28 Sept, 2023

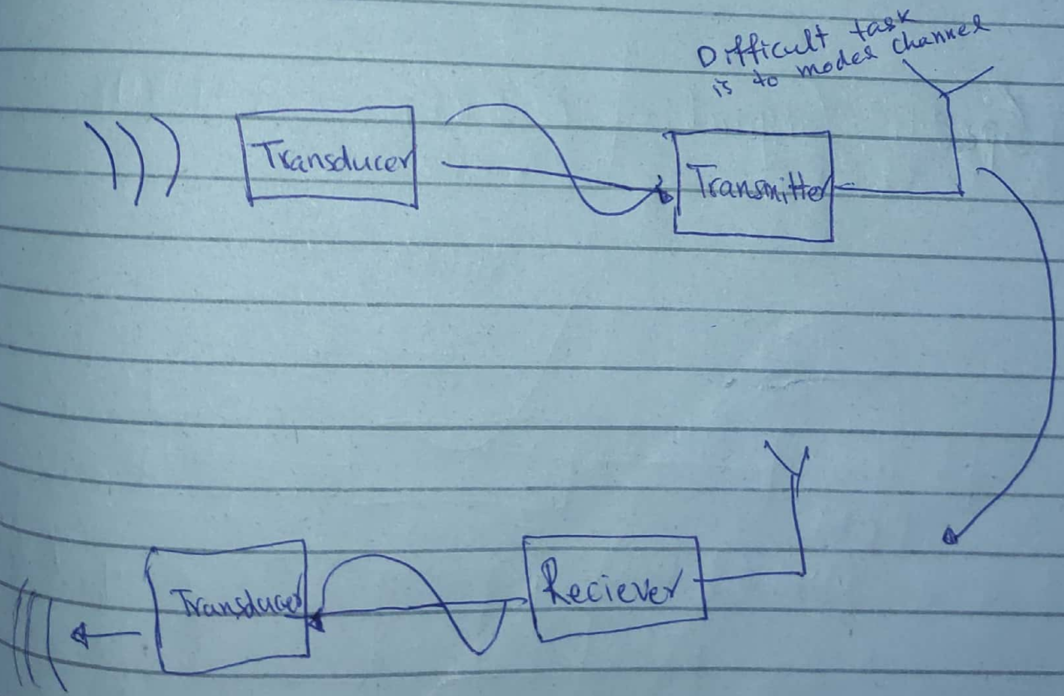
Com. Sys

Chap 4 & 5 are important

Tele Communication → Exchange of info

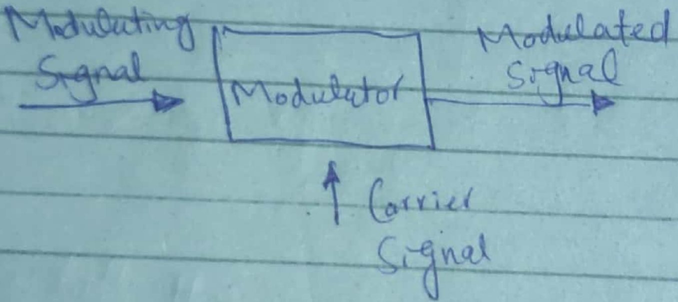
→ Exchange of messages over a long distances by using some electro-technical aid.

- Telegraphy — written
- Telephony — Audio
- Television — Visual

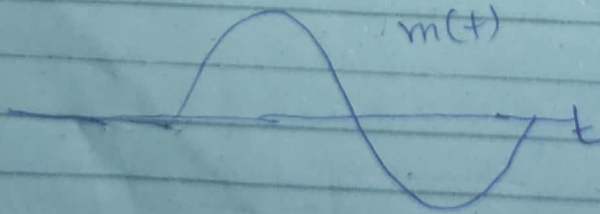


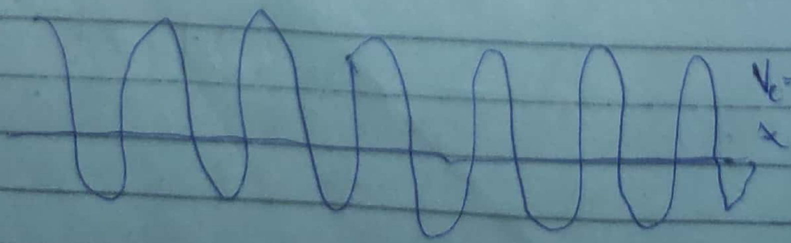
Essential part of Transmitter.

Modulator:- If we vary any attribute of the carrier signal in accordance with the instantenous value of base-band signal, the process is said to be modulation.



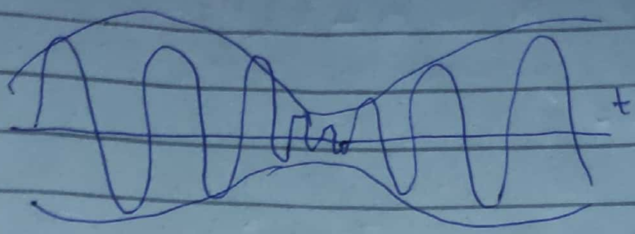
Speech Signal:- 0.3 KHz - 3.4 KHz
300 Hz





$V_c = V_c \cos(\omega_c t + \theta$

A.M chapter 4

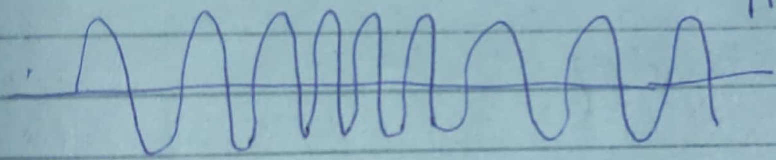


Modulated Signal

Only Ampl changed.

Now if we write amplitude in Modulator definition then it is called Amplitude Modulation.

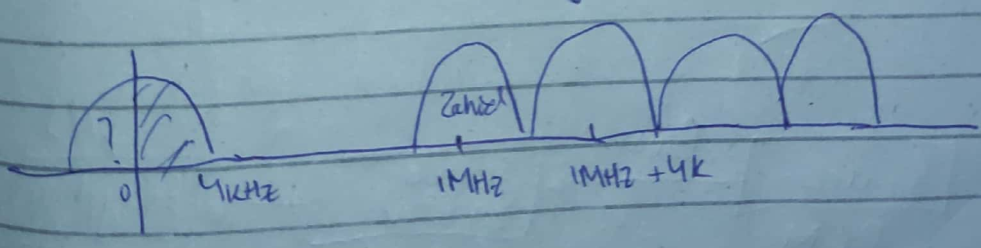
FM
Angle Modulation



This Analogue Modulation

★ Why Modulation?-

(i) Frequency Translation



(ii) Practicality of Antenna

Antenna Theory: dimensions of antenna should be comparable with wavelength of signal.

Let f is 0–4 KHz

$c = f\lambda$

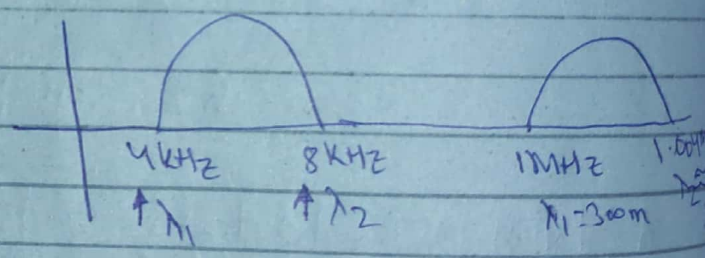
$$\lambda = \frac{c}{f} = \frac{3\times10^8}{4\times10^3} = 75\text{ km}$$

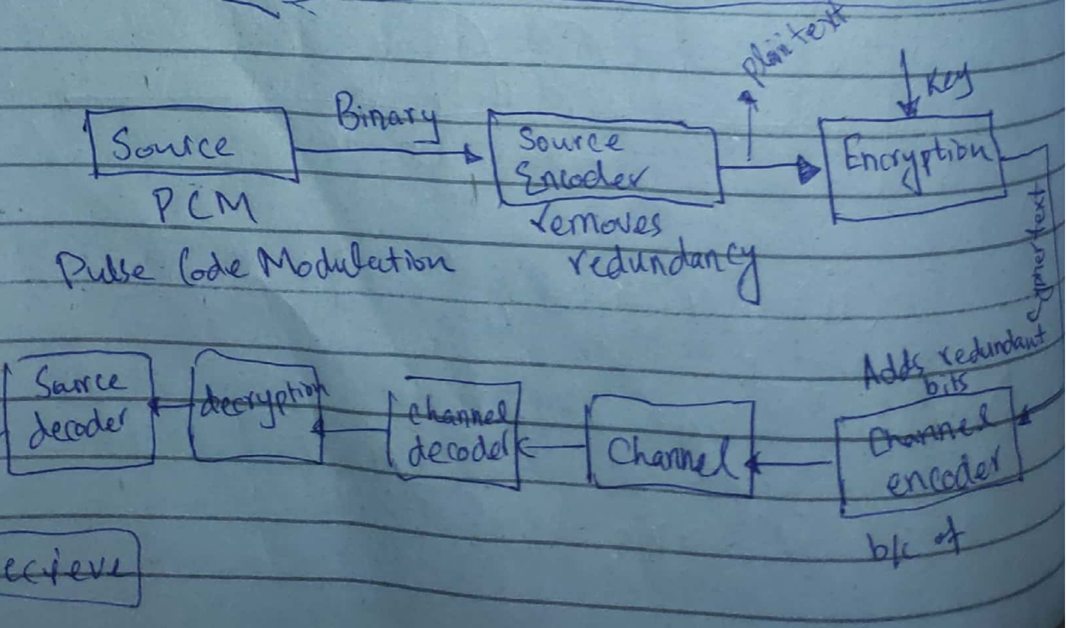
we have to decrease it, increasing f.

$$\lambda = \frac{3\times10^8 \text{ m/s}}{1\times10^6} = 3\times10^2 = 300\text{m}$$

(iii) Narrow banding

$\lambda_1 = 75$ Km
$\lambda_2 = 37.5$ Km





Date 04 Oct, 2023

	P.B
0001	1
1110	1
1100	0

Even parity has limitation. Hence, Hamming code came.

Hamming Code:-

m bits to be transmitted
k bits must be added.

m bits + k bits

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

Let $m = 8$, if $k = 4$

$$\boxed{16 \geq 13}$$

So we should add 4 extra bits

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	C_8	D_3	D_2	D_1	C_4	D_0	C_2	C_1

$C_1 = D_0 \oplus D_1 \oplus D_3 \oplus D_4 \oplus D_6$ (Exor of least significant bits)

$C_2 = D_0 \oplus D_2 \oplus D_3 \oplus D_5 \oplus D_6$

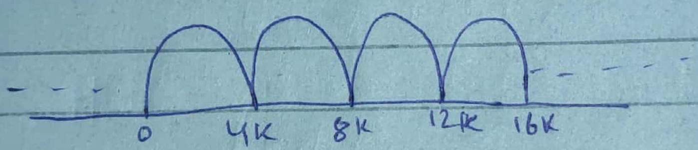
$C_4 = D_1 \oplus D_2 \oplus D_3 \oplus D_7$

$C_8 = \ldots \oplus D_7$

Let we want to transmit
1 1 1 1 1 1 1 1 → 8 bits

★ if one of the bits is containing error, then we will take EXOR of key and measured key whose answer will give us the location of parity bit.

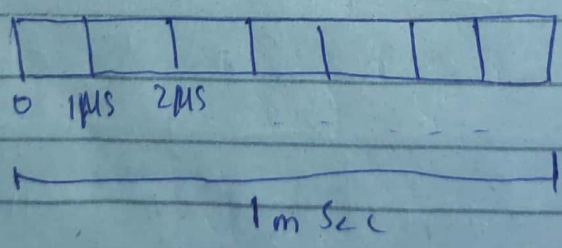
★ FDM (Frequency Division Multiplexing)



Time is compromised by band.

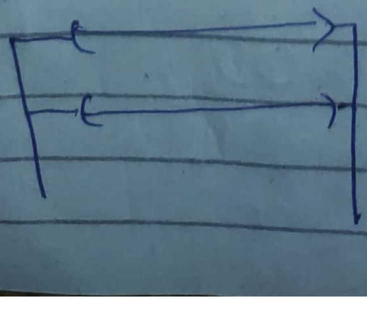
★ TDM

Different time slots



★ SDM

Distribution of space among channels



Space is divided using physical / Non-physical link

Advanced

★ FDM / FDMA → 1G Technology → Analogue Tech

GSM ★ FDM / TDMA → 2G Tech.

↳ Digital Tech.

rect ⟷ Sinc

|8|7|6|5|4|3|2|1| |8|7|6|5|4|3|2|1|

Pause for 7 μSec

★ FDM / CDMA → Code division multiple access.

→ 5MHz Bandwidth.

→ Costly

→ data rate increased

→ we give tag to each signal. to avoid confusion.

$$C_1 \qquad C_2$$

$$\frac{1}{\sqrt{4}}\begin{bmatrix}1 & 1 & 1 & 1\end{bmatrix} \quad \frac{1}{\sqrt{4}}\begin{bmatrix}-1 \\ 1 \\ -1 \\ 1\end{bmatrix}$$

$$\begin{cases} C_1 \cdot C_2^T = 0 \\ C_1 \cdot C_1^T = 1 \end{cases}$$

Code selection Criteria

$$m_1(t) \cdot c_1(t) + m_2(t) \cdot c_2(t)$$

Now we multiply $c_1(t)$ to get $m_1(t)$

21

→ Ext Noise → Multiplicative Effect

→ Internal Noise → Additive Effect like AWGN

Date 05/10/2023

★ Signal to Noise Ratio:-

$$SNR = \frac{P_s \rightarrow \text{Power of signal}}{P_n \rightarrow \text{〃 〃 Noise}}$$

$$y(t) = g(t) * h(t) + n(t)$$

★ Shannon Capacity:-

$$C = B \log_2(1 + SNR) \text{ bits/sec}$$

$$C = 1000 \log_2(1+100) \text{ bits/sec}$$

$$10 \cdot \log P_s/P_n = 10 \cdot \log 100 = 20 \cdot \log 10$$
$$= 20 \cdot dB$$

if $P = 100mW$

$$10 \cdot \log P = 10 \cdot \log 100 = 20 dBm$$

if $P = 100$ Watts

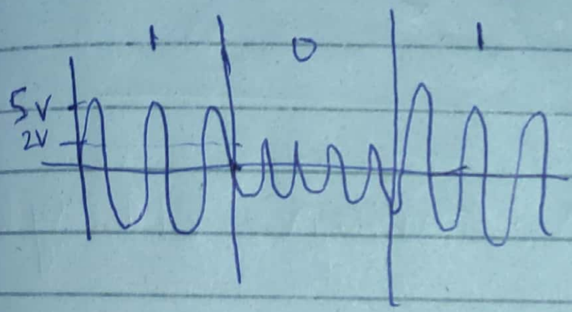
→ $100\,dBw - 50\,dBw = 50\,dB$

$$10 \cdot \log \frac{10^2}{10^5}$$

$$20\log 10 - 50 \cdot \log 10$$

→ $10\,dB + 50\,dBw = 60\,dBW$

→ $100\,dBw + 10\,dBw = 60\,dBw$



ASK

FSK

QPSK

Date 06/10/2023

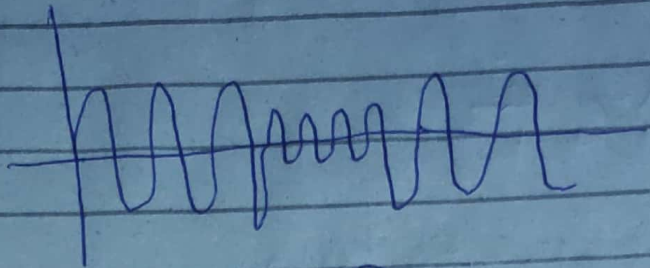
AMPS → 30KHz

$$C = B \cdot \log(1 + SNR) \quad \text{bits/sec}$$

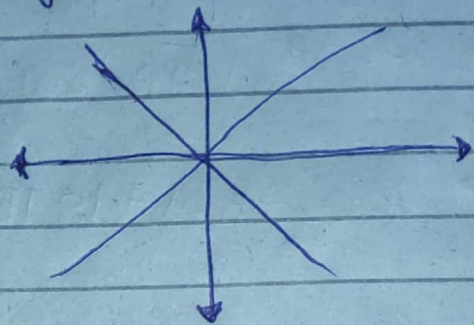
It contributes more

$$P_e = 10^{-4} = \frac{1}{10,000}$$

CDMA → 5 MHz



Constellation Diagram



★ Signal Transmission through LTI System:

$$g(t) \longrightarrow \boxed{\text{LTI}} \longrightarrow y(t)$$

$$y(t) = g(t) * h(t) + n(t)$$

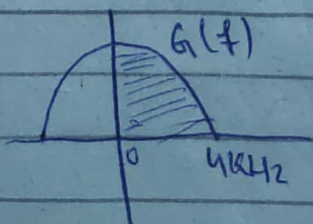
$n(t) \rightarrow$ AWGN $\rightarrow$ Internal Noise

$\hat{g}(t)$

$$h(t) = \delta(t)$$

★ Impulse Response

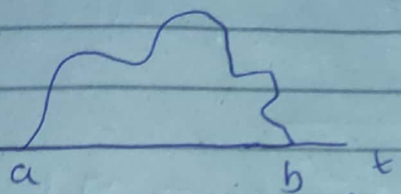
$$Y(\omega) = G(\omega) \cdot H(\omega) \quad \text{— (i)}$$

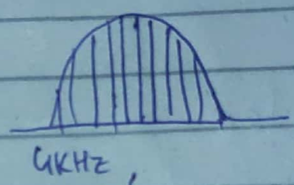


$$|Y(\omega)| \cdot e^{j\theta_y(\omega)} = |G(\omega)| \cdot e^{j \cdot \theta_g(\omega)} \cdot |H(\omega)| \cdot e^{\theta_h(\omega)}$$

$$|Y(\omega)| = |G(\omega)|\,|H(\omega)| \rightarrow \text{Amplitud Response}$$

$$\theta_{y(\omega)} = \theta_{g(\omega)} + \theta_{h(\omega)} \rightarrow \text{Phase Response}$$

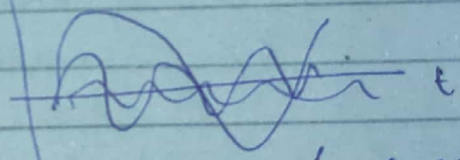




and outside a-b boundary they form zero.

↓

Marvelous Balancing Act.



many f component are added and form

★ Distortion less transmission.

If any of response (Amp or Phase) is not ideal then signal will be distorted.

So we do trade off on it b/w

→ ear is insensitive to phase response of speech signal.

→ In terms of video signal, it is opposite. i.e eye is more sensitive to phase response.

0.01 — 0.1 sec Average Speech syllable

→ Digital Comm. is very much sensitive to phase response.

Now Let

$$y(t) = k \cdot g(t - t_d)$$

it is distortionless if all the components are delayed by same amount.

Now $g(t-t_d) \Longleftrightarrow G(\omega) . e^{-j\omega t_d}$

$$Y(\omega) = k . G(\omega) . e^{-j\omega t_d} \quad \text{— (ii)}$$

Compare with (i)

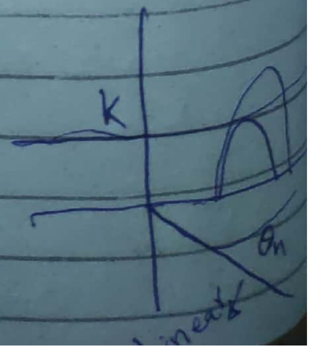
$$\cancel{G(\omega)} . H(\omega) = k . \cancel{G(\omega)} . e^{-j\omega t_d}$$

$$H(\omega) = k . e^{-j\omega t_d}$$

$$|H(\omega)| = k$$

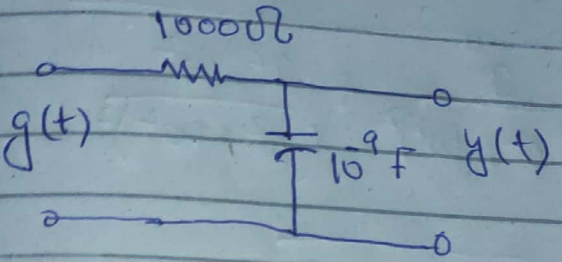
$$\theta_h(\omega) = -\omega . t_d$$

$$y = mx + c$$



Now $\frac{d.\,\theta_n(\omega)}{d\omega} = -t_d$

't_d' is constant for all $\phi\,\omega$.



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

$$\frac{Y(\omega)}{G(\omega)} = \left[\frac{1/j\omega C}{R + 1/j\omega C}\right] = H(\omega)$$

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

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

Let $a = RC$

$$H(\omega) = \frac{a}{a+j\omega} \times \frac{a-j\omega}{a-j\omega} = \frac{a^2}{a^2+\omega^2} - j\frac{a\omega}{a^2+\omega^2}$$

$$|H(\omega)| = \sqrt{\left(\frac{a^2}{a^2+\omega^2}\right)^2 + \left(-\frac{a\omega}{a^2+\omega^2}\right)^2}$$

$$\text{"} = \sqrt{\frac{a^4}{(a^2+\omega^2)^2} + \frac{a^2 \cdot \omega^2}{(a^2+\omega^2)^2}}$$

$$\text{"} = \sqrt{\frac{a^4+a^2\omega^2}{(a^2+\omega^2)^2}} = \frac{a\left(\sqrt{a^2+\omega^2}\right)}{(a^2+\omega^2)}$$

$$\text{"} = \cancel{\frac{\sqrt{a^2(a^2+\omega^2)}}{a^2+\omega^2}} \quad \cancel{a}$$

$$\text{"} = \frac{a}{\sqrt{a^2+\omega^2}}$$

$$\theta_n(\omega) = \tan^{-1}\left(\qquad \right) = \omega/a$$