16/1/18 Subject - Code - 303 (Advance Communication System)

II - Test

Q1.) Explain the Concept of Information in "Information Theory"?

Q2). Explain the Concept of "Entropy"?

Q3). What is multiplexing? Explain Time division multiplexing?

Solutions

Ans: 01) Information :-

Let us consider a communication system in which the Allowable messages are $m_1, m_2 ---- m_n$, with Probabilities of occurance $P_1, P_2 --- P_m$

$$P_1 + P_2 + ----- + P_m = 1 \quad — (1)$$

If Probability of occurance of a symbol is $P[x_i]$ then information associated with that symbol is;

$$I[x_i] \propto \frac{1}{P[x_i]} \quad — (2)$$

$$I[x_i] = \log_b \left[\frac{1}{P(x_i)}\right]$$

$$I[x_i] = -\log_b (P(x_i)) \quad — (3)$$

unit of the Information depends upon the Base (b) of log.

Base (b)	unit
2	bit
e	nat
10	decit

· If the Probability of occurance of a symbol is high, then information associated with it will be less and vice versa.

Properties of $I(x_i)$:-

(a). The Information contained by a symbol x_i, denoted by $I(x_i)$ satisfies the following Properties -

1. $\boxed{I(x_i)=0}$; if $\boxed{P(x_i)=1}$

   • A certain Event Conveys zero Information.

2. $\boxed{I(x_i)\geq 0}$; Information can not be negative.

3. $\boxed{I(x_i) > I(x_j)}$ if $\boxed{P(x_i) < P(x_j)}$

   Events having more certainity contains less Information.

Q2) What is the Concept of "Entropy"?

Ans):- Entropy:-

Entropy tells that how many bits of Information is contained by each symbol.

unit of Entropy is $\Rightarrow$ (Bits/symbol)

$$\text{Entropy } H = \sum_i I(x_i) \cdot P[x_i] \text{ bits/symbol.} \quad \text{—①}$$

we know that $I[x_i] = \log_2\left[\frac{1}{P(x_i)}\right]$ bits —②.

$$\Rightarrow H = \sum_i P[x_i] \cdot \log_2\left(\frac{1}{P(x_i)}\right]$$

$$\Rightarrow \boxed{H = -\sum_i P(x_i) \cdot \log_2\left[P(x_i)\right]} \text{ Bits/symbol.}$$

Case(A)

Tr. — $x_1 x_2 x_1 x_2 \ldots$ Tr. is transmitting two symbols.

(1). Let $P(x_1) = P(x_2) = \frac{1}{2}$

$$\Rightarrow H = \sum_{i=1}^{2} P(x_i) \cdot \log_2\left(\frac{1}{P(x_i)}\right]$$

$$H = \frac{1}{2}\log_2(2) + \frac{1}{2}\log_2(2)$$

$$\Rightarrow \boxed{H = 1} \text{ bits/symbol}$$

(ii) $P(x_1)=1$; $P(x_2)=0$ it means Tr. is only transmitting symbol x_1 and not x_2

$$H=\sum_{i=1}^{2} P(x_i)\cdot\log_2\left[\frac{1}{P(x_i)}\right]$$

$$H=-\sum_{i=1}^{2} P(x_i)\cdot\log_2[P(x_i)]$$

$$H=-1\cdot\log_2(1)+0\cdot\log_2(0)$$

$$\Rightarrow \boxed{H=0} \text{ bits/symbol}$$

Case (B):- Transmitter is transmitting three symbols-

① Let $P(x_1)=P(x_2)=P(x_3)=\frac{1}{3}$

$$H=\sum_{i=1}^{3} P(x_i)\cdot\log_2\left(\frac{1}{P(x_i)}\right]$$

$$H=\frac{1}{3}\cdot\log_2(3)+\frac{1}{3}\cdot\log_2(3)+\frac{1}{3}\log_2(3)$$

$$\Rightarrow \boxed{H=\log_2 3} \text{ bits/symbol}$$

②. $P(x_1)=1$; $P(x_2)=P(x_3)=0$

$$\Rightarrow \boxed{H=0} \text{ bits/symbol.}$$

③. $P(x_1)=\frac{1}{2}$; $P(x_2)=\frac{1}{2}$; $P(x_3)=0$

$$\Rightarrow H=\frac{1}{2}\cdot\log_2(2)+\frac{1}{2}\log_2(2)+0$$

$$\Rightarrow \boxed{H=1} \text{ Bits/symbol}$$

Generalised Case:-

Let Transmitter is transmitting m such symbols such that

$$P(x_1)=P(x_2)=\text{-----}\ P(x_m)=\frac{1}{m}$$

$$H=\frac{1}{m}\cdot\log_2 m+\frac{1}{m}\cdot\log_2 m+\text{------ m times}$$

$$\boxed{H=\log_2 m} \text{ Bits/symbol.}$$

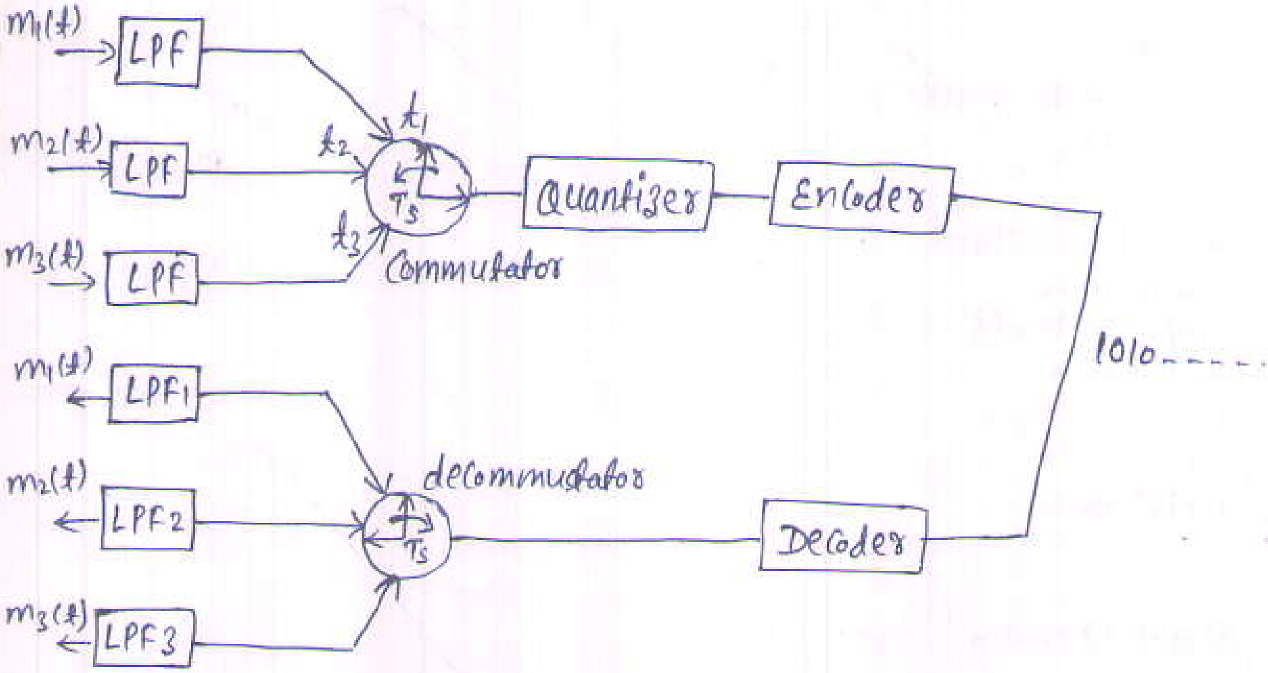
Q3). What is multiplexing? Explain Time division multiplexing (TDM)?

Sol). multiplexing:-

multiplexing is the process of transmitting multiple number of signals through a single channel at the same time.

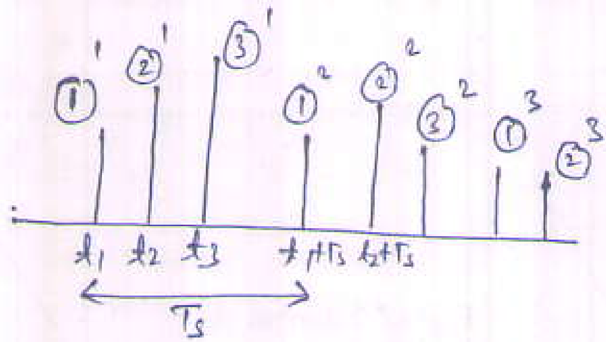
Time division multiplexing (TDM) :-

· TDM is used to multiplex digital signals.



1. Low pass filter are used as Anti-Aliasing filter.
2. Commutator is a Rotating switch which rotates in Anti-Clockwise direction with uniform speed.
3. Time taken by Commutator to make one complete rotation is Identified as "frame time" (T_s).
4. Commutator is used to sample multiple no. of Continuous signals.

Commutator o/p.



Let No. of signals multiplexed = N

no. of bits required to represent each sample = n

$$\boxed{T_s = N \cdot n \cdot T_b}$$ $T_b \rightarrow$ Pulse width.

$$\Rightarrow \boxed{T_b = \frac{T_s}{N \cdot n}} \text{ sec.}$$

Bit Rate $R_b = \frac{1}{T_b}$

$$\Rightarrow \boxed{R_b = N \cdot n \cdot f_s}$$