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Multi level ASK –

(a) Now suppose our data is

00	01	10	11	00	01	10	11
1	2	3	4	05	06	07	08

(b) Here BW of the channel shall be BW = baud rate as baud rate change is ~~domant~~ dominant factor

(c) Suppose if Band with also called = x

Baud rate = x

Digital bit rate = $x \times \log_{02} 04 = x \times 2$

(d) If V = no of Amplitude levels

Then Digital Bit rate

$= \text{Baud rate} \times \log_2 V$

where Baud rate = BH.

(e). Now, so long as bandwidth of channel is fixed.

Baud rate is fixed.

So Digital Bit Rate $\propto$ ($\log_2$ No of levels (V) created.)

(f) (i) Now suppose the Power Rating of The Modulator $= P$ (fixed)

(ii) $P \propto C^2 \Rightarrow P = KC^2$

Prop Constant

Amplitude of Carrier

$C = \sqrt{\frac{P}{K}}$ = fixed.

(iii) Suppose we create V no of Amplitude levels

ΔV (Difference between successive amplitude level) $= \frac{C}{V}$

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(iv) As V increases —

ΔV decreases. —

(v) if Δv is too small

then it ~~may be~~ bits may be corrupted

by ~~error~~ noise. —

(vi) $\Delta V \propto \frac{N}{S}$ (inverse of (signal value - Noise value))

(vii) $V \propto \frac{S}{N}$ —

So we have a maximum value of

V = no of levels depending

on the noise environment

Less noise $\Rightarrow$ More $\frac{S}{N}$ value

$\Rightarrow$ more V

$\Rightarrow$ more digital Bit rate

(viii) So we can not increase V beyond limit

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② Frequency shift keying (FSK)

(a) 2 Level FSK : two frequency fL and fH are used.

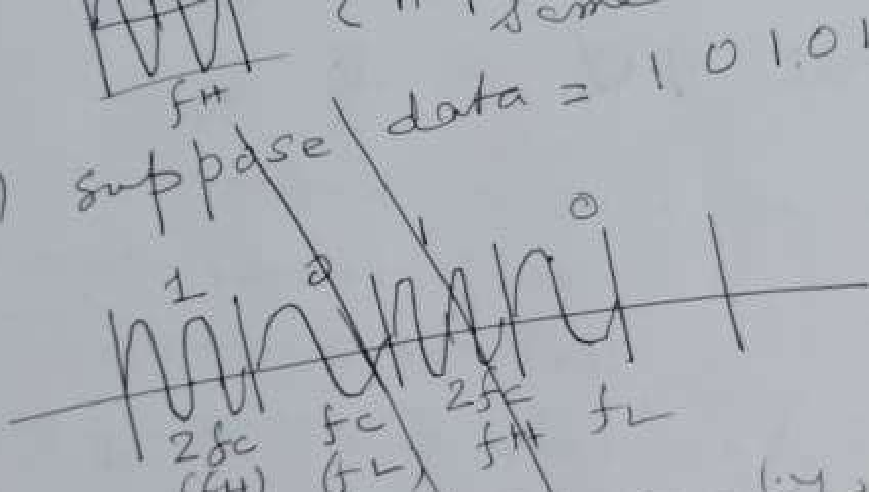
(i) ⇒ carrier frequency fc

(ii) $L0 = \frac{fc}{2}$

$L1$ = say $2fc = f_H$

⇒ (Amplitude remaining same.)

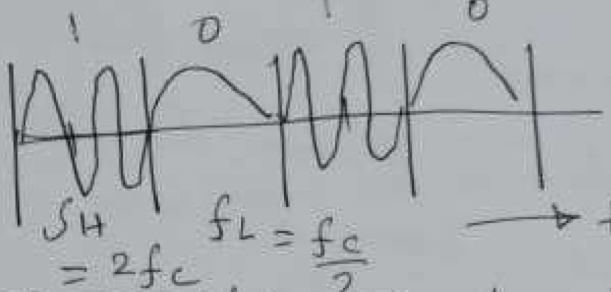
(b) suppose data = 101010



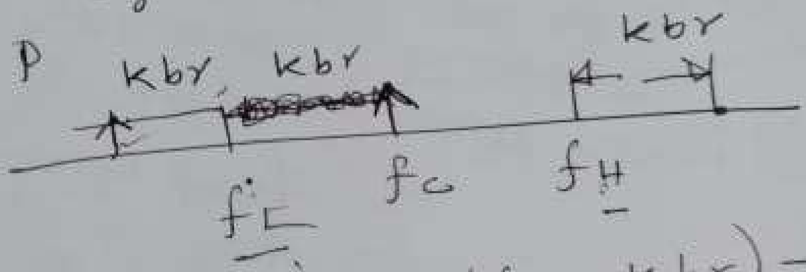
(c) Bandwidth Analysis

(b) Data = 101010...

(c)



(d) BW of channel: Above is composite analog signal



$$BW = (f_H + k_f br) - (f_L - k_f br)$$

$$= (f_H - f_L) + 2k_f br$$

$$= br + (f_H - f_L) \quad \text{Assume } \left(k_f = \tfrac{1}{2}\right)$$

$$Br_{fsk} = BW - (f_H - f_L)$$

$$= < Br_{ask}$$

is FSK is not used in digital Modulation.

(3) (a) 2 Level PSK (phase shift keying)

$f_c(t) = C \sin(2\pi f_c t + \phi_c)$

Here C and f_c constant

ϕ_c (phase of the carrier)

is changed by L0 (= 0V), L1 = 5V

phase ~~carrier~~ carrier corresponding

to ~~L0 = 0°~~

~~L1 = 180 (say)~~

(i) Phase corresponding to L0

$= \phi_c + k_p \times 0$

$= \phi_c = 0^\circ$ (say $\phi_c = 0$)

(ii) Phase corresponding to L1

$= \phi_c + k_f \times 5$

$= 0 + 180$ (by adjusting k_f)

(iii) signalling element for L0

0 phase of carrier.

(iv) signalling element for L1

180 phase of carrier

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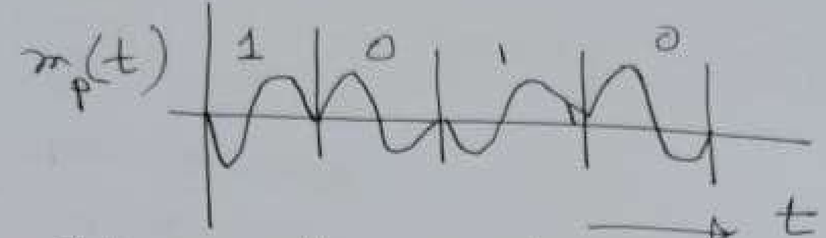
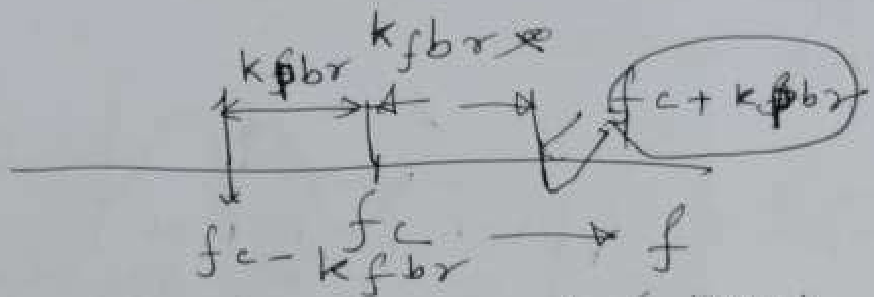
(v)

1 0 1 0 1 0 . . . . transmitted



Above is composite signal.

(20 i) BW of the channel



BW of channel (PSK)

$$= BW_{PSK} = (fc + kpbr) - (fc - kpbr)$$

$$= 2\, kp\, br$$

$$= br \quad (kp = \tfrac{1}{2})$$

like ASK.

(20 ii) Digital data rate 2 Level PSK

$$= br \times \log_2 2 \quad \text{(1 bit /baud)}$$

$$= \underline{br}$$

(viii) Multilevel PSK - 4 Level or 4-PSK.

Four phases say for bit

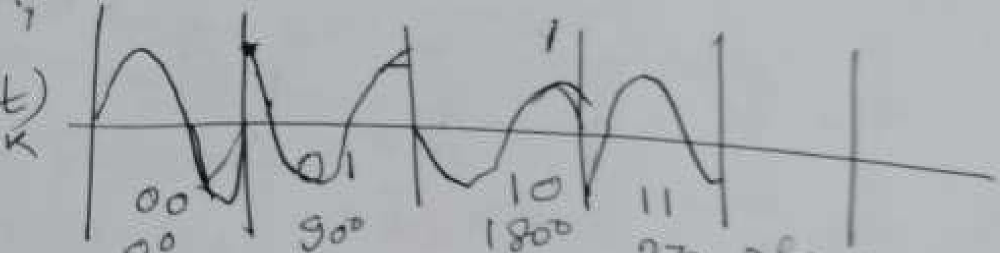
$0^\circ \Rightarrow 00$

$90^\circ \Rightarrow 01$

$180 \Rightarrow 10$

$270 \Rightarrow 11$

Suppose we require to send bit stream 0001101100...



(ix) Band width of channel will be same as 2 Level PSK as it will primarily depend on baud rate (effect of phase change for four phase level and for 4-PSK and effect of phase change for 2-PSK is negligible)

(x) Digital Data Rate PSK

$= br \times \log_2 V$

$= BH \times \log_2 V$

V = No of phase levels.

*(x) Limit of V :

Since noise does not effect Phase V_{PSK} can be much than V_{ASK}.

2- PSK ⇒ V = 2
4 - PSK ⇒ V = 4
8 - PSK
16 - PSK ⇒ Common.
⋮

(4) (i) QAM we combine ASK and PSK. to make QAM (Quardrature Amplitude Modulation)

(ii) Suppose Maximum Amplitude level for ASK for a particular noise environment $= V_A = 4$ say

(iii) Maximum phase level (depends on the phase ~~decter~~ detecter of De-Modulator)) $= V_P = 8$

(iv) $V = V_A \times V_P = 4 \times 8 = 32$ will create 32- QAM.

(v) Here assume $V_A = 2$ ($A/2$ and A)

$VP = 4$ ($P1, P2, P3, P4$)

Constellation pattern = (0, 90, 180, 270)

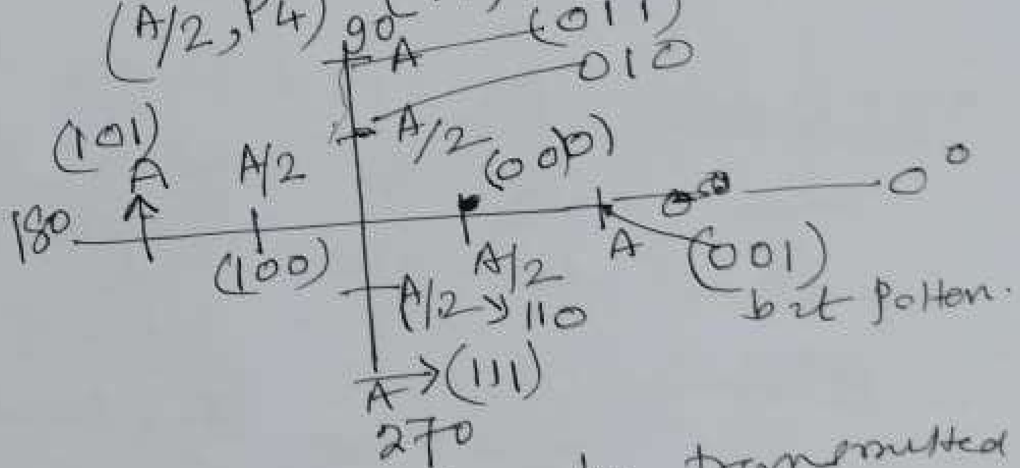
each point is denoted by ordered pair:

(A, P) ordered pair : (A/2 P2)

(A/2, P1), (A, P1), (A/2 P2)

(A, P2) (A/2, P3) (A, P3)

(A/2, P4) (A, P4)



Now 3 bits can be transmitted by one signalling element as $V = 8$

(vi) Data Rate$_{QAM}$ $= Br \times \log_2^{(VA \times VP)}$

$BW = Br$