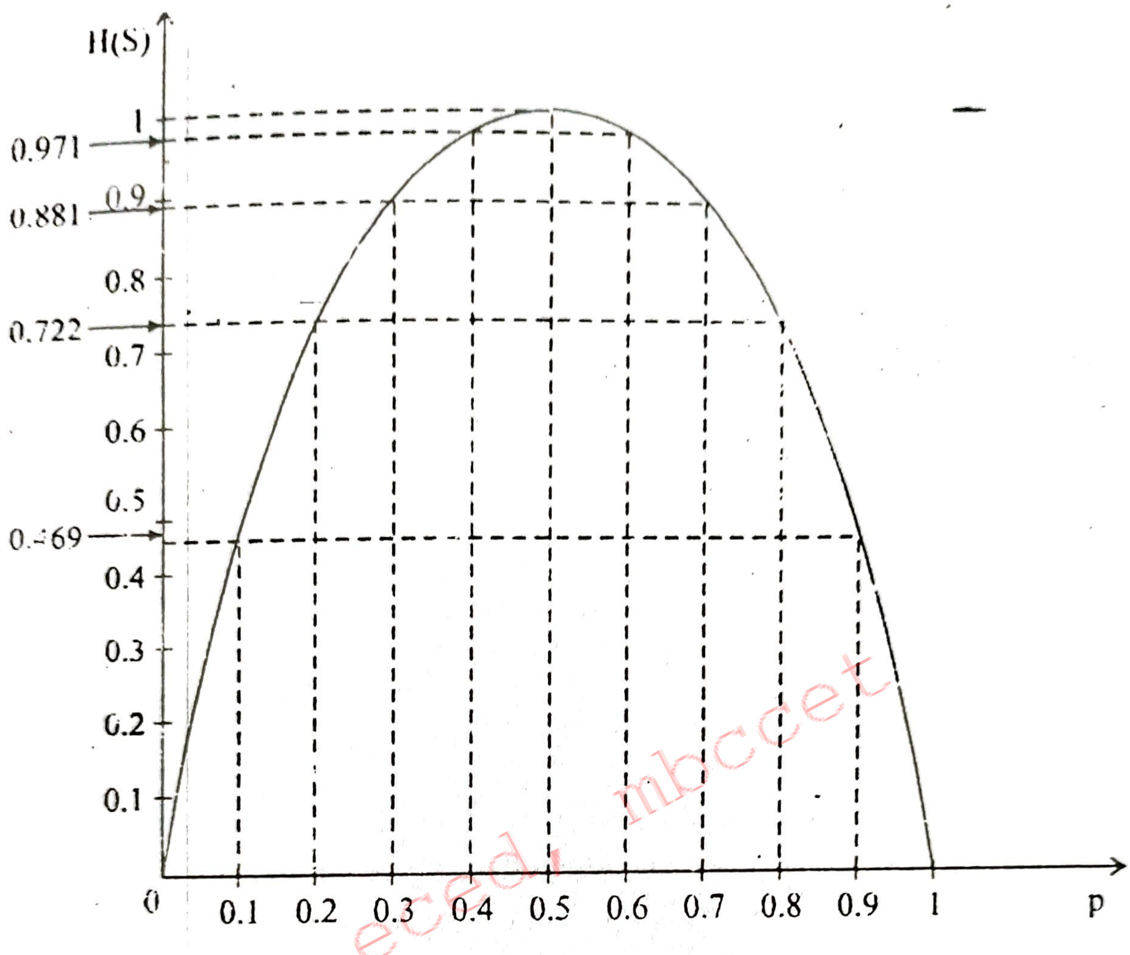

Fig. 1.2 : Plot of H(S) versus p of example 1.14

From all the three cases we have to seen, entropy is less when uncertainity is less and more when uncertainity is more. So we can say that,

"Entropy is a measure of uncertainity."

RATE OF INFORMATION (R)

If a source generates msgs at the rate of 'r' msgs per second.

The rate of information is defined as the average number of bits of information per second.

Rate of information ; $\boxed{R = r \cdot H \text{ bits/sec.}}$

where H is the Avg number of bits of information per msg.

Consider two sources of equal entropy H, generating r_1 and r_2 msgs/sec respectively. First source will transmit information at a rate $R_1 = r_1 H$ and second at a rate $R_2 = r_2 H$.

If $r_1 > r_2$, Then $R_1 > R_2$. ie In a given period, more information is transmitted from first source than second. ie the source is not described only by its entropy, also by its rate of information.

R $\longrightarrow$ bits/sec (entropy in bits/sec).

H $\longrightarrow$ bits/msg (entropy in bits/msg).

Q.4. An event has six possible outcomes;

$$X = \begin{cases} a & \text{where } p_1 = 1/2 \\ b & \quad " \quad p_2 = 1/4 \\ c & \quad " \quad p_3 = 1/8 \\ d & \quad " \quad p_4 = 1/16 \\ e & \quad " \quad p_5 = 1/32 \\ f & \quad " \quad p_6 = 1/32 \end{cases}$$

Find the entropy? Also find the rate of information if there are 16 out comes per second.

Sol: $H = -\sum_{k=1}^{6} p_k \log p_k$

$= -\left[\frac{1}{2}\log\frac{1}{2} + \frac{1}{4}\log\frac{1}{4} + \frac{1}{8}\log\frac{1}{8} + \frac{1}{16}\log\frac{1}{16} + \frac{1}{32}\log\frac{1}{32} + \frac{1}{32}\log\frac{1}{32}\right]$

$= \frac{31}{16}$ bits/msg.

Given $r = 16$ msg/sec

Rate of information ; $R = r \cdot H$

$= 16 \times \frac{31}{16} = 31$ bits/sec

Q5. A continuous signal is band limited to 5 kHz. The signal is quantized to 8 levels of a PCM system with probabilities 0.25, 0.2, 0.2, 0.1, 0.1, 0.05, 0.05, 0.05. Calculate the entropy and rate of information ?

Sol: Entropy ; $H = -\sum_{k=1}^{8} p_k \log p_k$ (Consider each quantized level as a msg)

$= -[0.25 \log 0.25 + 2\times 0.2 \log 0.2 + 2\times 0.1 \log 0.1 + 3\times 0.05 \log 0.05]$

$= 2.74$ bits/msg.

Given $f_m = 5$ kHz.

Signal ~~obtained~~ should be sampled at a freq,

$f_s = 2 f_m$

$= 2\times 5$ kHz $= 10$ kHz (sampling theorem).

As sampling freq, $f_s = 10$ kHz

$= 10,000$ Hz,

Then the msg rate, $r = 10,000$ msg/sec.

Rate of information, $R = r \cdot H$

$= 10000 \times 2.74$

$= 27,400$ bits/sec.