$\left.\begin{array}{l} f_H = W \\ f_L = 0 \end{array}\right\} BW = f_H - f_L = W$

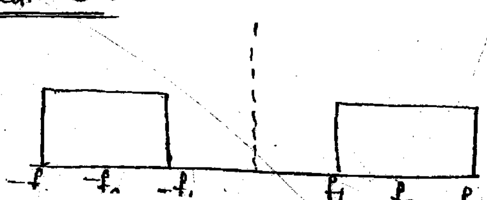
Ideal HPF



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

$BW = W$

Ideal BPF



$BW = f_H - f_L$

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

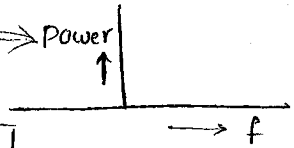
$$x(t) \longrightarrow \boxed{h(t)} \xrightarrow{y(t)}$$

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

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

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

Power spectrum $\Longrightarrow$



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

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

PSD

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

Power = Area under PSD

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

$x(t)$ Signal

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

Properties of $\delta(t)$

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

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

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

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

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

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

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

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

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

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

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

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

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

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 $= \dfrac{\left(\frac{5}{\sqrt{2}}\right)^2}{R}$

~~Pow~~

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

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

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

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

$$= 75W$$