PART-A (WITH ANSWERS)

1. Define lossless channel.

The channel described by a channel matrix with only one nonzero element in each column is called a lossless channel. In the lossless channel no sources information is lost in transmission.

2. Define Deterministic channel

A channel described by a channel matrix with only one nonzero element in each row is called a deterministic channel and this element must be unity.

3. Define noiseless channel.

A channel is called noiseless if it is both lossless and deterministic. The channel matrix has only one element in each row and in each column and this element is unity. The input and output alphabets are of the same size.

4. Explain Shannon-Fano coding.

An efficient code can be obtained by the following simple procedure, known as Shannon- Fano algorthim.

1) Arrange the source messages such as the probabilities are in the descending order

2) Divide the list of messages into two (*Q*) subsets as balanced as possible, in the sense of the sum of elementary probabilities messages.

3) Assign respectively the symbol "0" and "1", (up to ... *Q-1*) to the first and second(*up to Q-1*) subsets (rootdivided into Q = 2 branches)

4) Repeat the steps 2) 3) with each subset (nodes divided into 2 (or Q) new branches) until that the operation becomes impossible (then each message has become a corresponding code-word left on the tree).

5.Define entropy.

It is defined as the process of producing average information per individual message in a particular interval

$H(S) = \sum_{k=1}^{K} p_k L \log_2 \left[\frac{1}{p_k}\right]$ Bits/sample.

6.Define mutual information.

Mutual information I(X,Y) of a channel is defined by

I(X,Y)=H(X)-H(X/Y) bits/symbol

H(X)- entropy of the source

H(X/Y)- conditional entropy of Y.

7.State the properties of mutual information.

1. I(X,Y)=I(Y,X)
2. I(X,Y)>=0
3. I(X,Y)=H(Y)-H(Y/X)

4. I(X,Y)=H(X)+H(Y)-H(X,Y).

8.Give the relation between the different entropies.

H(X,Y)=H(X)+H(Y/X)
=H(Y)+H(X/Y)
H(X)- entropy of the source(Y/X),H(X/Y)-conditional entropy
H(Y)-entropy of destination
H(X,Y)- Joint entropy of the source and destination

9.Define information rate.

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

$R = rH$ 5.18

Where R is the rate at which messages generated from the source .
H is the average number of bits of information per message (ie) Entropy
and r is the average message generated from the source
.

10.What is data compaction?

For efficient signal transmission the redundant information must be removed from the signal prior to transmission .This information with no loss of information is ordinarily performed on a signal in digital form and is referred to as data compaction or lossless data compression.

11.State the property of entropy.

a) For sure event or impossible event entropy is zero.
b) For M number of equally likely symbols, entropy is log 2 M
c) Upper bound on entropy is H max = log 2 M
d) Entropy is lower bound on average number of bits per symbol.

12.What is differential entropy?

The average amount of information per sample value of x(t) is measured by
H(X)= $\int_{-\infty}^{\infty} fx(x) \log fx(x)\, dx$ bit/sample
H(X) –differential entropy of X.

13. What is the channel capacity of a discrete signal?

It is defined as the maximum mutual information $I(X;Y)$ in any single use of the channel, where the maximization is over all possible input probability distributions $\{p(x_j)\}$ on X.

Where C is measured in bits per channel use or bits per transmission
$C = \max_{\{p(x_j)\}} I(X;Y)$

14. What is source coding and entropy coding?

A conversion of the output of a DMS into a sequence of binary symbols is called source coding. The design of a variable length code such that its average cod word length approaches the entropy of the DMS is often referred to as entropy coding.

15.State Shannon Hartley theorem.

It is defined as the maximum of mutual information between the channel input X_k and channel output Y_k over all possible distributions on the input X_k that satisfy the power constraint $E[X_k^2]=P$

Information capacity can be expressed as

$$C = Blog_2\left[1+\frac{P}{N_oB}\right]\text{bits/sec}$$

$$C = Blog_2\left[1+\frac{S}{N}\right]\text{bits/sec}$$

It ha s three important parameters

(i) Channel bandwidth
(ii) Average transmitted power
(iii) Noise power spectral density at the output

16.How is the efficiency of the coding technique measured?

Efficiency of the code =H(X) /L
H(X) is entropy
L= average code word length .

17.What happens when the number of coding alphabet increases?

When the number of coding alphabet increases the efficiency of the coding technique decreases.

18.What is channel diagram and channel matrix?

The transition probability diagram of the channel is called the channel diagram and its matrix representation is called the channel matrix.

19.What is information theory?

Information theory deals with the mathematical modeling and analysis of a communication system rather than with physical sources and physical channels

20.What is the channel capacity of a BSC and BEC?

For BSC the channel capacity C=1+plog2 p +(1-p)log2(1-p).
For BEC the channel capacity C=(1-p)

PART-B (16 Marks)