Monday

23.09.2019

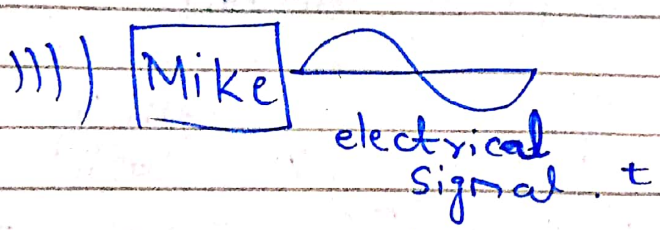
COMMUNICATION SYSTEM.

Lecture 1

Transducer.

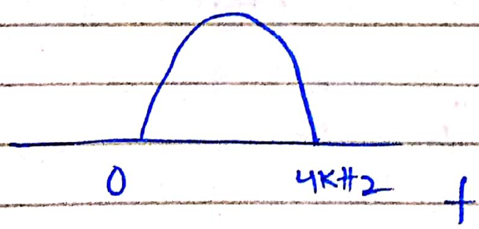
one form into another.
energy

①



Speed signal frequency:

0.3 to 3.4 KHz.



Problems (for transmitting electro magnetic signal).

i) Frequency translation

[if mostly is range me frequency hogi then wo overlap kr jayegi
no voice will be heard.)

Monday

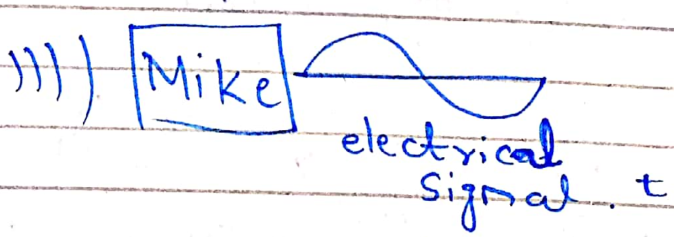
23.09.2019

COMMUNICATION SYSTEM.

Transducer: Lecture 1

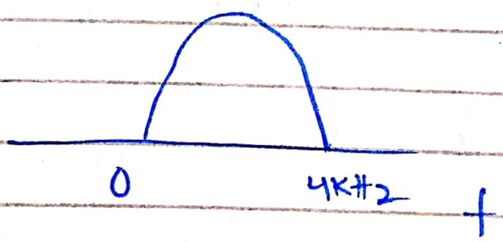
one form into another.
energy

(1)



Speed signal frequency:

0.3 to 3.4 KHz.

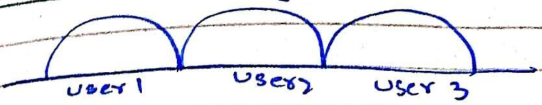


Problems (for transmitting electro magnetic signal).

i) Frequency translation

[if mostly is range me frequency hogi then wo overlap kr jayegi no voice will be heard.)

Keep the users in diff frequency space.



so that it will not overlap each other.

→ Time domain Representation of signal.
frequency " " "

ii) Practicality of Antena.

Antena Theory: → width & length.

The dimensions of antena should be comparable with the signals.

(1/10th of wavelength) 2

$$f\lambda = c$$

$$\lambda = \frac{c}{f}$$

$$\lambda = \frac{3\times10^{8}}{4\times10^{3}}$$

$$= \frac{3}{4}\times10^{5}$$

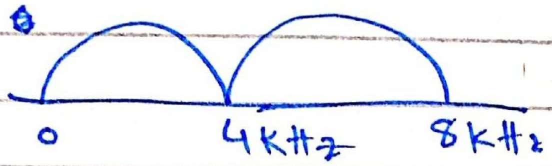
$= 75$ K meters.

(The antena height for above band should be 75 k met.

→ . for this enhance frequency of signal .

(iii) Narrow banding.

(bandwidth)
↓
4 kHz .



3

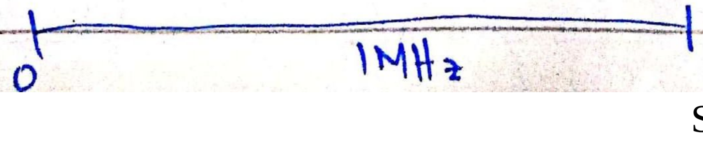
$$\lambda_2 = \frac{3\times10^8}{8\times10^3}$$

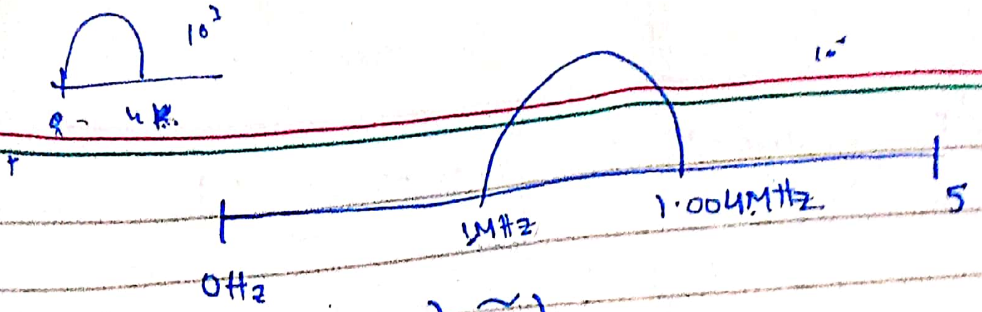
= 37.5 Kmeters .

(first 75 kmeters & then 37.5 kmeter
one antena is not enough)

(We have to shrink the band)

if we want to shrink, we won't be able to hear proper sound .)





$\lambda_1 \cong \lambda_2$.

$$\begin{array}{r} 1000000 \\ 4000 \\ \hline 1004000 \end{array}$$

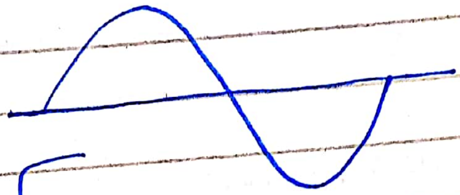
1.004 MHz

$\frac{3\times10^{8}}{1\times10^{6}} = 3\times10^{2}$

4

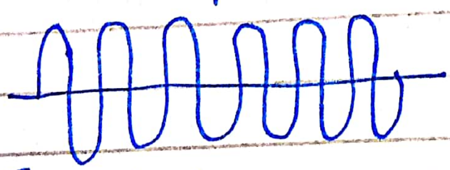
Solutions:

paper & stone
↓
wrap stone in paper



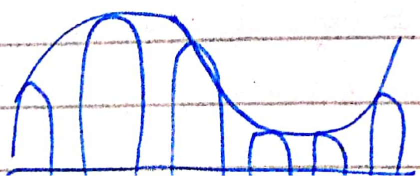
of paper ← Modulating Signal (paper)

of stone ← Carrier Signal (stone)



(Carrier Signals)

Modulated Signal (paper & stone)



→ Transducer : step 1
→ Transmitter : step 2.

Attributes of Signals

→ amplitude.
→ frequency
→ phase.

* Modulating Signal is same but the amplitude of carrier signal is changed. → amplitude Modulation.

this process is.

<u>Modulation</u>.

• if we vary any attribute of a carrier signal in accordance with the instantaneous value of the base band / modulating signal, the processs is said to be modulation.

5

Lecture # 2.

Channel: ⑥

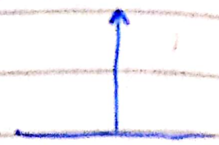
$$s(t) \longrightarrow \boxed{\text{channel}} \longrightarrow s(t)$$

Transmitter — receiver.

$\delta(t)$

Transfer function:

$\delta(t)$

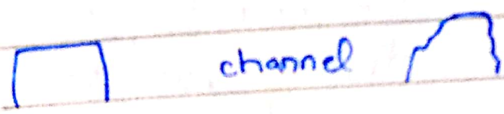


$s(t) * \delta(t) = s(t)$.

(Ideal case).

→ Property of channel

→ linear destortion.



* the signal may be attennated (Amplitude change)

non linear distortion.

$P_t \longrightarrow P_r$ (received power)

$$\boxed{P_r \propto \frac{P_t}{d^n}}$$

$n = 2$ to 6.

n depends on landscape.

⇒ streets, high n.

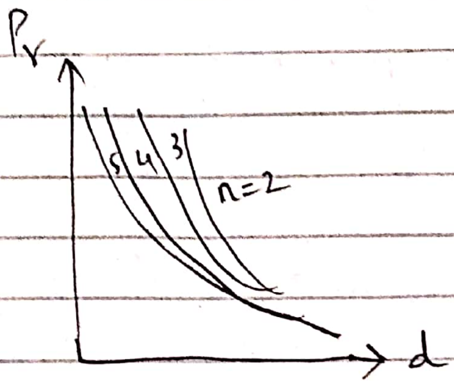
n is Path lose exponant.

① channel distortion

② spreading of signal.

little change in d causes abrupt change in denominator

$$P_r = k \frac{P_t}{d^n}$$



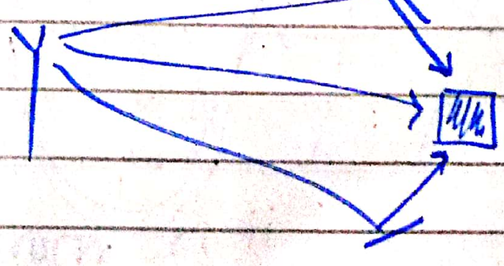
$\boxed{\text{Occumura \& Hata}}$

Distortion kinds.

* Multipath;

jab signal ko radiate kia jata ha it is in omni directional.

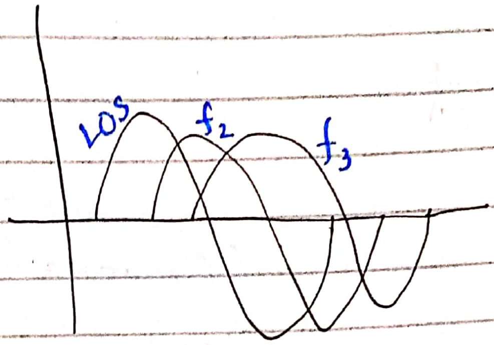
All power will be distributed.



we don't need copies of signal due to spreading of signal.

8

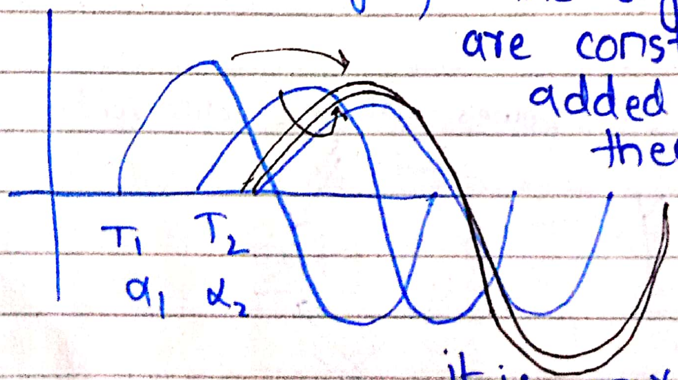
one signal is from LOS (line of side)



when it is added together, all the signal. have diff time delay.

RAKE Receiver

→ (Delay the first signal to the last signal) when all the signals are constructively added then



it is more beneficial.

Channel → contains .

9 Noise

PTA
Pak Telecom..
Authority.

→ Internal Noise
→ External Noise

Galactic Noise .
Atmosphere Noise.

⇒ (Sun radiations)
⇒ (Star radiations) (Man made).

Distortion due to manmade is interference .

External noise act as interference .

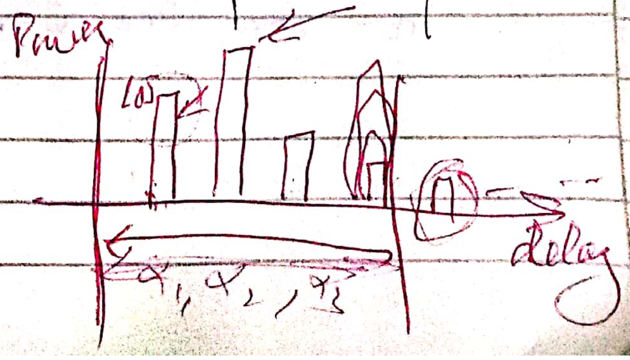
The noise which is created in the device is called internal noise

⇒ Due to temp , imition of energy occurs creates thermal noise

Noises are part of channel .

$\boxed{\text{Signal to Noise}}$ Ratio . $= \dfrac{S \text{ power}}{N \text{ power}}$ | $\dfrac{S}{1+N}$

↓
internal noise created due to thermal noise



(10)

Ufone	Mobilink
10 MHz	20 MHz

↓

License Band.
(Precious freq Band).

Shenon Capacity

$$C = B \log_2 (1+SNR)$$

Dependant on Bandwidth.

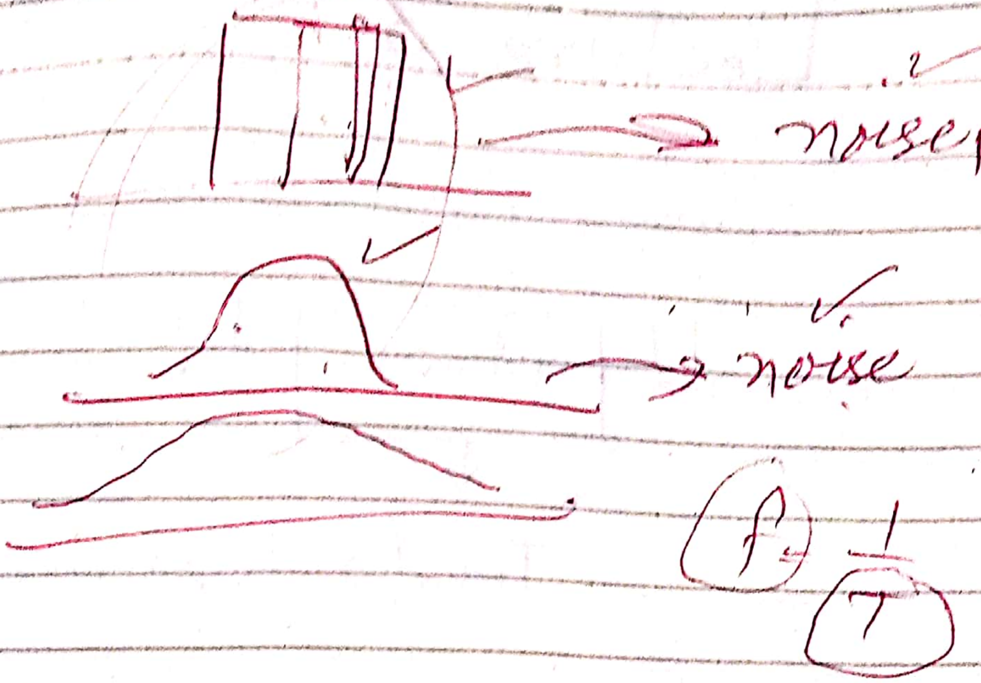
u can't transmit more than the given capacity.

if Noise = 0

& S&N will became infinite.

In zero time, infinite data is transmitted
↓
impossible.

$\boxed{\text{Noise is important.}}$

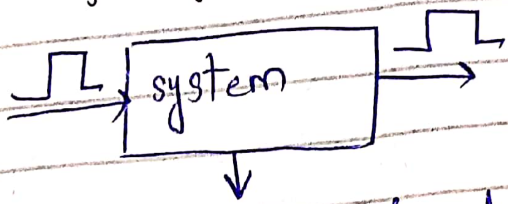


➜ What is Regenerative Repeaters?

201

Lecture 3:

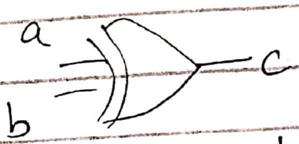
Transfer function:



Transfer function.

↳ Transfer function can be represented by a mathematical expression or logical expression.

12



$c = a \oplus b$
= Transfer function.

System:

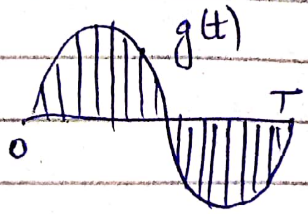
Which give you desired output when you give inputs.

Size of Signal:

The area under the curve is size of the signal.

e.g $g(t)$ is a signal

$$\text{size} = \int_{-\infty}^{\infty} g(t)\,dt.$$

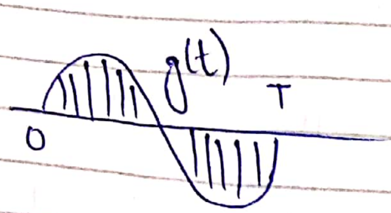


$$\text{size} = \int_{-\infty}^{\infty} g^2(t)\,dt = \text{Energy}$$

This is called E of signal.

Size of cylinder

$$\pi \int_0^h r^2 dr.$$

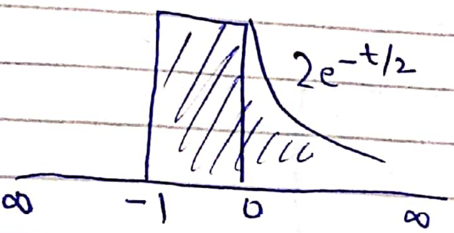


$$Siz = \int_{-\infty}^{\infty} g^2(t)\, dt$$

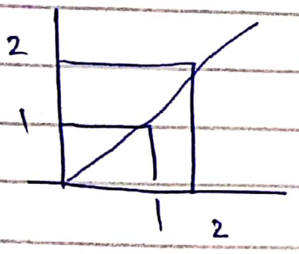
13

$$\int_0^T g(t)\, dt = 0$$

So,



$$Energy \Rightarrow \int_{-1}^{0} 4dt + 4\int_0^{\infty} e^{-t} dt$$



→ It has infinite energy because it is a continuous signal.

- Every signal is not an energy signal.

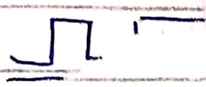
↳ if a signal has infinite value fro from $-\infty$ to ∞ then its energy cannot be calculated.

↳ Those signals which have statistical symmetry and are continuous. They have infinite E & cannot be calculated.

Lecture

Power Signals :

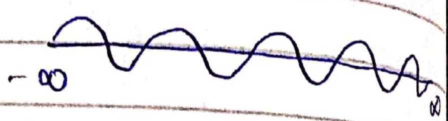
Transfer



Some signals are not energy signals but have some power

$$P_g = \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} g^2(t)\, dt$$

14

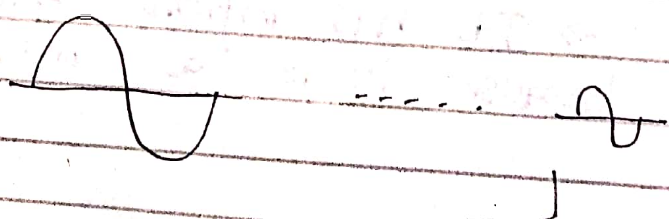


$C \cos(\omega t + \theta)$

$\Rightarrow$ energy cannot be calculated but power can be.

Digital Signal:

↳ Conversion of Analog to Digital Signal



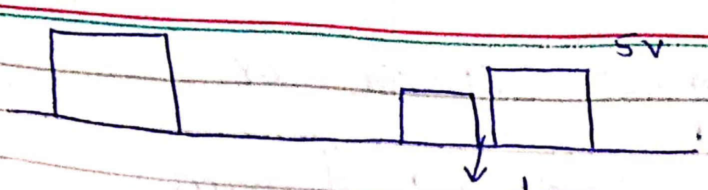
We amplify it

↳ $\frac{S}{N}$

↳ SNR increases.

5v

5v



13

↳ In digital system

↳ we have some regenerative repeaters at some distances which generate the original signal.

↳ No effect on SNR.

↳ Steps of Conversion.

Sampling:

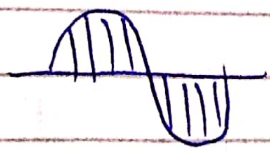
→ Take the samples of Analogue signal

↳ The samples have to be taken

According to Sampling theorem

↳ No. of Samples should be taken atleast twice of the highest frequency component present in signal.

e.g



→ $f = 4kHz$

No. of samples taken should be 8k samples/sec

Otherwise the signal can not be recovered.

Nyquist Criteria or Sampling Theorem

Step#1:

Samplify

6

Step#2 : QUANTIZATION

↳ Must given a no. or quantity to the signal.

↳ Give levels

↳ More no. of levels give accurate signal.

Step#3

Encoding

0 0000
1 0001
2
⋮
16 1111

↳ Every sample will be converted into binary.

Telecom using 128 levels
256 levels
↳ 7 bits require to represent the signal.

The entire process is said to be

$\boxed{\text{Pulse Code Modulation}}$.

Bandwidth :

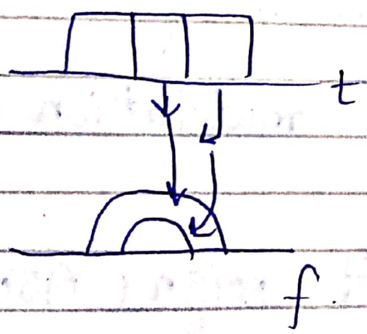
↳ Transmitting signal with more power, less bandwidth will be required.

↳ If signals has greater width, it will acquire less space in time domain (less band-width) and viceversa

⇒ Signal Trade b/w signal Signal Power & bandwidth.

rect function

T/τ



↳ Only analog have the property to travel

↳ Analog have one to one correspondance with digital signal

↳ Pulse Code Modulation

↳ More no. of levels
↳ less quantization error
but bandwidth increases.

↳ If digital signal undergoes some errors during transmission
↳ junk of data
↓
packets

Steps:
→ Detection of error
→ Send that packet again
(req the sender)
or
Receiver detects the error and corrects it
that is make the reciever smart.

Lecture # 4

↳ Three kinds of modulation in digital signals

1. Amplitude Shift keign (ASK)
2.
3.

(19)

⇒ Error Detection & Correction:

↳ Receiver is Smart, it detects the error.

Hamming Error Detection Code :-

① Error detection and error correction would only be possible at the far end only if some reductant bits transmitted along with the message.

② These reductant bits are not part of the message but will fasicilitate the communication.

Let we have 8 bit of communication.

$D_7 \ D_6 \ D_5 \ D_4 \ D_3 \ D_2 \ D_1 \ D_0$

The number of reductant bits should satisfy the below formula.

$$2^n \geq n+m+1$$

n = reductant bits

m = message "

$2^4 \geq 4+7+1$

$16 \geq 13$

12 11 10 9 8 7 6 5 4 3 2 1 0

(5: 0101, 4: 0100, 3: 0011, 2: 0010, 1: 0001)

Lecture #4

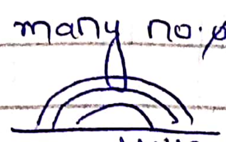
CDMA – Code division multiple access.

20

1MHz to 1 user

data rate increased → more no. of bits increased / s

→ f band limited → many no. of users in same band



1MHz

→ all messages mix with one another but in CDMA they give no. to each user and accomodate them in same f band.

BER Bit Error Rate:

Some bits loss during communication & information is lost.

– bcz of noise.

$$BER = 10^{-3} = \frac{1}{1000}$$

E is large make packet
↓
have some number of bits

Hamming Correction Code:

→ We have to append some extra bits with message

→ These extra bits are called redendant bits.

(21)

→ no part of actual info but it facilitates communication.

- Extra bits should not be appendant at any side of msg.

$D_7\ D_6\ D_5\ D_4\ D_3\ D_2\ D_1\ D_0$

→ Spread within the message.

How many redendant bits

$$2^n \geq n+m+1$$

n = no. of redendant bits

m = no. of bits in message.

$$2^4 \geq 4+8+1$$
$$16 \geq 13$$

n = 4 → no. of redendant bits.

4 redendant, 8 message.

1100	1011	1010	1001	1000	0111	0110	0101	0100	0011	0010	0001
12	11	10	9	8	7	6	5	4	3	2	1
D_7	D_6	D_5	D_4	R_8	D_3	D_2	D_1	R_4	D_0	R_2	R_1

In binary → only one time one = 1 → 1st redendant bit placed here
2 → 2nd " "
4 → 3rd " "
8 → 4th " "

Rest position is reserved for data bit.

Values of rebendent bits

Exclusive OR operation

1 on least significant bit included is

$$R_1 = D_0 \oplus D_1 \oplus D_3 \oplus D_4 \oplus D_6 .$$

1 on next significant position.

$$R_2 = D_0 \oplus D_2 \oplus D_3 \oplus D_5 \oplus D_6$$

$$R_4 = \overset{1}{D_1} \oplus \overset{0}{D_2} \oplus \overset{1}{D_3} \oplus \overset{1}{D_7}$$

$$R_8 = \overset{0}{D_4} \oplus \overset{1}{D_5} \oplus \overset{0}{D_6} \oplus \overset{1}{D_7}$$

1010

D_7	D_6	D_5	D_4	R_8	D_3	D_2	D_1	R_4	D_0	R_2	R_1
1	0	1	0	0	1	0	1	1	0	0	0

$R_1 = 0\ 1\ 1\ 0\ 0 = 0$
$R_2 = 0\ 0\ 1\ 1\ 0 = 0$
$R_4 = 1\ 0\ 1\ 1 = 1$
$R_8 = 0\ 1\ 0\ 1 = 0$

Ex = OR

01 / 10 = 1

If no. of 1' even = 0

if no. of 1 odd = 1.

$R_8 R_4 R_2 R_1 = 0100$

(23)

At receiver $R_5 = 0$

Receiver again calculated R_1, R_2, R_4, R_8

$R_1 = 0$

$R_2 = \overset{0}{D_0} \oplus \overset{1}{D_2} \oplus \overset{0}{D_3} \oplus \overset{0}{D_5} \oplus D_6 = 1$

$R_4 = 1$

$R_8 \oplus D_5 = 1$

$R_8' R_4' R_2' R_1' = 1110$

different then previous

↓

Perform exclusive OR

Now receiver know that there is error.

↓

$R_8 \; R_4 \; R_2 \; R_1 = 0100$

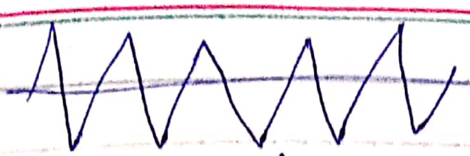
$R_8' \; R_4' \; R_2' \; R_1' \quad 1110$

1010

⇓

10 at position 10 it was an error.

(24)



infinite
energy = power signal

→ Hence receiver have ability to correct not Energy message. → no need to transmit msg again.

2 → bit error ⇒ then cannot fix it

Every system have limitations

BER $= 10^{-6} = \frac{1}{1000,000}$

Redendant bit is lost.

0001
0010
0100
1000

} No need of correction.

0001
R_1 lost.

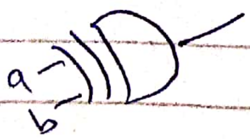
received error

$R_8\ R_4\ R_2\ R_1 = 0101$
$R_8'\ R_4'\ R_2'\ R_1' = 0100$, originally data bit is safe

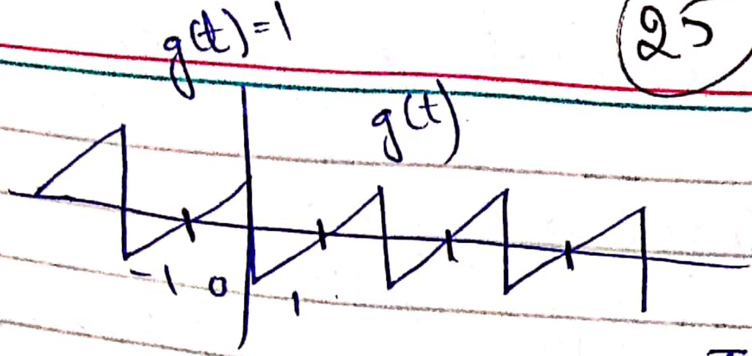
0001

Assignment 2
MATLAB
Transmitter
receiver

$c = a \oplus b$



25



$$P_g = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} g^2(t)\,dt$$

$$P_g = \frac{1}{2} \int_{-1}^{1} t^2\,dt$$

$$= \frac{1}{2} \cdot \frac{t^3}{3} \Big|_{-1}^{+1}$$

$$= \frac{1}{6} \left[(1)^3 - (-1)^3 \right]$$

$$= \frac{1}{6} \times 3 = \frac{1}{2}$$

7/oct/2019

Communication Lab

Signal → electromagnetic form of data.

↙ Mathematical expressions.

26

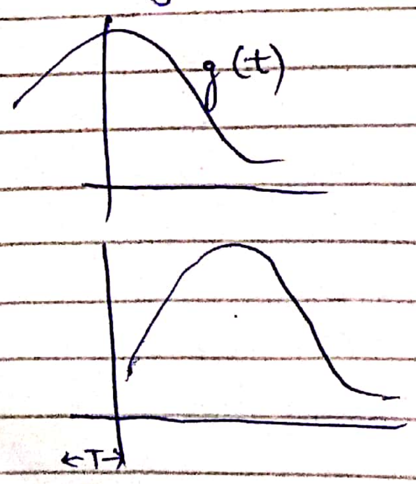
⇒ Here we will assume signal as source of communication.

Lecture # 5

Time Shifting Property :

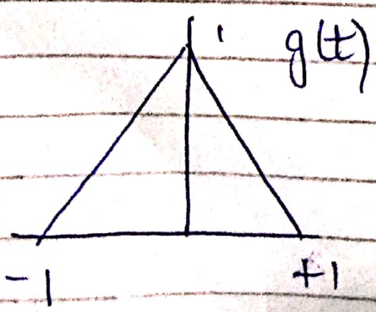
$$g(t) = \phi(t+T)$$

$$g(t-T) = \phi(t)$$



$g(t-T)$

↙ Advance.

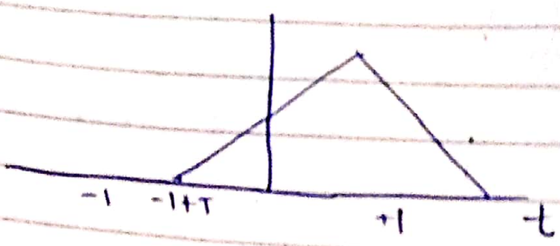


21

$g(t-T)$

$t-T=-1$

$t = -1+T$



Time Scaling Property

$g(t) = \phi(t/2)$

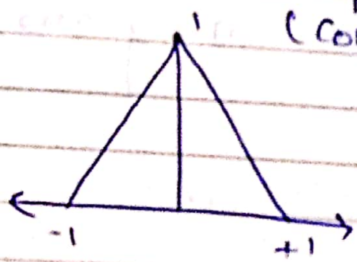
$g(2t) = \phi(t)$

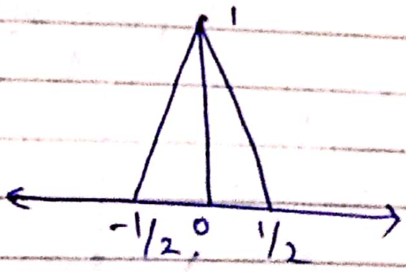
Multiplication (Compression)

$g(2t) = ?$

$2t = 1$

$t = -1/2$

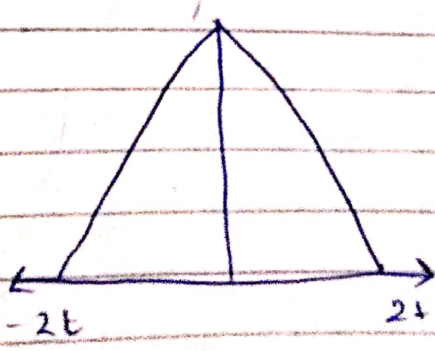




Division

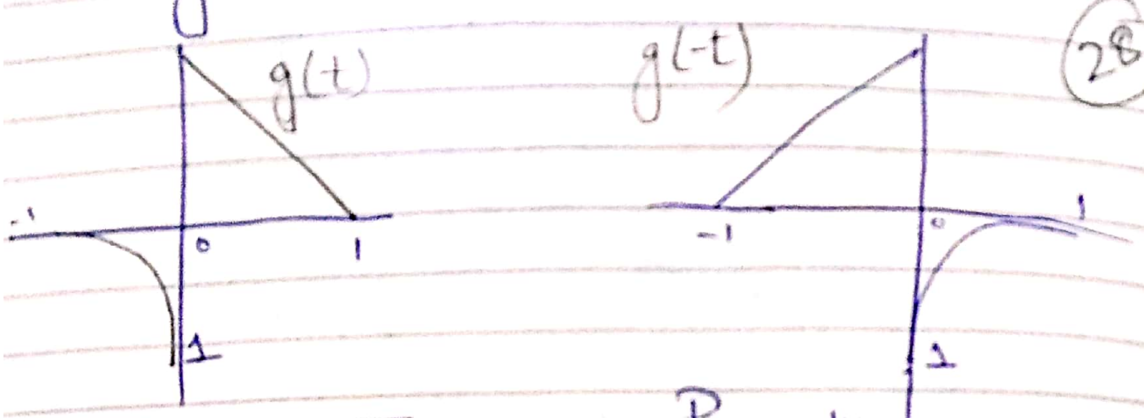
$\boxed{\text{Expansion}}$

$g(t/2)$



3) Time Inversion:

We shift ∿ by 180° across y-axis.



Time inversion Property.

$-t = 1$	$t = 0$
$t = -1$	$-t = 0$
	$t = 0$.

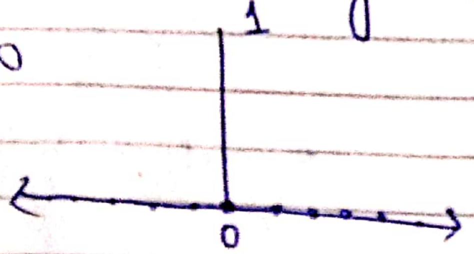
→ invert on y-axis.

4) Unit Impulse ftn.

$t = 0$ (only defined here)

$-\infty \rightarrow +\infty$

$= 1$



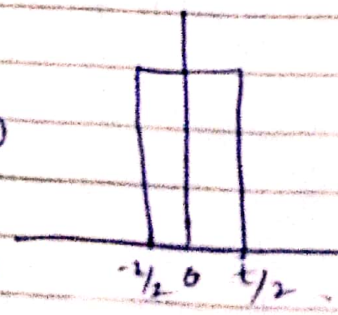
$\left(\text{width} \times \frac{1}{\text{height}} \quad w = 0 \right)$

$h = \infty$

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

at $t = 0$

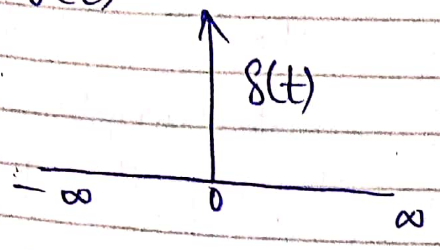
0 Else where



Height : Area under curve = 1 : $1/\epsilon$.

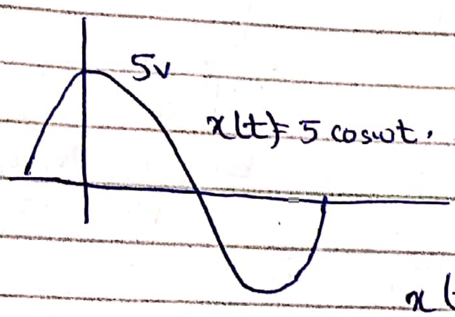
(29) ↳ $\epsilon \times \frac{1}{\epsilon} = 1$.

$\delta(t)$



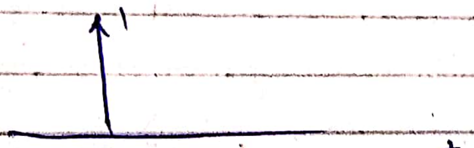
$$\int_{-\infty}^{\infty} x(t)\, \delta(t)\, dt.$$

↓ derived data function.



$x(t) = 5\cos\omega t$

$\delta(t)$



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

$= x(0) \Rightarrow 5. \rightarrow$ We use it in sampling

Samples kaise le skta

→ derived data func $\underbrace{x}$, $x(t)$.

⇒ 2 times of the highest frequency component present in Signal.

$$0 - 4KHz \xrightarrow{} \text{Highest freq.}$$

Laquis → A → D → take sample → sample rate → (2 time the highest frequency component present in signal)

30

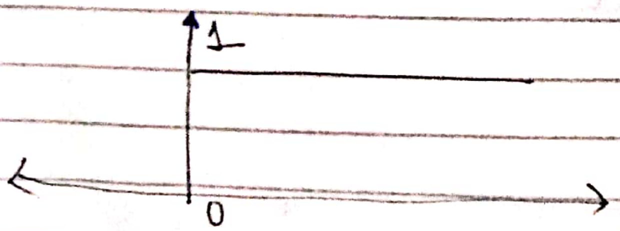
Sampling Rate $\geq 2B$.

$2 \times 4K = 8K$ samples.

↓

signal will be recovered with this rate.

Unit Step Function:



$g(t) = 0 \quad t < 0$

$g(t) = 1 \quad t \geq 0$

This system is known as causal ftn.

started at 0, remain 1 & till infinity.

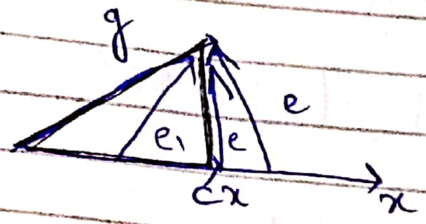
$$\int_0^{\infty} \delta(\tau)\, d\tau \rightarrow \text{Tao variable.}$$

(31)

$$\frac{d\,u(t)}{dt} = \delta(t).$$

Signals and vector :-

Signals are vectors.



$c = 0$ to 1

$0 \leq c \leq 1$

tilt → Similarity
Expand → Difference.

x-vector par projections hai

when e is perpendicular then error willbe less.

$$g \cong cx$$

$$g = e + cx.$$

e → vector

$$g = e + c_1 x$$ → this is not calculated addition

$$g = e + c_2 x$$ this is resultant of two vectors.

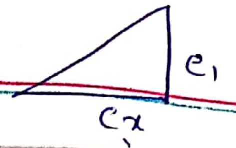
⇒ Coz of addition of these two forces

Signals are similar to vectors? No

Signal are like vectors? No

Signal are Vector ✓

For right angle Δ



$\Rightarrow$ Only valid for right angle triangle.

$$|g|^2 = |e|^2 + |Cx|^2.$$

31

$$\cos\theta = \frac{cx}{|g|} \left(\frac{b}{h}\right)$$

only right angle Δ.

$$c|x| = |g|\cos\theta.$$

$$c|x||x| = |g||x|\cos\theta.$$

$$c|x|^2 = g\cdot x$$

$$c = \frac{g\cdot x}{|x|^2}.$$ $\rightarrow$ Minimum error in this Case.

$g(t)$, $x(t)$

(How much they are related)

(less error)

$$g(t) \cong cx(t)$$

$$g(t) = e(t) + cx(t)$$

error is fn of time

$$e(t) = cx(t) - g(t)$$

What is error energy. ?

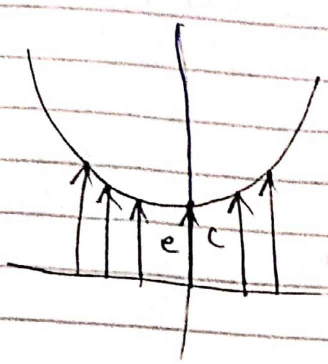
formula $a^2 + b^2 - 2ab$

$$\int_{-\infty}^{\infty} e^2(t)\,dk \quad \int_{-\infty}^{\infty} [x(t) - g(t)]^2\,dt$$

$$E_e = \int_{-\infty}^{\infty} c^2 x^2 dt + \int_{-\infty}^{\infty} g^2(t)\, dt$$

32

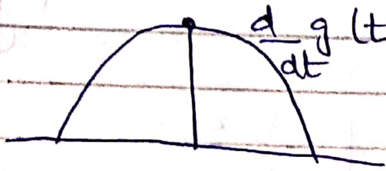
$$- \int_{-\infty}^{\infty} 2\, c\, x(t)\, g(t)\, dt.$$



c is the main contributor of error

E of error is dependant on C.

On one value of C, e is minimum otherwise increases.



$$\frac{d}{dt} g(t) = 0$$

⇒ When Rate of change g(t) becomes Zero.

$$\frac{dE_e}{dc} = 0$$

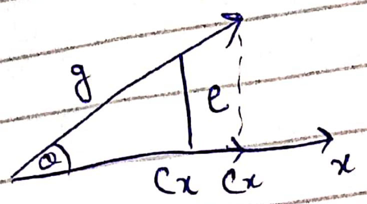
$$\Rightarrow 2c \int_{-\infty}^{\infty} x^2(t)dt + 0 - 2\int_{-\infty}^{\infty} x(t)\, g(t)\, dt = 0$$

$$c = \frac{\int_{-\infty}^{\infty} x(t)\, g(t)\, dt}{\int_{-\infty}^{\infty} x^2(t)\, dt}$$

This eqtn causes minimum error.

Scanned by CamScanner

Lecture 6



C was defective error b/w g & x.

33

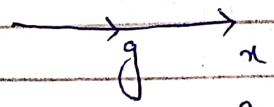
$$g \cdot x = |g||x| \cos \theta$$

$$C_x = \cos\theta = \frac{g \cdot x}{|g||x|}$$

↓

(relation b/w signal) corelation co-efficient

$\theta = 0$, $g = x$

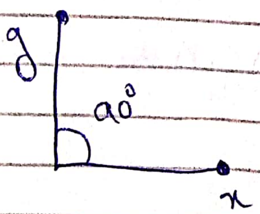


g & x similar to one another.

(g will be like x and is independant upon magnitude as well)

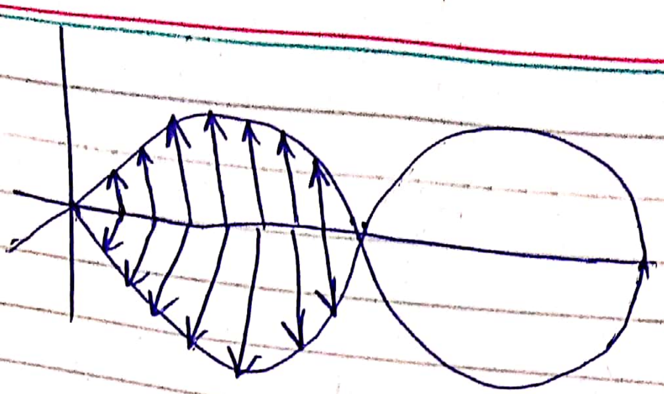
if $\theta = 0$ $C_n = \cos\theta \Rightarrow \cos 0 = 1$

$\theta = 90 \Rightarrow C_n = \cos 90 = 0$



$\Rightarrow 0$ projection.

(orthogonal to one another)



Same frequency signal → is orthogonal to each other → they won't mix → such signals can be isolated.

(34) $\theta = 180^\circ$, $C_x = \cos 180 = -1$

$-1 \leq C \leq 1$

$$C_x = \frac{g \cdot x}{|g||x|} = \frac{\int_{t1}^{t1} g(t)\, x(t)\, dt}{\sqrt{E_g}\ \sqrt{E_x}}$$

$C_x = 0$ have no effect on one another (strangers)
$C_x = -1$ (enemies)
$C_x = 1$ (friends)

$$C_x = \frac{1}{\sqrt{E_g}\sqrt{E_x}} \int_{t1}^{t2} g(t)\, x(t)\, dt$$

$|g| = \sqrt{g_2}$

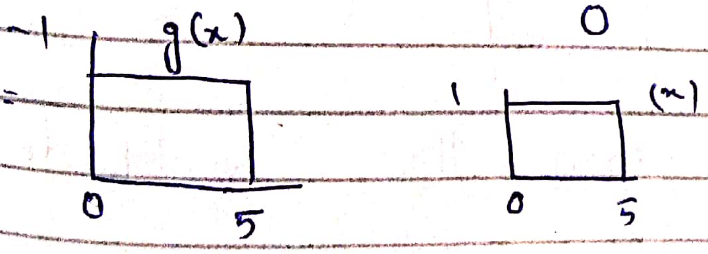
$\sqrt{\int_{t1}^{t2} g^2(t)\, dt}$.

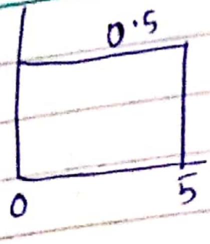
↓

if g & x
↓
orthogonal
↓
0

g^2 is energy in signals $\sqrt{E}$.

$C_x =$





$$C_x = \frac{1}{\sqrt{5}\sqrt{1.25}} \int 1 \cdot x \cdot 0.5 \, dt$$

$$= \frac{1}{\sqrt{5 \times 1.25}} \; 0.5 \, t \Big|_0^5$$

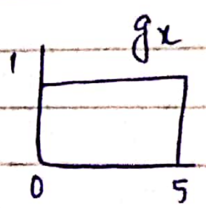
$$= \frac{1}{\sqrt{5 \times 1.25}} \; 2.5$$

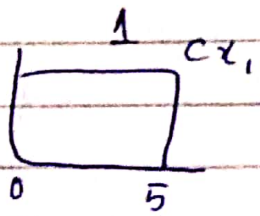
35

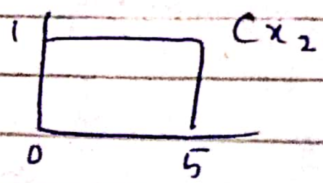
$$= \frac{2.5}{\sqrt{6.25}}$$

$$= \frac{2.5}{2.5}$$

$$= 1$$



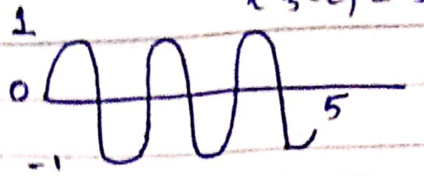




Independant upon the amplitude.

Cx_1 & Cx_2 are bffriends of $g(x)$

$$x_3(t) = \sin t$$



$$E_{x_3} = \int_0^5 \sin^2(t)\, dt$$

$$= \int \left[1 - \frac{\cos 2t}{2} \right] dt$$

36

$$= \int_0^5 \frac{1}{2} t - \int_0^5 \cos 2t \, dt$$

$$= \frac{1}{2} t$$

$$= \frac{5}{2} = 2.5$$

$$C_x = \frac{1}{\sqrt{5}\sqrt{2.5}} \int_0^5 1 \cdot \sin t \, dt = 0.$$

Lecture

$$g(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos n\omega_0 t + b_n \sin n\omega_0 t$$

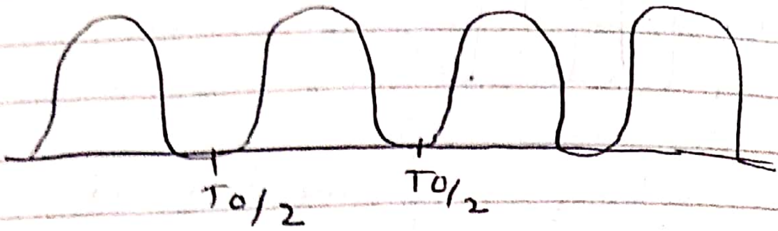
we want to see signal in

$$g(t) = \sum_{n=-\infty}^{\infty} C_n \cos(n\omega_0 t + \theta_n)$$

we want to see system in frequency ~~Domain~~ Response

$$g(t) = \sum_{n=-\infty}^{\infty} D_n e^{jn\omega_0 t}$$

$$D_n = \frac{1}{T_0} \int_{-T_0/2}^{T_0/2} g(t) e^{-jn\omega_0 t} \, dt$$



if To increases , loops will be more far away from each other.

$T_0 \to \infty$

Right & left loops are eliminated.

$$\lim_{T_0 \to \infty} g_{(T_0)}(t) = g(t)$$

↓
Periodic signal
↓
when limit → infinity
↓
Aperiodic

---

integrate + limits → expression will not be dependant on time.

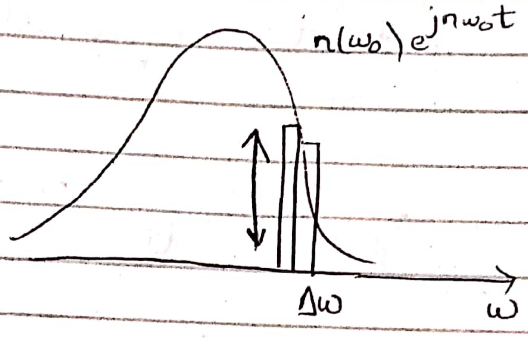
$$(n\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-jn\omega_0 t}\, dt$$

$$D_n = \frac{G(n\omega_0)}{T_0}$$

$$\omega_0 = \frac{2\pi}{T_0} \Rightarrow T_0 \Rightarrow \frac{2\pi}{\omega_0}$$

$$g(t) = \sum_{n=-\infty}^{\infty} \frac{G(n\omega_0)}{T_0} e^{jn\omega_0 t}.$$

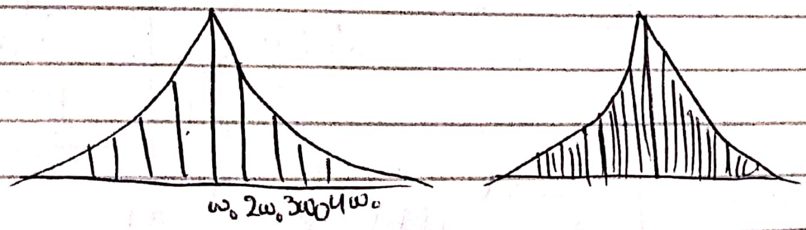
39



$\omega = 0$

$D_n = \infty$

$$= \sum_{n=-\infty}^{\infty} \frac{G(n\Delta\omega)\Delta\omega}{2\pi} e^{jn\omega_0 t}$$



if T_0 doubles ω_0 becomes Half

if $T_0 = \infty$

$D_n = 0$

The graph become denser & Compressed

$$g(t) = \frac{\sum_{n=-\infty}^{\infty} G(n\Delta\omega)\Delta\omega e^{jn\Delta\omega t}}{2\pi}$$

$$g(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} G(n\Delta\omega)\, e^{jn\Delta\omega t}\, d\omega$$

↳ small change in ω.

$$g(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} G(\omega)\, e^{j\omega t}\, dt$$

$$\boxed{G(\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-j\omega t}\, dt} \quad \text{— imp}$$

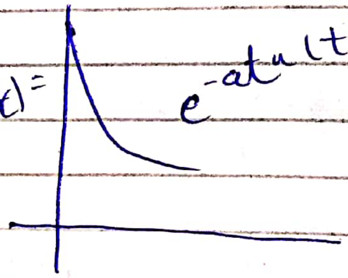
if signal is in ω-domain we can find its equvivalent in time Domain.

$$\boxed{g(t) = \frac{1}{2\pi} G(\omega)\, e^{j\omega t}\, dt.} \quad \text{— imp}$$

$$g(t) \Longleftrightarrow G(\omega)$$

39

$g(t) = e^{-at}u(t)$



$G(\omega)$

0 → ∞
coz
unit
step
function

$$G(\omega) = \int_{-\infty}^{\infty} e^{-at}\, u(t)\, e^{-j\omega t}\, dt.$$

$$G(\omega) = \int_{\infty}^{0} e^{-at}\, e^{-j\omega t}\, dt + \int_{0}^{\infty} e^{-at}\, e^{-j\omega t}\, dt$$

$$\int_{0}^{\infty} e^{-at} \cdot e^{-j\omega t}\, dt.$$

When base is same powers are added

$$G(\omega) = \frac{e^{-t(a + j\omega)}}{-at + jn\omega t}\Bigg|_0^{\infty}$$

$$= \frac{1}{a + jn\omega_0}\left(e^{-\infty} - e^{-0}\right)$$

$$= \frac{1}{-(a+jn\omega_0)}(0-1)$$

(40)

$$= \frac{1}{a+jn\omega_0}.$$

That single jo zero par converge nahi horaha uska Fourier signal nahi hota and is known as.

$$\int_{-\infty}^{\infty} |g(t)|\, dt < \infty$$

$$G(\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-j\omega t}\, dt$$

$G(\omega) = |G(\omega)| \, e^{j\theta_g(\omega)}$ → angle

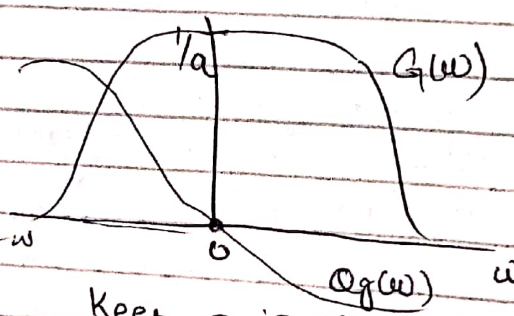
↓ ~~magnitude~~ → amplitude

Find Amplitude:

$$G(\omega) = \frac{1}{\sqrt{a^2+\omega^2}} e^{j \tan^{-1} \omega/a}$$

$$G(\omega) = \frac{1}{\sqrt{a^2+\omega^2}} e^{-j \tan^{-1} \omega/a}$$

$$G(\omega) = \frac{1}{\sqrt{a^2+\omega^2}}$$



when $\omega = 0$
$G(\omega) = \frac{1}{a}$

Keep on increasing ω → $G(\omega)$ decreases.

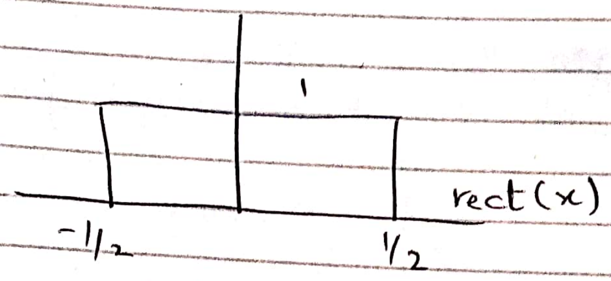
$$\theta_g(\omega) = \tan^{-1}(\omega/a)$$

$$\theta_g(\omega) = 0 \qquad \omega = 0$$

All the discussion is valid $a > 0$ otherwise the e^{-at} will beome positive & it will never converge.

& no fourier integral.

Unit Gate Function:



When width & height is 1 then it is known as rect.

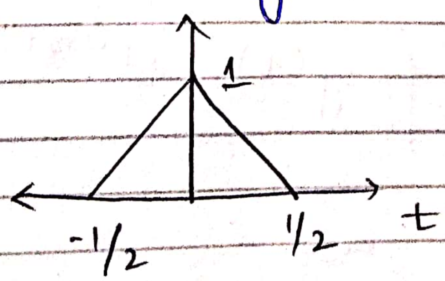
$$\text{rect}(x) = 0 \quad , \quad |x| > \frac{1}{2}.$$

$$\text{rect}(x) = 1 \quad , \quad |x| < \frac{1}{2}.$$

$\Rightarrow \text{rect}\left(\frac{x}{\text{width of signal}}\right)$

42

Unit triangle Function.



if $-\frac{T}{2}$ to $\frac{T}{2}$

$\Delta\frac{x}{T} \quad 0 \quad |x| > T/2$

$= 1 - \frac{2|x|}{T} \quad |x| < \frac{T}{2}$

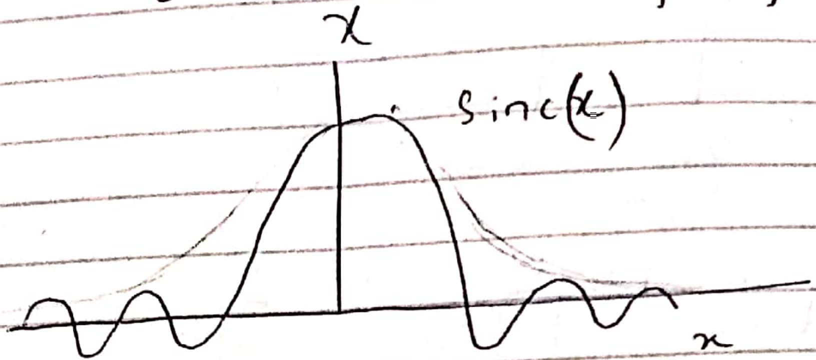
$$\Delta x = 0 \quad , \quad |x| > 1/2$$

$$= 1 - 2|x| \quad |x| < \frac{1}{2}$$

Interpolation Function

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

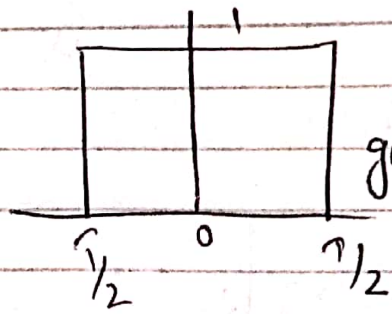
Sinc x will be 0 at all values except for $x = 0$.



for

$x = \pm n\pi$, Sinc x = 0

W3



$g(t) = \text{rect} = \frac{t}{T}$

$$G(\omega) = \int_{\infty}^{-\infty} g(t)\, e^{-j\omega_0 t}\, dt$$

$$= \int_{0}^{\infty} 1 \; e^{-j\omega t}$$

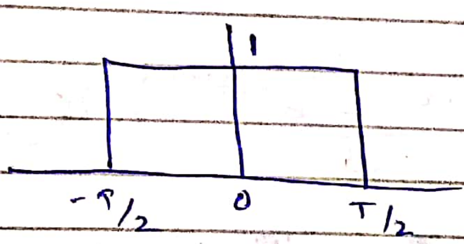
$$\Rightarrow \left. \frac{e^{-j\omega t}}{-j\omega} \right|_{-T/2}^{T/2}$$

$$= \frac{1}{-j\omega}$$

44

Lecture

$g(t) = \text{rect}$



component of F.S are orthogonal to one another.

$$g(t) = \text{rect}\left(\frac{t}{T}\right)$$

$$G(\omega) = \int_{-T/2}^{T/2} \text{rect}\,\frac{t}{T}\, e^{-j\omega t}\, dt$$

frequency Response

$$= \left. \frac{e^{-j\omega t}}{-j\omega} \right|_{-T/2}^{T/2}$$

Exponential F.S :-

$$g(t) = \sum_{n=-\infty}^{\infty} \left[D_n e^{jn\omega_0 t} \right]$$

$$D_n = \frac{1}{T_0} \int_{-T_0/2}^{T_0/2} \underline{g(t)\, e^{-jn\omega_0 t}\, dt} \quad G(\omega)$$

$$g(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} G(\omega)\, e^{j\omega t}\, d\omega .$$

$\bigstar$

$$G(\omega) = \frac{e^{-j\omega T/2} - e^{j\omega T/2}}{-j\omega}$$

1

Magnitude

$$= \frac{e^{j\omega T/2} - e^{-j\omega T/2}}{j\omega}$$

45

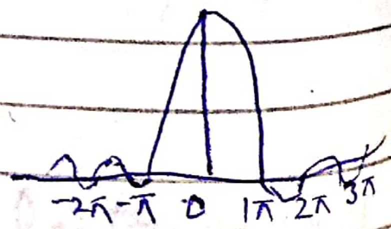
$$= 2\left(\frac{e^{j\omega T/2} - e^{-j\omega T/2}}{\omega}\right) / 2j$$

$$\sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$$

$$\frac{2 \sin \omega T/2}{\omega}$$

$$= \frac{T \sin \omega T/2}{\frac{\omega T}{2}}$$

$$\Rightarrow \quad \mathrm{Sinc}\,\theta = \frac{\sin\theta}{\theta}$$



$\theta = \pm n\pi$

at 0 it will give u one.

$$= T\, \mathrm{Sinc}\, \frac{\omega T}{2}$$

Scanned by CamScanner

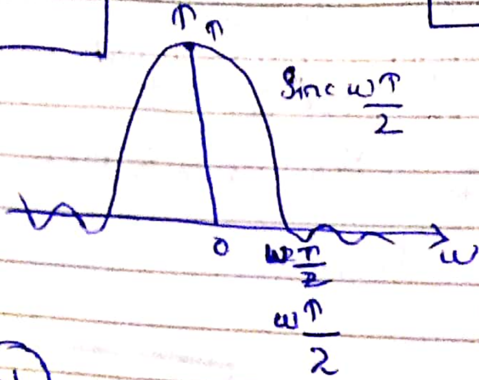
In time domain
$Bw \propto \omega$.

Bw is diff b/w two frequencies

time duration when reduced Bw increases

freq
no. of revolutions per sec

$\Theta = \pm n\pi$



46

$\frac{\omega T}{2} = \pi$

$\boxed{\omega = \frac{2\pi}{T}}$ (=1)

$\frac{\omega T}{2} = 2\pi$

$\Rightarrow$ The width b/w 0 & 2π is dependant upon T.

$\boxed{\omega = \frac{4\pi}{T}}$ (= 2)

freq is a +ve term

$\frac{\omega T}{2} = 3\pi$

$\boxed{\omega = \frac{6\pi}{T}}$ (= 3)

$0 - 2\pi$ is the bandwidth of rect.

T (tno) is the width of the Signal

if width is decreased, the sys will become fast & will occupy

if T (width) decreases the bandwidth increases

Scanned by CamScanner

⇒ if 10 kHz total

1 kHz to 10 user

if bits per second is increased

2 kHz ⇒ 5 user.

Users decreased.

AMP

Advanced Mobile Phone System . 1G

$\boxed{\text{PakTEL}}$ → 30 kHz

Instaphone need → 4 kHz

they wanted to provide us with better Quality.

FDM → Frequency Division Multiplexer

GSM

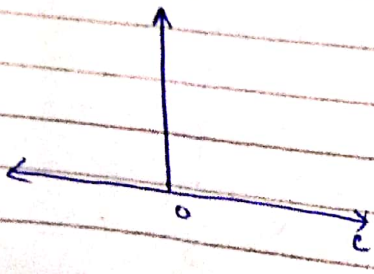
FDMA/TDMA → 200 kHz

$\boxed{\text{CDMA}-2000 \quad 5\text{MHz}}$

47

$$g(t) = \delta(t)$$

$\delta(t)$



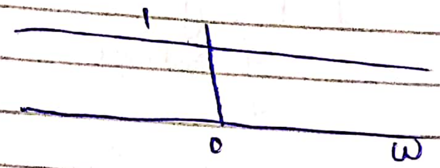
The function which don't any width is unit impulse ftn

$$G(\omega) = \int_{-\infty}^{\infty} \delta(t)\, e^{-j\omega t}\, dt$$

$$= 1$$

$$\boxed{\delta(t) \Leftrightarrow 1}$$

T.D



frequency Domain.

$$G(\omega) = \delta(\omega)$$

u8

$$= \frac{1}{2\pi} \int_{-\infty}^{\infty} 1 \; e^{j\omega_0 t} \, d\omega$$

$\omega = 0$

$$= \frac{1}{2\pi} \int 1 \; e^{j(0)t} \, d\omega$$

$$= \frac{1}{2\pi} \times 1$$

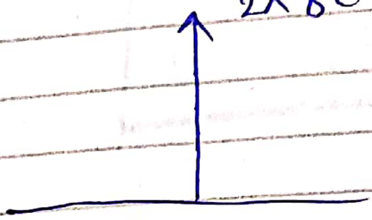
T.D

$$g(t) \; \cancel{G(\omega)} = \frac{1}{2\pi} \Leftrightarrow \delta(\omega)$$

F.D

$$2\pi \times \frac{1}{2\pi} \Leftrightarrow 2\pi\,\delta(\omega)$$

$$1 \Leftrightarrow 2\pi\,\delta(\omega)$$



frequency Domain function.

In Time domain length is very $\infty \rightarrow -\infty$

in freq bit point decrease to zero.

$$G(\omega) = \delta(\omega-\omega_0)$$

$$g(t) = ?$$

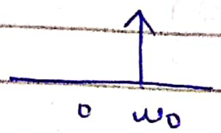
$$g(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} \delta(\omega-\omega_0)\, e^{j\omega_0 t}\, d\omega$$

49

$$g(t) = \frac{1}{2\pi}\int_{\omega=\omega_0} \delta(\omega_0-\omega_0)\, e^{j\omega_0 t}\, dt$$

$\omega-\omega_0=0$

$\omega=\omega_0$



$$= \frac{e^{j\omega_0 t}}{2\pi} \Leftrightarrow \delta(\omega-\omega_0)$$

$$e^{j\omega_0 t} \Leftrightarrow \delta(\omega-\omega_0)$$

T.D F.D

$$e^{-j\omega_0 t} \Leftrightarrow 2\pi(\omega+\omega_0)$$

50

Scanned by CamScanner

$e^{-j\omega_0 t} \Leftrightarrow 2\pi(\omega+\omega_0)$

28/10/17

INVERSE FOURIER Transform.

$\delta(\omega-\omega_0)$

$$F^{-1}[\delta(\omega-\omega_0)] = \frac{1}{2\pi}\int_{-\infty}^{\infty} \delta(\omega-\omega_0)\, e^{j\omega t}\, d\omega$$

$\omega = \omega_0 \rightarrow$ unit impulse.

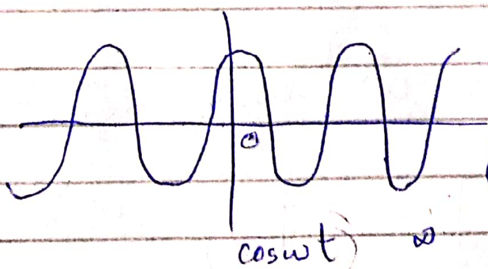
$$= \frac{1}{2\pi} e^{j\omega_0 t}$$

$$\frac{1}{2\pi} e^{j\omega_0 t} \Leftrightarrow \delta(\omega-\omega_0)$$

$$e^{j\omega_0 t} \Leftrightarrow 2\pi\, \delta(\omega-\omega_0)$$

$$e^{-j\omega_0 t} \Leftrightarrow 2\pi\, \delta(\omega+\omega_0)$$

$g(t) = \cos\omega_0 t$



$\cos\omega t$

$$g(t) = \frac{e^{j\omega_0 t} - e^{-j\omega_0 t}}{2}$$

$$G(\omega) = \int_{-\infty}^{\infty} g(t)\, e^{-j\omega t}\, dt.$$

$$G(\omega) = \int_{-\infty}^{\infty} \frac{e^{j\omega_0 t} - e^{-j\omega_0 t}}{2}\, e^{-j\omega t}\, dt.$$

$$G(\omega) = \frac{1}{2}\int_{-\infty}^{\infty} e^{j\omega_0 t} e^{-j\omega t}\,dt + \frac{1}{2}\int_{-\infty}^{\infty} e^{-j\omega_0 t} e^{-j\omega t}\,dt.$$

$$= \frac{1}{\cancel{2}}\left[\cancel{2}\pi\,\delta(\omega-\omega_0) + \cancel{2}\pi\,\delta(\omega+\omega_0)\right]$$

$$= \pi\left[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)\right]$$

$$G(\omega) = \int_{-\infty}^{\infty} \cos\omega_0 t\, e^{-j\omega t}\,dt \qquad 5$$

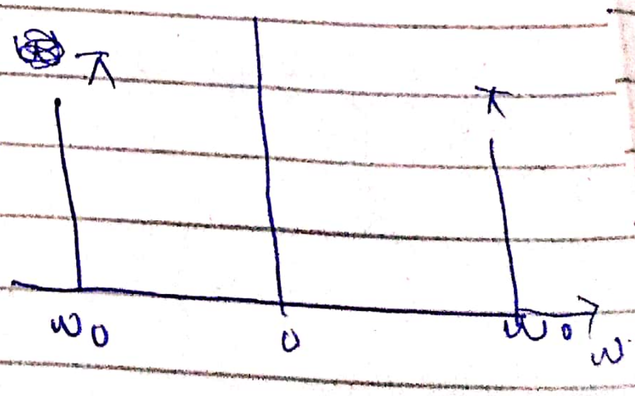
$$= \frac{1}{2}\int_{-\infty}^{\infty} e^{j\omega_0 t} e^{-j\omega t}\,dt + \frac{1}{2}\int_{-\infty}^{\infty} e^{-j\omega_0 t} e^{-j\omega t}\,dt$$

$$= \frac{1}{2}\left[\int e^{-j(\omega-\omega_0)t}\,dt\right] + \frac{1}{2}\int_{-\infty}^{\infty} e^{-j(\omega+\omega_0)t}\,dt.$$

$$= \frac{1}{2}\left[2\pi\,\delta(\omega-\omega_0) + 2\pi\,\delta(\omega+u_0)\right]$$

$$= \pi(\omega-\omega_0) + \delta(\omega+\omega_0)]$$

$$F = [\cos\omega_0 t] = \pi[\delta(\omega-\omega_0) + \delta(\omega+\omega_0)$$



$g(t) = \frac{1}{2\pi}$

$G(\omega) = \int_{-\infty}^{\infty} G$

Duality Property

If you having shift in time so, we change the correspondin signal in T.D to F.D.

$$g(t-t_0) \longleftrightarrow G(\omega)\, e^{-j\omega t_0}$$

$$g(t)\, e^{j\omega_0 t} \longleftrightarrow G(\omega-\omega_0).$$

if there is shift in time so in f

Scaling Property:

$$g(t) \longleftrightarrow G(\omega)$$

$$g(at) \Leftrightarrow$$

if $a>1$ compres

if $a<1$ Expanded

$$F[g(at)] = \int_{-\infty}^{\infty} g(at)\, e^{-j\omega t}\, dt$$

$x = at$

$t = \frac{x}{a}$

$dt = dx/a.$

Scanned by CamScanner

$$\Rightarrow \int_{-\infty}^{\infty} g(x)\, e^{-j\frac{\omega}{a}x} \times d\frac{x}{a}$$

53

$$= \frac{1}{a}\int_{-\infty}^{\infty} g(x)\, e^{-j\frac{\omega}{a}x}\, dx$$

$\therefore G(\omega)$

$\int_{-\infty}^{\infty} g(t)\, e^{-j\omega t}\, dt$

$$= \frac{1}{a} G(\omega/a)$$

$G(\frac{\omega}{a})$

$$\boxed{g(t) = e^{-at}u(t) + e^{at}u(-t)}$$

$\downarrow$

$g(t) = e^{-a|t|}$

Bit per sec

More space covered

a Power Domain

$$G(\omega) = \int_{-\infty}^{\infty} \left(e^{-at} + e^{at}u(-t)\right)$$

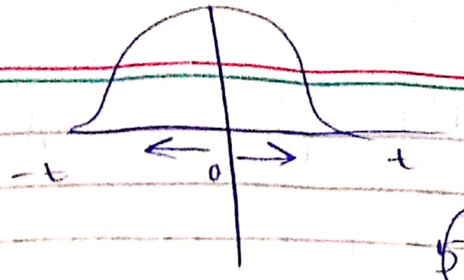
$$G(\omega) = \int_{0}^{\infty} e^{-at} e^{-j\omega t}\, dt + \int_{\infty}^{0} e^{-at} e^{-j\omega t}\, dt$$

$$= \Rightarrow \frac{e^{-(a+j\omega)t}}{-(a+j\omega)}\Bigg|_{0}^{\infty} + \frac{e^{(a-j\omega)t}}{a-j\omega}\Bigg|_{\infty}^{0}$$

$$= \frac{0-1}{-(a+j\omega)} + \frac{1}{a-j\omega} \qquad 0+(1)$$

$$= \frac{a+j\omega + a-j\omega}{a^2+\omega^2} = \frac{3}{a^2+\omega^2}$$

$\frac{2a}{a^2+\omega^2}$



5-4

$\Rightarrow$ $\omega \uparrow$ Amplitude decrease

Time Shifting Property.

$$g(t) = G(\omega)$$

$$g(t-t_0) \Longleftrightarrow G(\omega)\, e^{-j\omega t_0}$$

$$F[g(t-t_0)] = \int_{-\infty}^{\infty} g(t-t_0)\, e^{-j\omega t}\, dt$$

~~us~~: 2et

$$t - t_0 = x$$

$$t = x + x_0$$

$$dt = dx.$$

$$= \int_{-\infty}^{\infty} g(x)\, e^{-j\omega(x+t_0)}\, dx.$$

$$e^{-j\omega t_0} \int_{-\infty}^{\infty} g(x)\, e^{-j\omega x}\, dx.$$

$$\Rightarrow e^{-j\omega t_0}\, G(\omega)$$

Frequency Shifting Property:

$$g(t)\, e^{j\omega_0 t} \Leftrightarrow G(\omega-\omega_0)$$

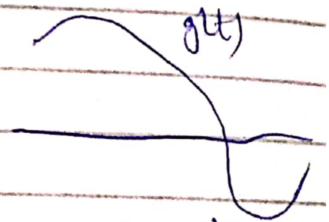
35 $F\left[g(t)\, e^{j\omega_0 t}\right] =$

$$\Rightarrow \int_{-\infty}^{\infty} F\left[g(t)\, e^{j\omega_0 t}\right] e^{-j\omega t}\, dt$$

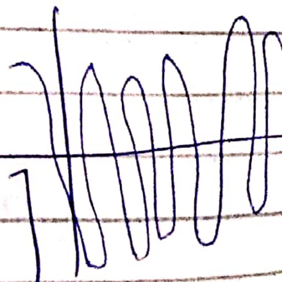
$$= \int_{-\infty}^{\infty} g(t)\, e^{-j(\omega-\omega_0)t}\, dt$$

$$= G(\omega-\omega_0)$$

$$\boxed{g(t) \cos \omega_0 t}$$



$$G(\omega) = \int_{-\infty}^{\infty} g(t) \cos \omega_0 t$$



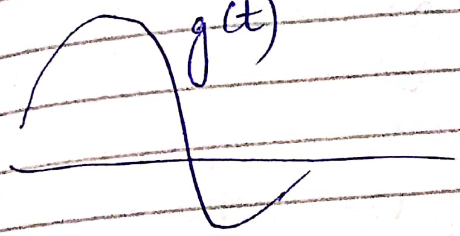
$$= g\int_{-\infty}^{\infty} \left[\frac{g(t)\, e^{j\omega_0 t} + g(t)\, e^{-j\omega_0 t}}{2}\right] e^{-j\omega t}\, dts$$

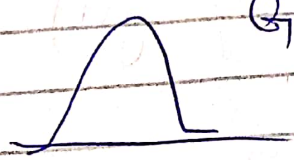
5-6

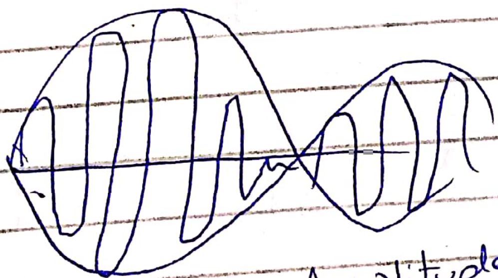
$$\int_{-\infty}^{\infty} g(t)\, e^{-j(\omega-\omega_0)t}\, dt + \int_{-\infty}^{\infty} g(t)\, e^{-j(\omega+\omega_0)t}\, dt$$

$$\Rightarrow \frac{G(\omega-\omega_0)}{2} + \frac{G(\omega+\omega_0)}{2}$$

$$g(t) \longleftrightarrow G(\omega)$$







Amplitude Modulation.

⇒ Coz am of carries signal changes in according to value of base band signal.

$$g(t)\ \cos(\omega_0 t + \theta_0)$$

$$G(\omega) = \int_{-\infty}^{\infty} g(t) \cos(\omega_0 t + \theta_0)$$

57

$$\Rightarrow \int_{-\infty}^{\infty} g(t)\ \frac{e^{j(\omega_0 t + \theta_0)} - e^{-j(\omega_0 t + \theta_0)}}{2}\ e^{-j\omega t}\, dt$$

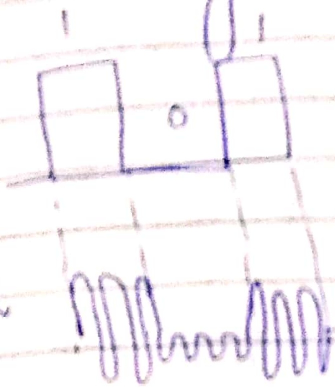
$$\frac{1}{2}\int_{-\infty}^{\infty} g(t)\ e^{\omega_0 t} e^{\omega t} + \frac{1}{2}e^{j\theta}\int_{-\infty}^{\infty} e^{-\omega_0 t}$$

$$\frac{1}{2}e^{j\theta_0}\int_{-\infty}^{\infty} g(t)\ e^{(\omega-\omega_0)} + \frac{1}{2}e^{j\theta}\int_{-\infty}^{\infty} g(t)\, e^{(\omega-\omega_0)}$$

$$\boxed{\Rightarrow \frac{1}{2}e^{j\theta_0}\ G(\omega-\omega_0) + \frac{1}{2}e^{-j\theta}\ G(\omega-\omega_0)}$$

Lecture :

Signal transmission through linear System.



ASK

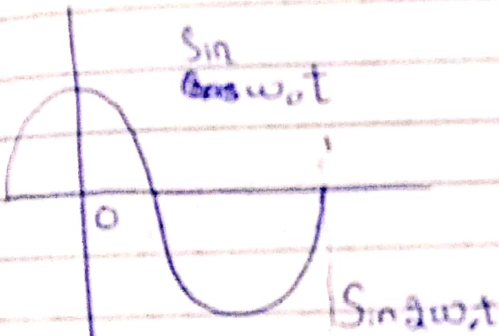
Modulation Techniques

→ PCM

→ Amplitude Shifting

→ Frequency Shifting

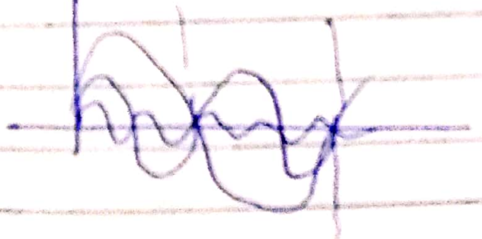
Properties :-



$\cos \omega_0 t$, $\cos 2\omega_0 t$

↓

all will be orthogonal to each other.



→ if every one is delayed same time then there will be no change n signal at other side.

Fundamantal Component → Hormonics

$\theta = \omega t$

5

↓

Phase angle

if S has high freq, then

Phase angle increases in proportion

$$\theta = -\tan^{-1}\left(\frac{\omega}{a}\right)$$

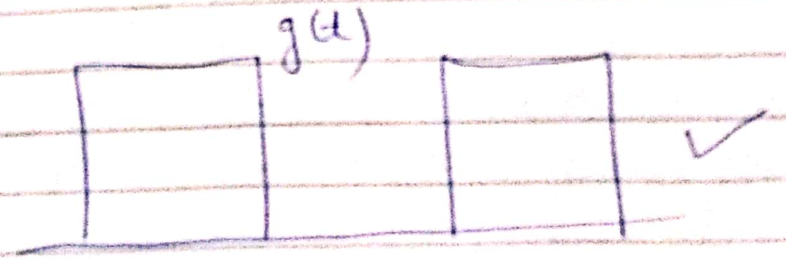
$$= -\left(\frac{\omega}{a}\right) \rightarrow \theta \text{ angle for distortion less}$$

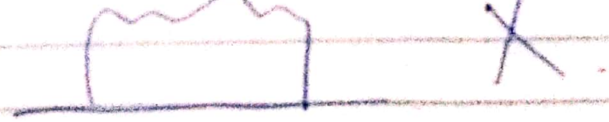
$\boxed{f \propto p}$

↳ linear func

→ Every particular comp of F.S is delayed wd same amount and wd no distortion

→ Phase should be linear ftn of ω





if we get distortion less transimission then it is known as similar signal.

6 $y(t)$

$$g(t) \longrightarrow \boxed{h(t)} \longrightarrow y(t)$$

$$y(t) = g(t) * h(t) \quad \text{(convolve)}$$

1 — $$Y(\omega) = G(\omega)H(\omega) \quad \text{(multiplication)}$$

$$\underbrace{G(\omega)}_{\text{Basic signal}} = \underbrace{|G(\omega)|}_{\text{amplitude}} e^{j\underbrace{\theta_g(\omega)}_{\text{base angle}}}$$

$$|Y(\omega)| e^{j\theta_g(\omega)}$$

$$= |G(\omega)| e^{j\theta_g(\omega)} \cdot |H(\omega)| e^{j\theta_G(\omega)}$$

$$|Y(\omega)| = |G(\omega)| \, |H(\omega)|$$

$$\theta_y(\omega) = \theta_g(\omega) + \theta_G(\omega).$$

$$y(t) = kg(t - t_d)$$

2 — $$Y(\omega) = KG(\omega) e^{-j\omega t_d}$$

$$H(\omega) = \frac{KG(\omega) e^{-j\omega t_d}}{G(\omega)}$$

$$|H(\omega)| e^{j\theta_h(\omega)} \,/\, H(\omega) = K e^{-j\omega t_d}$$

$|H(\omega)| = K$ → Condition for distortion less Transmission.

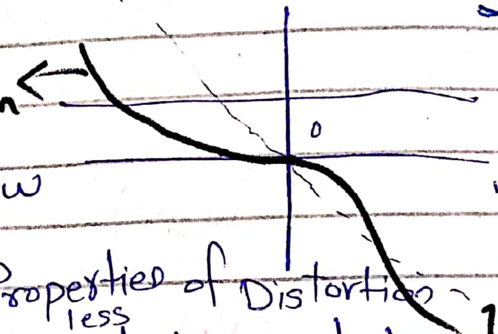
61

$\theta_h(\omega) = -\omega t_d$

$-\frac{d\,\theta_h(\omega)}{d\omega} = t_d$

keep on increasing ω

decrease

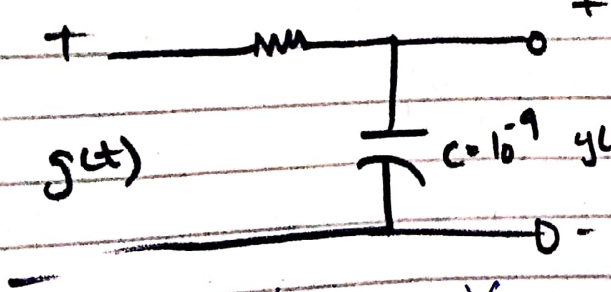


⇒ Properties of Distortion less

Amplitude constant

phase angle (linear fn of ω) → distortion less

Voltage Division Rule:



$Y(\omega) = \frac{1/j\omega C}{R + \frac{1}{j\omega C}}$

shape (signal) thab tak change nahi hota jab delay sare comp ka same amount se ho.

$$\Rightarrow \frac{R_2}{R_1+R_2}$$ 02

$$= \frac{1}{1+j\omega RC}$$

$$= \frac{1/RC}{1/RC + j\omega}$$

$$= \frac{a}{a+j\omega}$$ $$\boxed{a = 1/RC}$$

$$|Y(\omega)| e^{j\theta_y(\omega)} =$$

Magnitude

$$|Y(\omega)|^2 = \frac{\sqrt{a^2}}{\sqrt{a^2+\omega^2}} = \frac{a^2}{\sqrt{a^2+\omega^2}}.$$

$$\theta_y(\omega) = \tan^{-1}\frac{\omega}{a} \quad \boxed{\frac{p}{b}} \quad \Rightarrow \frac{a}{\sqrt{a^2+\omega^2}\, e^{j\tan^{-1}\frac{\omega}{a}}}$$

$$= \boxed{e^{j\tan^{-1}\frac{\omega}{a}}}$$

$$|Y(\omega)| e^{j\theta_y(\omega)} = \frac{a\, e^{-j\tan^{-1}\frac{\omega}{a}}}{\sqrt{a^2+\omega^2}}$$

$$|Y(\omega)| = \frac{a}{a^2+\omega^2}.$$

$$\theta_y(\omega) = -\tan^{-1}\left(\frac{\omega}{a}\right)$$

C3 $\quad a = \frac{1}{R_c} = \frac{1}{10 \times 10^{-7}}$

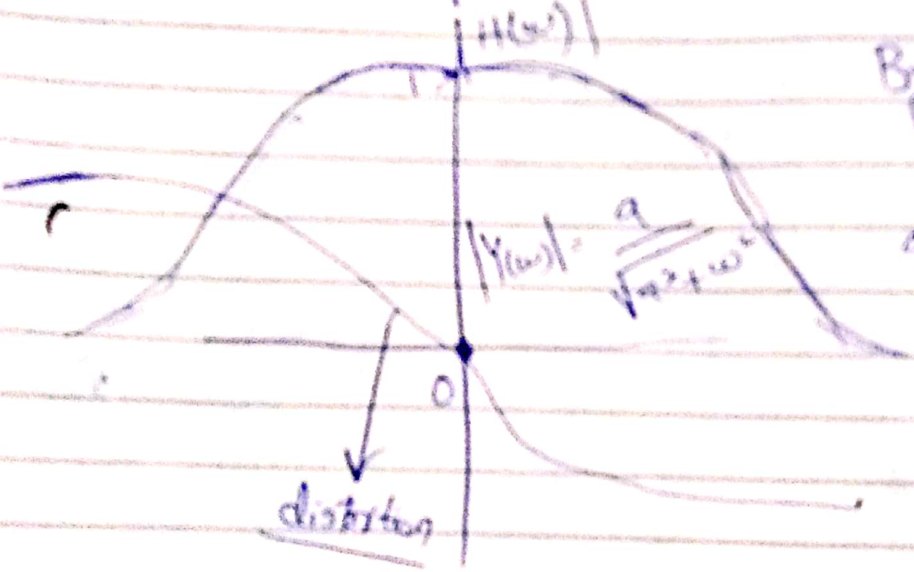
$a = 10^6$

$\omega \ll a$

$\theta_y(\omega) = 1$

$|Y(\omega)| = \frac{a}{\sqrt{a^2+\omega^2}} \approx 1$

ω is very small as compared to a



By ↑ omega approximation nahi rahega

if $\theta_y(\omega) = -\tan^{-1}\left(\frac{\omega}{a}\right)$, $\omega \neq 0$