Communication theory

"Analog Communication"

Analog Signals:

their values vary over Continuous range

Communication:-

Process of sending & receiving messages through medium which Called "channel".

For Example:-

Sending Voice

electrical signal [information - baseband - Modulating]

at T_x

))))voice → mic → ∿∿ → To be sent through Channel "wireless"

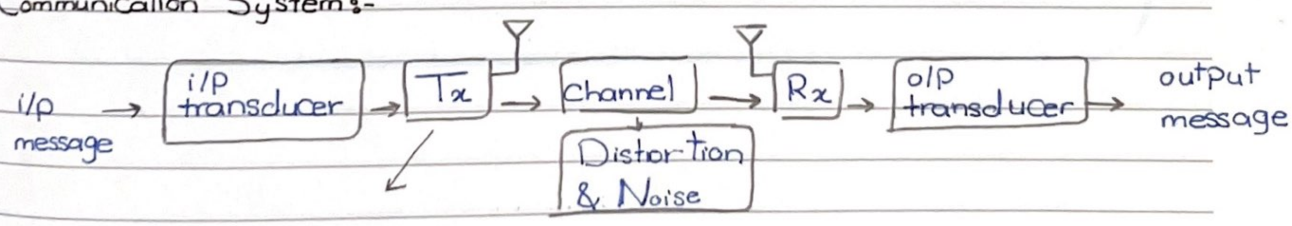
at R_x

input transducer
"Convert Non-electrical signal to electrical signal"

∿∿ → Speaker →))))Voice

output transducer

Communication System:-



modifies baseband signal
Consist of one or more of
subsystems Like: (Modulator ... Amplifier..)

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- baseband signal has Low Frequency, So it Can't propagate.

- Design of Antenna

Length of antenna $\leftarrow L \propto \lambda \rightarrow$ wave length of baseband signal

$\uparrow \lambda = \frac{c}{\downarrow F}$ $L\uparrow$ $\Rightarrow$ that's Impractical

I need to load baseband signal on [wave Form sinusoid with high Frequancy] $\rightarrow$ Carrier

This process is Modulation

Fourier

$\overbrace{\hspace{6em}}$

Series	Transform
How to express any periodic Function into Sum of sines & Cosines to be able to make signal analysis.	Transformation From time domain to Freq domain

Fourier Transform

$$G(F) = \int_{-\infty}^{\infty} g(t)\, e^{-J2\pi F t}\, dt \qquad \text{(From time to Freq)}$$

$$g(t) = \int_{-\infty}^{\infty} G(F)\, e^{J2\pi F t}\, dF \qquad \text{(From Freq to time)}$$

Ex: $g(t) = e^{at}\, u(-t)$ Find $G(F)$

$$G(F) = \int_{-\infty}^{0} e^{(a-J2\pi F)t}\, dt = \frac{1}{a-J2\pi F} \quad \#$$

Properties :-

1) Linearity :-

$h(t) \longrightarrow H(F)$ $\qquad g(t) \longrightarrow G(F)$

$y(t) = h(t) + g(t)$, $\Rightarrow Y(F) = H(F) + G(F)$

2) Scaling

$$g(at) = \frac{1}{|a|} G\left(\frac{F}{a}\right)$$

3) Time Shifting

$$g(t-t_0) \longrightarrow G(F)\, e^{-J2\pi F t_0}$$

4) Frequency Shifting "Modulation"

$$g(t)\, e^{\pm J2\pi F_0 t} \longrightarrow G(F \mp F_0)$$

$$g(t) \cos(2\pi F_0 t) \longrightarrow \frac{1}{2}\left[G(F-F_0) + G(F+F_0) \right]$$

$\Rightarrow$ By Euler Equation

- $\cos\theta = \frac{1}{2}(e^{J\theta} + e^{-J\theta})$
- $\sin\theta = \frac{1}{2J}(e^{J\theta} - e^{-J\theta})$

$$\frac{1}{2}\left[g(t)\, e^{J2\pi F_0 t} + g(t)\, e^{-J2\pi F_0 t} \right]$$

Convolution

Any System has 3 Functions

$$\text{i/p Func} \longrightarrow \boxed{\text{Sys transfare}} \longrightarrow \text{o/p Func}$$

i/p Func	Sys transfare	o/p Func
$x(t)$	$h(t)$ impulse response	$y(t)$
$\downarrow$	$\downarrow$	$\downarrow$
$X(F)$	$h(F)$	$y(F)$

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$$y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)\, h(t-\tau)\, d\tau$$

$$= \int_{-\infty}^{\infty} x(t-\tau)\, h(\tau)\, d\tau$$

$Y(F) = X(F)\, H(F)$ #

Spectrum "draw in Frequency domain"

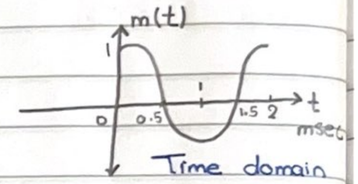
$m(t) = \cos(\overset{2\pi F t}{1000\pi t})$

draw it's time domain & spectrum.

$2\pi F t = 1000\pi t$

$F = 500$ Hz

$T = 2$ msec

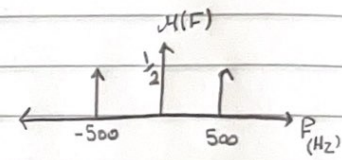


Time domain

$$m(t) = \frac{1}{2}\left[1 \cdot e^{J1000\pi t} + e^{-J1000\pi t}\right]$$

2 F_0

$$M(F) = \frac{1}{2}\left[\delta(F-500) + \delta(F+500)\right]$$



Find $S(F)$, if $m(t)$ is the modulating signal

$s(t)$ is modulating signal $= m(t)\cos(10{,}000\pi t)$

$F_m = 500$ Hz as envelop $F_c = 5000$ Hz

$s(t) = \underset{\sim}{m(t)} \cos(10000\pi t)$

$\hookrightarrow S(F) = \frac{1}{2}\left[M(F-F_c) + M(F+F_c)\right]$

$$S(F) = \frac{1}{2}\left[\frac{1}{2}\left(\delta(F-5500) + \delta(F-4500)\right) + \frac{1}{2}\left(\delta(F+4500) + \delta(F+5500)\right)\right]$$

$$= \frac{1}{4}\left[\left(\delta(F-5500) + \delta(F-4500)\right) + \left(\delta(F+4500) + \delta(F+5500)\right)\right]$$

In time domain