/ / التاريخ

14\10\2012
Lecture 3

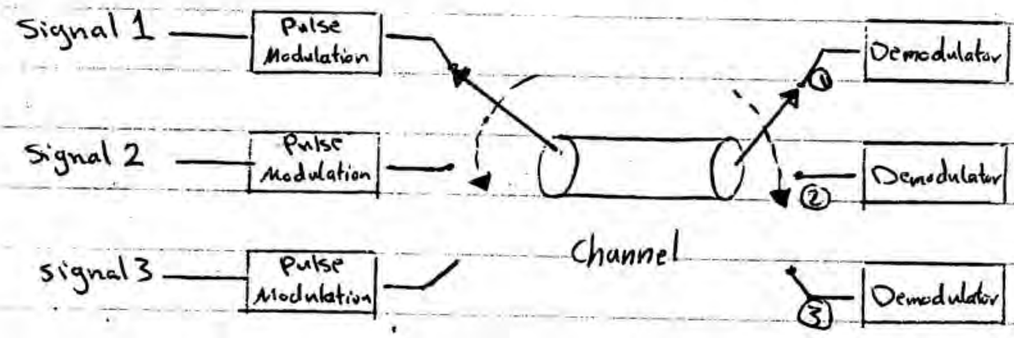
1.4 Time division Multiplexing (TDM) :-

Each signal is transmitted sequentially. The same carrier is used to transmitt each signal sequentially, one after another. A time slot is alloted to a signal.

TDM is more practical than FDM since FDM needs more sub carriers, therefore; additioned circutry is requiered at tx and Rx, the band width required is high and proportion with Number of channels. Generation of PWM

Freq of Saw tooth > from freq of sine wave

These problems are eliminated using TDM and pulse modulation



"block diagram TDM system"

at Tx : A rotating switch which is realized Electronically Connects the o/p each channel Modulator to the communication channel input in trarn كل واحد دورة

In TDM, each signal is transmitted for only a short period of time

Signal ①	Signal ②	signal ③	Signal ①

أي إشارة signal (مجموعة من) one frame → t

Time fram

- Each signal of the signals above is allowed to use the channel for afixed time interval called "time slot"

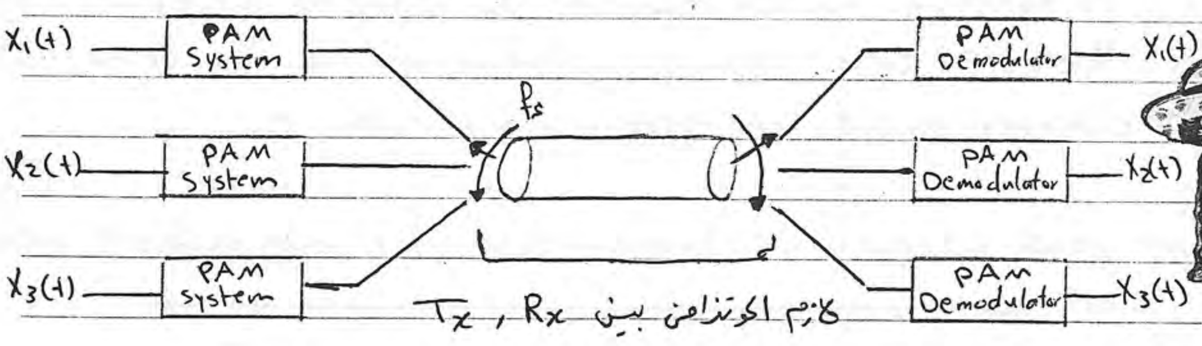
- one transmission of the signals completes one complets one cycle of operation called "frame"

at Rx: The Switch connects the channel with the corresponding demodulator the system needs absolute synchronization

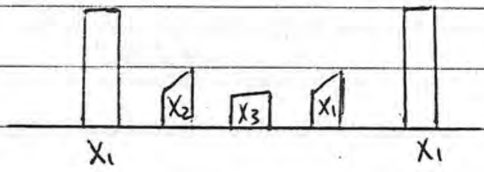
PAM / TDM system :-

The free space between pulses is occupied by pulses from other channels.

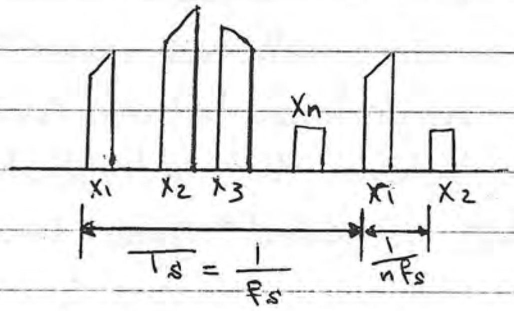
The fig below the block diagram of N PAM channels. The rotating switch rotates at "f_s" for synchronized TDM.
Note: f_s equal at each signals



PAM / TDM block diagram



راح نفرز الجزء من اشارة واحدة ولكن بوقت واحد



If the highest frequency present in all the channels is (W) then

$$f_s \geq 2W$$

$$T_s \leq \frac{1}{2W}$$

let N input channel then in each from there will be one Sample from each of the N-channels. This means that one frame of T_s seconds contain total of N Samples

$$\text{Spacing between two Samples} = \frac{T_s}{N}$$

$$\text{No. of pulses per Second} = \frac{1}{\text{spacing between two pulses}} = \frac{1}{\frac{T_s}{N}}$$

$$= \frac{N}{T_s} = N f_s$$

This is also called signalling rate (r)

$$\boxed{r = N f_s}$$

The minimum transmission bandwidth of TDM channel

$$\boxed{BT = NW}$$

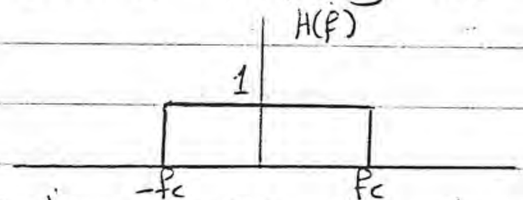
Crosstalk and Guard Time

The individual Signal Sample amplitudes interfere with each other. This interference can be reduced by increasing the distance between Samples of the signal. The min. distance between the individual Signal —— Samples to avoid crosstalk is called "guard time"

The min. channel Bandwidth to avoid cross talk :-

$$\boxed{f_c = N f_m}$$ → أعلى تردد

To prove the relation :- let us assume a channel has c/s of an ideal L.P.F with cut-off frequency and unity gain with no delay



If the i/p of the transmission channel are impulses, these impulses are passed through the channel.

Then the o/p is impulse responce

$|H(f)| = 1$ over $-f_c \le f \le f_c$

The impulse responce of the transmission_channel

$h(t) = I.F.T\ |H(f)|$

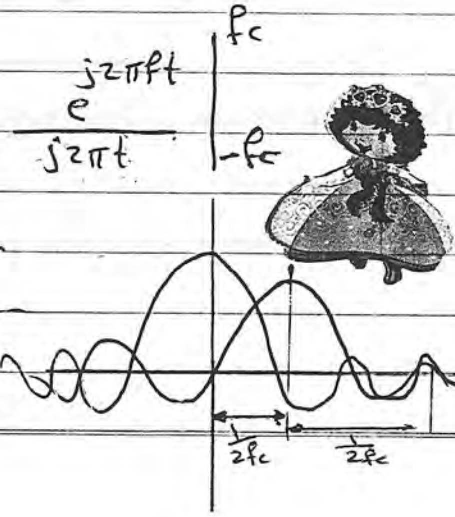
$y(t) = h(t) = I.F.T\ [H(f)]$

$= \int_{-\infty}^{\infty} H(f)\, e^{j2\pi f t}\, df = \left. \frac{e^{j2\pi f t}}{j2\pi t} \right|_{-f_c}^{f_c}$

$= 2f_c * \text{sinc}(2f_c t)$

$2f_c = \mp 1, \mp 2, \mp 3, \mp 4, ---$

$t = \frac{\mp 1}{2f_c}, \frac{\mp 2}{2f_c}, \frac{\mp 3}{2f_c}, ---$



$\therefore \frac{1}{2f_c} = \frac{1}{2Nf_m} \Rightarrow \boxed{f_c = Nf_m}$

Ex// Three independent Massage Signals of Bandwidth 1KHZ, 1KHZ, 2KHZ respectively are to be Transmitted Using TDM scheme Determine:-

1. Speed of the commutator if all the signals are sampled at it's Nyquist rate?

2. BT , 3. Draw the commutator arrangement?

Sol:- $f_{s_1} = 2KHZ$, $f_{s_2} = 2KHZ$, $f_{s_3} = 4KHZ$

Total No. of Samples $= 2 + 2 + 4$

$= 8$ K sample/sec

Since f_{s_3} is twice the first and second signals

No. of Commutator segments $= 4$

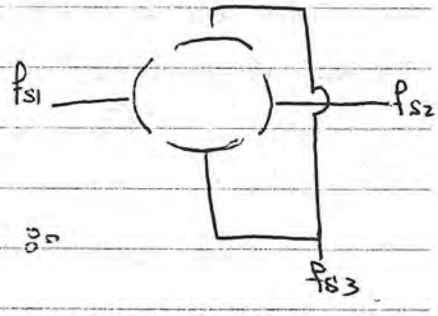
speed of the Commutator $= \frac{8K \text{ samples/sec}}{4}$

$= 2000$ rotation/sec

$B_T = N W$

$= W_1 + W_2 + W_3$

$= 1 + 1 + 2 = 4000 HZ$



Synchronization in TDM systems:-

Rx should operate in synchronization with Tx. In TDM Markers are inserted to indicate seperation between frames.