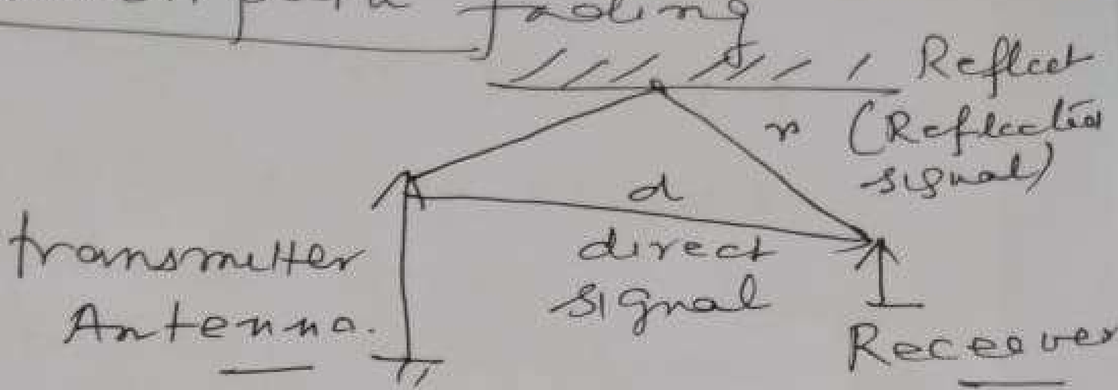
Page - 1

Q.1. Multipath fading



Distance travelled by direct signal $= d$

" " " Reflected signal $= r$

(i) $e(t, x) = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} x\right)$

(ii) $e_d(t, d) = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} d\right)$

(iii) $e_r(t, r) = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} \cdot r\right)$

effective signal at the receiver

(iv) $e_e = e_d(t, d) + e_r(t, r)$

$= E \sin\left(2\pi f t + \frac{2\pi}{\lambda} \cdot d\right) + E \sin\left(2\pi f t + \frac{2\pi}{\lambda} \cdot r\right)$

(v) Case-I Let $r = d + \lambda$

$e_e = E \sin\left(2\pi f t + \frac{2\pi}{\lambda} d\right) + E \sin\left(2\pi f t + \frac{2\pi}{\lambda}(d+\lambda)\right)$

$= E \sin(2\pi ft + \frac{2\pi}{\lambda} + 2\pi)$

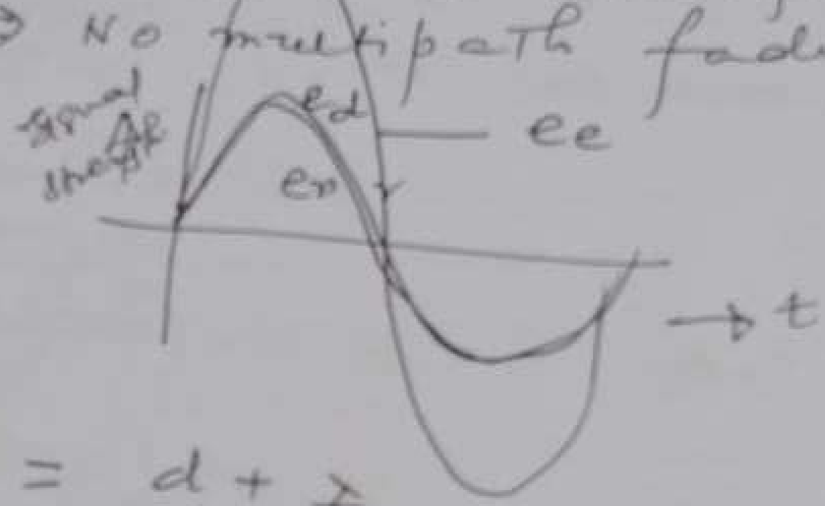
(page-2)

$= E \sin(2\pi ft + \frac{2\pi}{\lambda} d)$

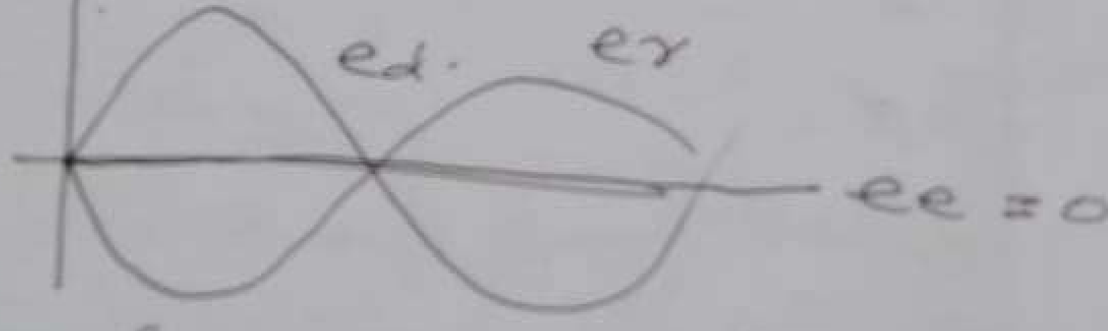
$+ E \sin(2\pi ft + \frac{2\pi}{\lambda} d + 2\pi)$

$= 2E(\sin 2\pi ft + \frac{2\pi}{\lambda} d)$

Signal strength double due to constructive interference
$\Rightarrow$ No multipath fading.



(vi) $= d + \frac{\lambda}{2}$



<u>Full fading</u>.

Full Multipath fading

$ed = E \sin 2\pi ft + \frac{2\pi}{\lambda} d)$

$er = E \sin(2\pi ft + \frac{2\pi}{\lambda} d + \pi)$

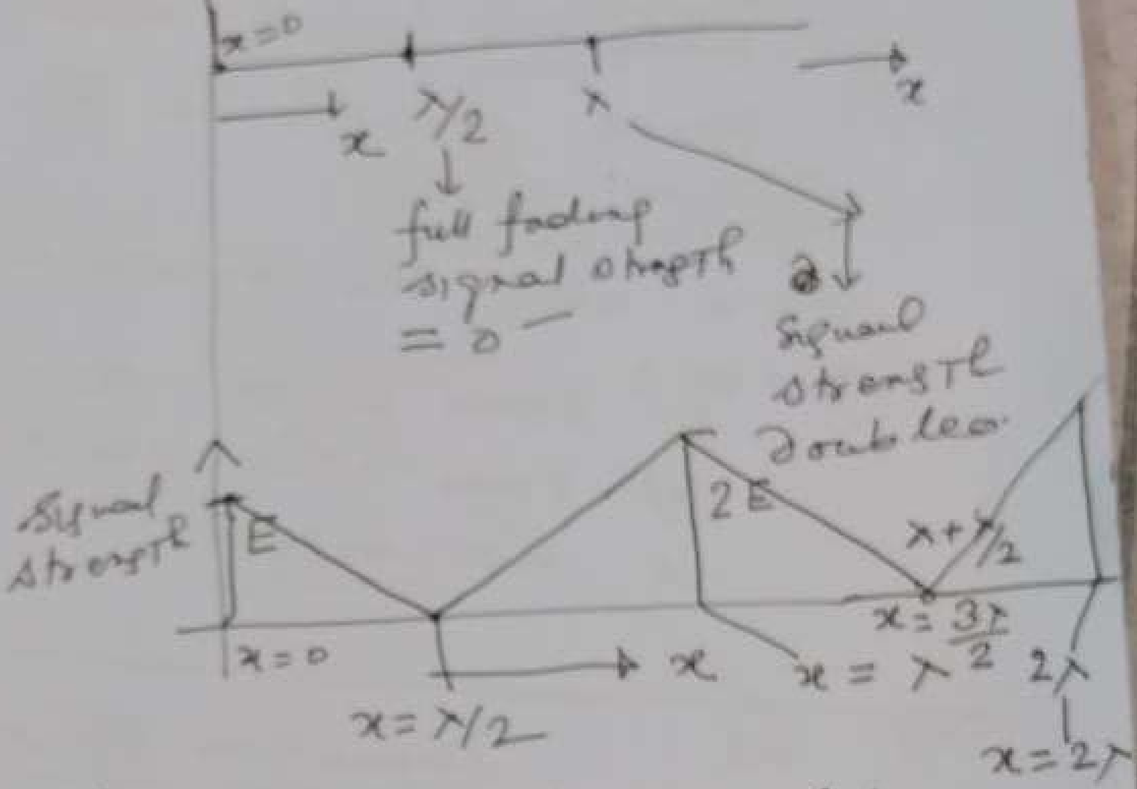
$= - E \sin(2\pi ft + 2\pi/\lambda d)$

$e_e = e_d + e_r = 0$

Page 3

(vii)

$r = d + x$



(viii) If a person talks while Moving towards x direction →

at (a) $x = \frac{\lambda}{2}$ signal $= 0 \Rightarrow$ Call drop.

(b) $\frac{\lambda}{2} < x \leq \lambda \Rightarrow$ signal strength Increasing $\Rightarrow$ better Conversation

(c) $\lambda < x \leq \frac{3\lambda}{2}$

$\Rightarrow$ Again signal strength decreases.

(X) Signal strength veries in a congested areas (with building, Mountains.) while a person moves.)

(IX) Signal strength in the Basement of an house:

Here also the signal stresth veries:

(a) Some point there is signal

(b) Some other point there is no signal

---

1. Definition of signal

— A time varying physical

(a) Quantity using which data is transmitted from one computer to another computer using Communication

(b) Medium

(a) physical Quantity: (i) Voltage/current (Electrical signal)

(b) → Twisted pair

EM signal (ii) Light intensity (optical signal)

(iii) $\vec{E}$ and $\vec{H}$ field

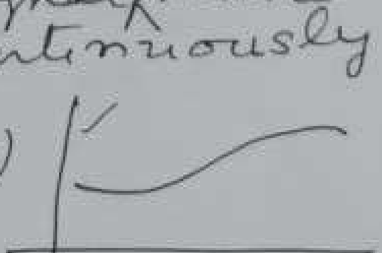
Page-5

(b) Medium
- → Twisted pair (signal is electrical)
- → coaxial cable (signal is electrical)
- → optical fibre (signal is light)
- → space (signal is electromagnetic

(2) signals

Analog

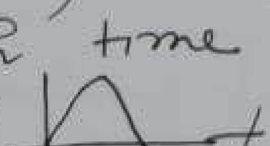
$s(t)$ signal varies continuously



signal → t

If $s(t)$ is continuous function with time ⇒ Analog signal.

Examples

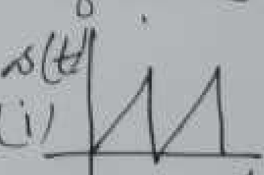


sine function

Discrete

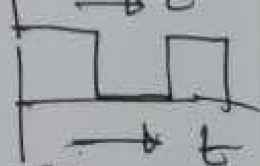
If $s(t)$ is a Non continuous function of time

(i)



→ t

(ii)

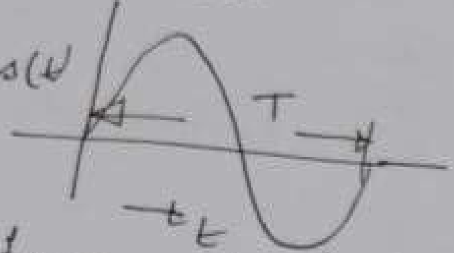


→ t

Square wave.

Analog signal

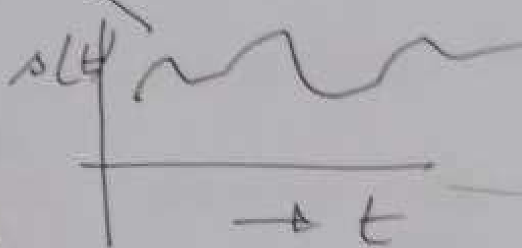
(I) sine()
cosine()



– pure Analog signal with single frequency

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

(II)



⇒ Composite Analog signal with many frequency – consisting of many sine() waves:

f_H = Highest frequency

f_L ⇒ Lowest frequency

$BW = f_H - f_L$

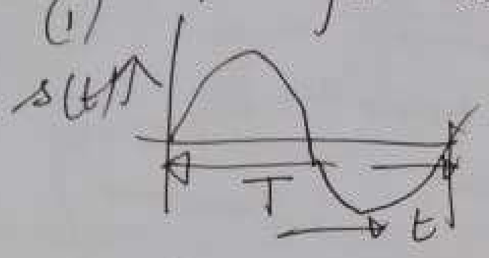
Page-7

Analog signal

periodic

If there exist constant T such that $s(t) = S(t+T)$ for all t.

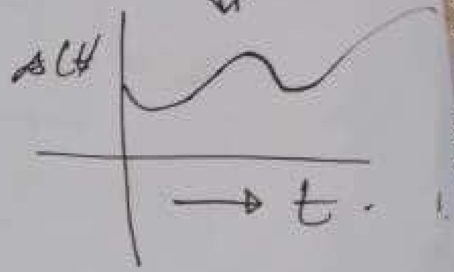
(1)

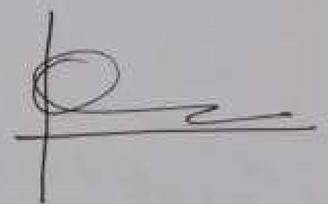


Non periodic

If $s(t) \neq S(t+T)$

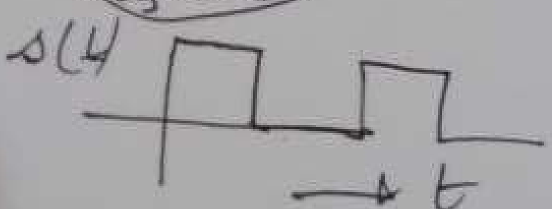
$\Downarrow$



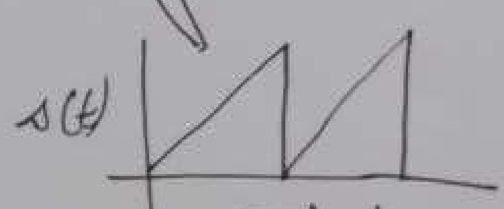


Discrete signal – see Page-5

Digital signal



Saw tooth

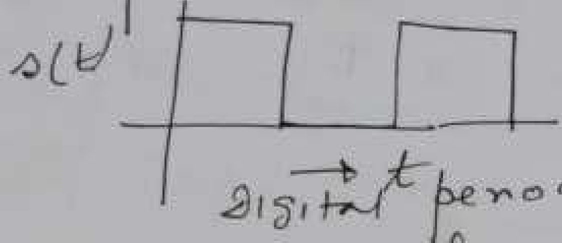


page 8

Digital ~~Discrete~~ signal

periodic

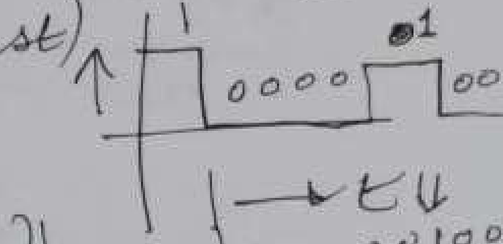
$s(t) = s(t+T)$



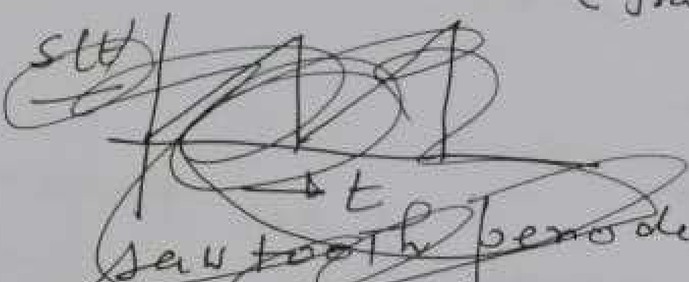
Digital periodic signal - 1 0 1 0 1 0
(Transmitter

Non periodic

$s(t) \neq s(t+T)$



10000100
Transmitter

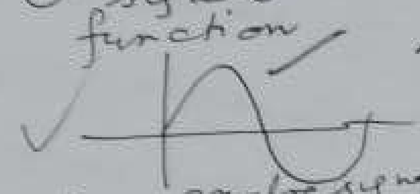


~~sawtooth periodic signal~~

Periodic signal

Analog

① signal function



If it only one sine wave ⇒ NO

pure analog signal

$s(t) = s(t+T)$

only one frequency $f = \frac{1}{T}$

① square wave

$s(t) = s(t+T)$

Fourier Analysis:-

If Any function $s(t) = s(t+T)$ then it can be analysed by fourier series:- ∞

$$s(t) = \frac{c}{2} + \sum_{n=1}^{\infty} A_n \sin(2\pi nft) + \sum_{n=1}^{\infty} B_n \cos(2\pi nft)$$

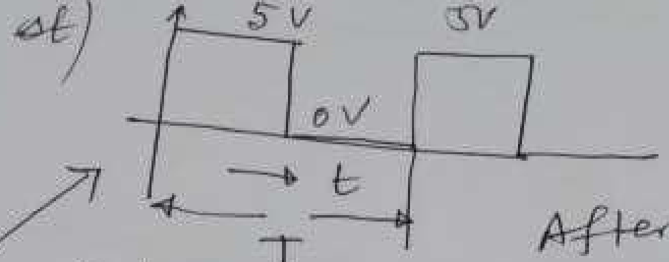
$$f = \frac{1}{T}$$

$\Downarrow$

$B_n \cos(2\pi nft)$

$2f \quad c = \cancel{10V}\ 5V$ (10)

$s(t)$



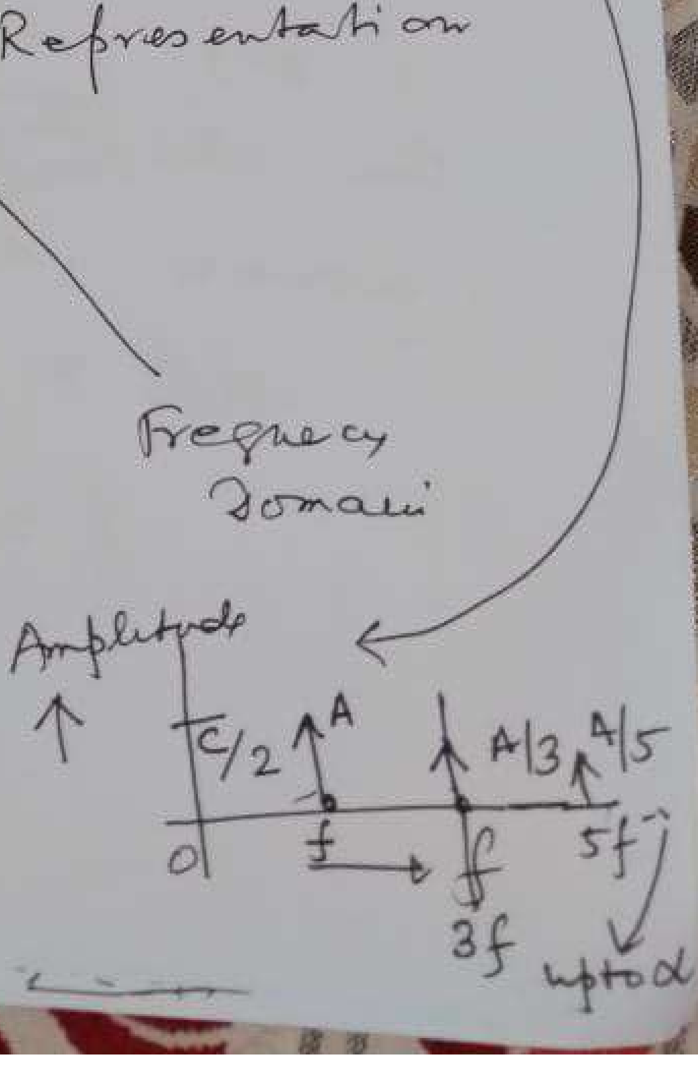
After fourier Analysis.

$$s(t) = \frac{5}{2} + A \sin 2\pi f t + \frac{A}{3} \sin 2\pi 3 f t + \frac{A}{5} \sin 2\pi (5 f t)$$

Signal Representation

Time Domain

Frequency Domain



$BW. = \alpha - 0 = \alpha$
(Absolute)

cut off frequency

$\underline{\text{BW effective}} = f_c - 0$

$= (nf - 0)$

$= \underline{nf}$ value of n depends on Applications.

If we want $n = 10$ for cut-off frequency

$\underline{A_n} = \frac{1}{10} A$

(Amplitude of cut off frequency $= \frac{1}{10}$ of amplitude of fundamental frequency (f)

Then BW effective $= \underline{\underline{10f}}$.

$f = \frac{1}{T} \Rightarrow$ fundamental frequency