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LECTURE # 02

Introduction to Communication Systems Contd.

(Reference : Principles of Comm Systems by Taub & Schilling)

1.3 Two Major Classification of Communication Systems

- Analog Communication
- Digital Communication

1.3.1 Analog Communication : The electrical signal (message) that has to be communicated to the Rx are Analog in nature ie continously varying with time. (See Fig 1.3.a)

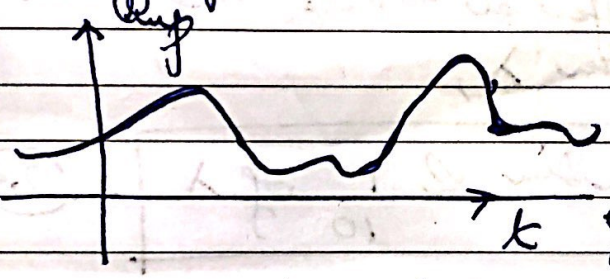


Fig 1.3.a : An Analog Signal.

e.g. Video, Speech, temp Variation with time are Analog in Nature.

1.3.2 Digital Communication : The electrical signal (message) that has to be communicated assumes discrete amplitudes from a finite set of values at discrete instant of times (See Figure 1.3.b).

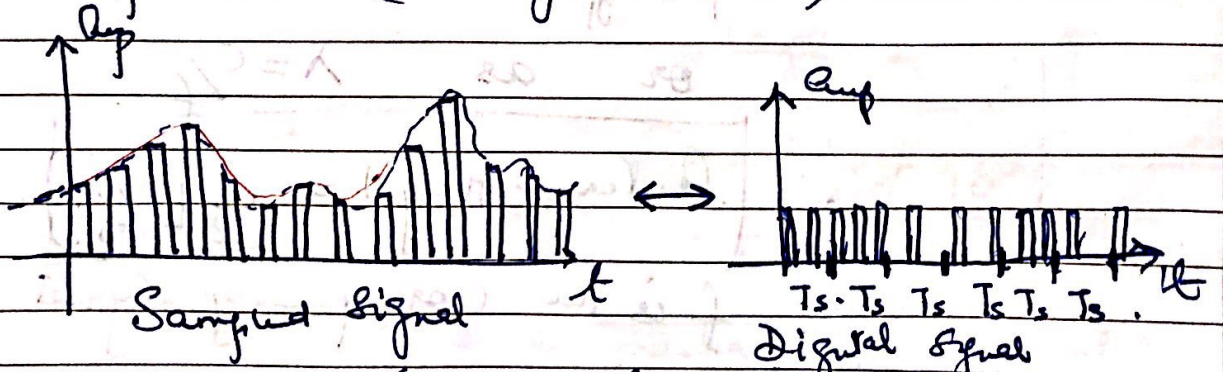


Fig 1.3.b : Digital Communication example - Ts → Sample time

e.g Text, data are primarily digital in nature

(PTO)

1.4. Need for Modulation in Communication System

There are several reasons for using modulation techniques in the process of signal transmission from the Tx to the Rx:-
- Practical Considerations.
- TDM & FDM possible

1.4.1 Practical Considerations:

In general for wireless communication (through atmosphere) the antenna dia should be approximately 1/10th of signal wavelength for effective signal radiation.

ie for effective signal radiation of signal wavelength λ,

$$\text{Antenna Dia} \simeq \frac{1}{10} \text{ of } \lambda \quad \text{--- (2.a)}$$

or

$$\text{Antenna Height} \simeq \frac{\lambda}{10} \quad \text{(2.b)}$$

for Effective radiation.

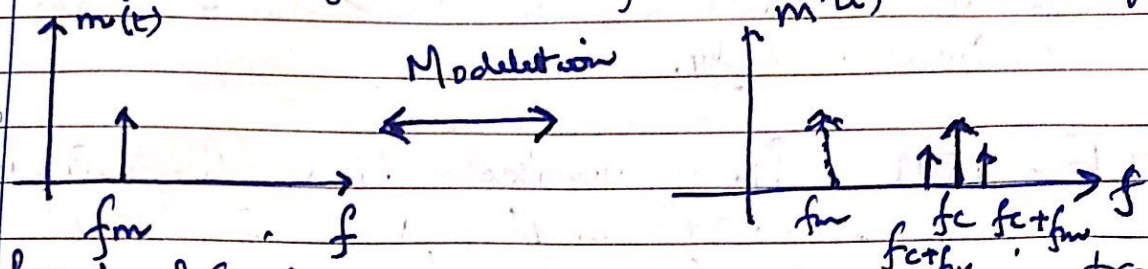
or as $\lambda = c/f$.

$$\therefore \text{Antenna Height} = \frac{1}{10}\left[\frac{c}{f}\right] \quad \text{2.c}$$

Where f is the corresponding signal frequency.

From above expressions it is clear that

if Signal frequency is small then required Antenna height shall be large & vice-versa. Now modulation translates the baseband message signal m(t) from low frequency to high frequency. Thus the frequency translated baseband signal shall require small Antenna size (Height) for effective transmission (see Fig 1.4).



Baseband signal
Freq low
⇒ Large Antenna Height required

Frequency translated signal at high frequency position around carrier fc.

∵ fc >> fm, ∴ Antenna Height required is very small comparatively.

Fig 1.4(a): Before Frequency Translation

f_m → Small

∴ Antenna Size ≈ $\frac{1}{10}\frac{c}{f_m}$ is large

Fig 1.4(b) After frequency translation or modulation

f_c → large (>> f_m)

∴ Antenna Size ≈ $\frac{1}{10}\frac{c}{f_c}$ is small

Conclusion: Modulation is a mechanism to translate original baseband signal (at fm) to a very high frequency (fc) to reduce the required antenna size.

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1.4.2 TDM & FDM possible

Typically original baseband signal occupies lower baseband frequency range ie

Speech signal frequency range ≈ 0.3Hz to 3.4KHz

Multiplexing techniques enable the simultaneous transmission of two or more signals over same channel simultaneously.

1.4.2.1 For TDM → Time Division Mux (Refer Fig 1.2.a on page no. 04) employed for digital signal, Here multiplexing can be achieved by dividing the time between two samples of signals in various time slots and use each time slot to send one signal pulse after the other successively. Fig 1.2.a on pg 04 shows example of 2-Signal TDM. Fig 1.5.a below gives example of 3-Signal TDM where all signal occupy same frequency band of 0.3Hz to 3.4KHz.

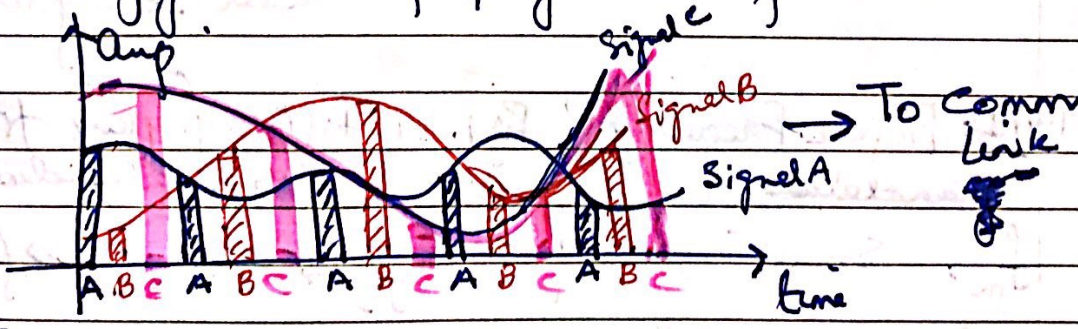

Fig 1.5.a 3-Signal TDM ready to be quantized for Digital communication.

1.4.2.2 For FDM - Frequency Division Multiplexing

Let three messages be required to be sent over same communication channel by FDM. Since all these signals occupy same band of 0.3 Hz to 3.4 KHz, there will interfere on the link.

To avoid this interference, FDM is employed to enable the simultaneous transmission over the same comm link. e.g one signal is placed / frequency translated around f_1 carrier, second signal is placed / frequency translated around f_2 carrier & third signal is placed / frequency translated around f_3 carrier.

where f_3 Carrier > f_2 Carr > f_1 carrier.

See fig 1.5.b as an example of 3-signal FDM whereas fig 1.2.b on pg. 04 is an example of 2-signal FDM.

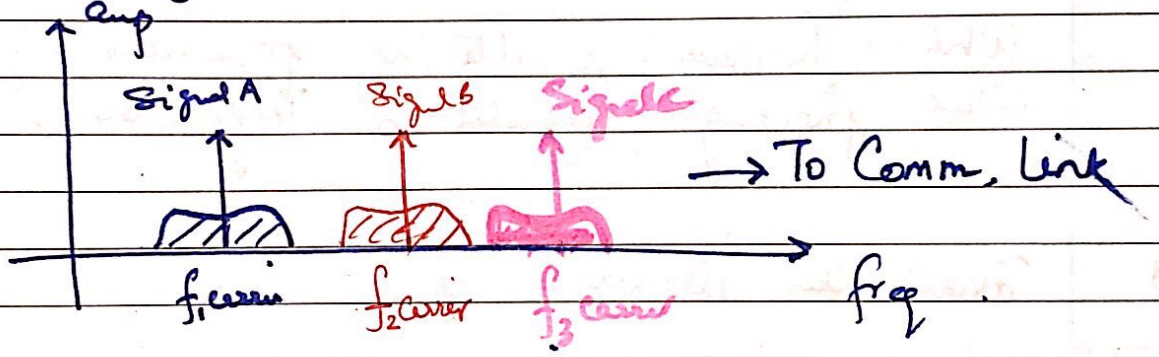

Fig 1.5.b - Three signal after FDM can be sent simultaneously on same comm. link with no interference!

(P.T.O)

Q.7. Calculate the antenna dia required to efficiently radiate a signal of frequency

(i) Signal A freq = 4 kHz

(ii) Signal B freq = 1 GHz.

[Hint: Signal A dia req $\simeq \frac{1}{10}\frac{c}{4000}$]

[Signal B dia req $\simeq \frac{1}{10}\frac{c}{1\,GHz}$]

$c = 3 \times 10^8$ m/s.

Which frequency results in practical size & which frequency results in impractical size.

Q.8. Draw an illustration of

(i) TDM → 4 signals are multiplexed

(ii) FDM → 4 signals are multiplexed.