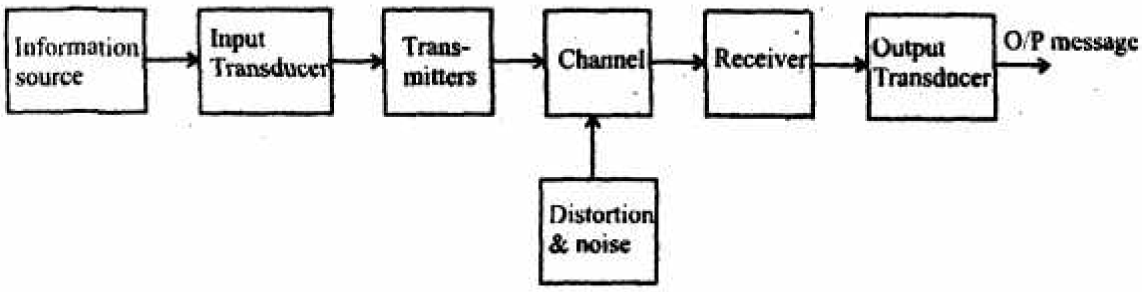
Third Semester Examination, Dec.-2008

DIGITAL AND ANALOG COMMUNICATION

Note : Attempt any five questions out of eight.

Q. 1. (a) Draw and explain the basic block diagram of communication system.

Ans. Communication System :



Block Diagram

- Essential Components are :

(i) Information Source :

Communication system servers to communicate a message or information. This message or information originates in information source.

(ii) Transmitter :

Transmitter modifies the message signal to efficient transmission. It's function is to process the electrical signal from diff., aspects.

(iii) Communication Channel :

Channel means the medium through which the message travels from transmitter to the receiver. In other worlds, it can be a physical connection between the transmitter & the receiver.

(iv) Receiver :

The main function of the receiver is to reproduce the message signal is electrical form from the distorted received signal.

(vii) Destination :

Destination is the final stage which is used to convert an electrical message signal into its original form.

Q. 1. (b) Explain various properties of Fourier transform.

Ans. Various Properties at Fourier Transform (F.T.) are :

(i) Linearity : For function.

$$n(t) = \sum_{n=-\infty}^{\infty} C_n . e^{jn\omega_0 t}$$

Where n(t) is any continuous-time periodic signal & C_n is Fourier series coefficient.

For our simplicity, we take $C_{nn} = \sum_{n=-a}^{\infty} C_n . e^{jnw_0 t}$ such that $n(t) \xleftrightarrow{F.T.} C_{nn}$.

Then linearity property may be stated as,

If $\quad n(t) \xleftrightarrow{F.T.} C_{nn}$ & $y(t) \xleftrightarrow{F.T.} C_{yn}$

Then $\quad z(t) = ax(t) + by(t) \xleftrightarrow{F.T.} C_{zn} = aC_{nn} + bC_{yn}$

(ii) Time shifting property :

If $\quad n(t) \xleftrightarrow{F.T.} C_{nn}$

Then, $\quad n(t - t_0) \xleftrightarrow{F.T.} e^{-jnw_0 t_0} C_{nn}$

(iii) Frequency-shifting property :

If $\quad x(t) \xleftrightarrow{F.T.} C_{nn}$

& $\quad e^{jnw_0 t} n(t) \xleftrightarrow{F.T.} C_{n(n-n_0)}$

(iv) Time-scaling :

If $\quad n(t) \xleftrightarrow{F.T.} C_{nn}$

Then, $\quad n(at) \xleftrightarrow{F.T.} C_{nn}$

(v) Time-Differentiation :

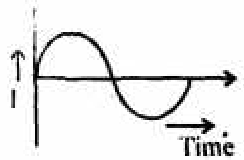
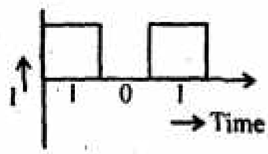
If $n(t) \xleftrightarrow{F.T.} C_{nn}$

then, $\frac{d}{dn} n(t) \xleftrightarrow{F.T.} j.\frac{2\pi n}{T_0} C_n$.

Q. 2. (a) What are the properties of a signal? Compare analog signal with digital signal.

Ans. Properties of signal :

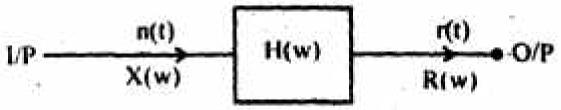
A function of one or more independent variables which contains some information is called a signal. In electrical sense, the signal can be voltage or current. The voltage or current is the function at time as an independent variable. In daily life, we come across severe electric signals such as radio signal, T.V. signal etc.

Analog Signal	Digital Signal
1. Analog signals are continuous electric signals that vary with time as shown : 	1. Digital signals are decrease signals & change in indivisible stress e.g., 
2. Analog signals cannot be compressed, which means less information can be put onto a channel.	2. Digital signal can be compressed easily & hence, more information can be send.
3. Analog signals are difficult to transmit & less reliable.	3. Digital signals are easier to transmit & also more reliable.
4. Analog signals are less complicated.	4. Digital signals are highly complicated as every data or information is to be sent.
5. Analog signals we error prone.	5. Digital signals offer less error while communicating a message.

Q. 2. (b) What is ESD and PSD? Derive expressions for both.

Ans. ESD (Energy Spectral Density) :

Consider a signal n(t) applied to an ideal low pass filter. The transfer function of low hash filter is shown,



$X(w) \rightarrow$ Fourier transform of n(t).

$R(w) \rightarrow$ Fourier transform of r(t)

Energy E_0 at output signal is :

$$E_0 = \frac{1}{2\pi}\int_{-\infty}^{\infty}|X(w)|^2 dw = \frac{1}{2\pi}\int_{-\infty}^{\infty}|H(w)X(w)|^2 dw$$

From fig. $H(w) = 0$ except from $-w_m$ to w_m

Hence,

$$E_0 = \frac{1}{2\pi}\int_{-w_m}^{w_m}|X(w)|^2 dw \Rightarrow E_0 = \frac{1}{2\pi}\left|X(w)^2\right|(\Delta w)$$

$$E_0 = |X(w)|^2(\Delta f) \Rightarrow \frac{E_0}{\Delta f} = |X(w)|^2$$

Energy spectral density (ESD)

$$\psi(w) = |X(w)|^2$$

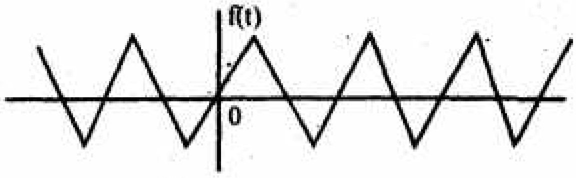
$$E = \frac{1}{2\pi}\int_{-\infty}^{\infty}\psi(w)dw$$

Or

$$\boxed{E = \frac{1}{\pi}\int_0^{\infty}\psi(w)dw}$$

P.S.D. (Power Spectral Density) :

Consider a power signal n(t).



Let us consider a transacted signal at $n_z(t)$ which can be,

$$n_z(t) = \begin{cases} n(t), & (t) < z/2 \\ 0, & \text{otherwise} \end{cases}$$

$$\boxed{E_z = \int_{-\infty}^{\infty} |n_z(t)|^2 dt = \int_{-\infty}^{\infty} |X_z(w)|^2 dn}$$

Q. 3. (a) What is data encoding? How NRZ coding is implemented?

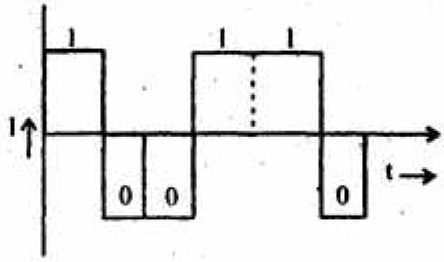
Ans. Data Encoding :

Encoding rules were the original rules laid out by the ANSI standard for encoding abstract information into a concrete data stream. The rules collectively referred to as a transfer syntax in ANSI pretence, specify the exact octete sequences which are used to encode a given data item. The syntax defines elements as : representation of basic data types, structure at length information & means at defining complex or compound types based on more primitive types.

NRZ (Non-return to zero) Coding :

In NRZ (Non-return to zero) coding, as its name implies, the value of the signal is always either positive as negative.

Example :



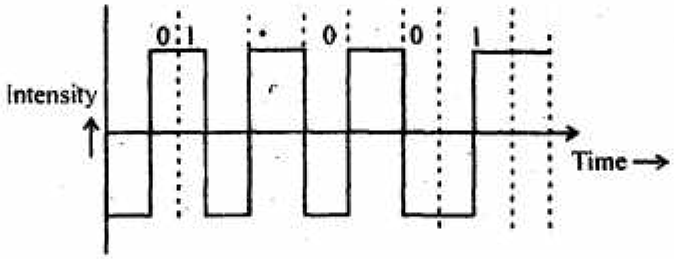
To represent 100110, its NRZ encoding will be as shown in fig.

It can be easily seen that signal is always either positive & not to zero.

Q. 3. (b) How differential manchester encoding is different from others?

Ans. Differential Manchester Encoding :

In differential manchester encoding, the inversion at the middle is used to synchronisation, but presence or absence of an additional transition at the beginning at the interval is used to identify the bit. A transition means binary 0 & no transition means binary 1. Differential manchester encoding requires two signal changes to represent binary 0 but only one to represent 1.



In differential manchester encoding, the transition at the middle at the bit is used only for synchronization. The bit representation is defined by the inversion & non-inversion at the beginning of the bit.

Q. 4. (a) Define and explain Shannon limit theorem.

Ans. Shannon Limit Theorem :

In reality, we cannot have a noiseless channel, the channel is always noisy. In 1944, claude shannon introduced a formula called shannon limit to determine the theoretical highest data rate for a noisy channel.

$$\text{Limit} = \text{Bandwidth} \times \log_2(1 + \text{SNR})$$

In this formula, Bandwidth is the bandwidth of the channel, SNR is the signal to noise ratio & limit is the max. Limit of the channel in bits per second. The signal to ratio is the statistical ratio of the power of the signal to the power of the noise. Note that in shannon formula, there is no indication at signal revel which means that no matter how many levels we use, we can't achieve a data rate higher than the capacity of the channel. In other words, the formula defines a characteristic of the channel, not the method of transmission.

e.g., If SNR is zero, then according to above formula,

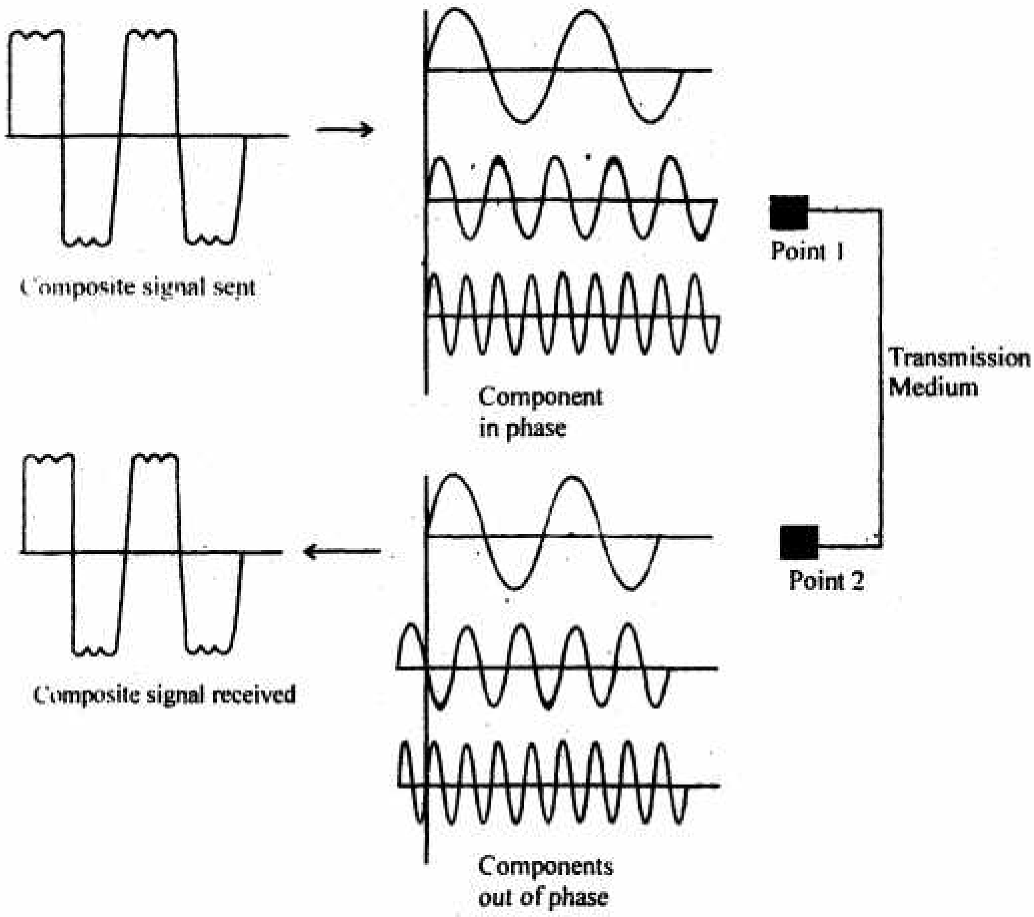
$$\text{Limit} = B\log_2(1+0) = B\log_2(1) = 0$$

Hence, no data can be received through this channel.

Q. 4. (b) What is delay distortion? How it affects the data rate of the channels?

Ans. Delay distortion :

Distortion means the signal changes its form or shape. Distortion occurs in composite signal, made at diff., frequencies. Each component has its own propagation speed through a medium & therefore, its own delay is arriving at the final destination. Following figure shows effect of distortion on a composite signal.



Q. 5. (a) Explain the different models of communication.

Ans. Different modes of communication are :

(i) Guided media &

(ii) Unguided media

(i) Guided media :

Guided media are those that provide a conduit from one device to another. It consist of :

(a) Twisted-pair cable :

A twisted pair consists of two conductors, each with its own plastic insulation, twisted together.

(b) Co-axial cable :

Co-axial cable carries signals of higher frequency ranges than twisted-pair cable, in part because the two media are constructed quite indifferently. Instead of having two wire cars has a central are conductor of solid wire enclosed in an insulating sheath, encased in an outer conductor.

(c) Fiber-optic cable :

A fibre-optic cable is made at glass or plastic & transmit signals in the form of light. To understand optical fiber. We first need to learn several aspects at nature of light.

(ii) Un-guided media :

The un-guided media transport electromagnetic waves without using a physical conductor. This type of communication signals are normally broadcast at different frequencies through air & thus are available to anyone who has a device capable at receiving them.

Q. 5. (b) Explain what is a protocol? Also clearly explain the concept of sliding window protocol.

Ans. Protocol :

A protocol is a set of rules that governs data communications. A protocol defines what, how & when it is communicated. The fey elements of protocol are :

(i) Syntax :

Syntax refers to the structure or format of the data, meaning the order is which they we presented.

(ii) Semantics :

Semantics refers to two characteristics : when dake should be sent & how fast they can be sent.

Sliding-window protocol :

The accomplish flow control, transmission control protocol uses a sliding window, with this method, both host use a window for each connection. The window spikes a portion of buffer containing bytes that a host can send before varying about an acknowledgment from other host. The window is called sliding window because it can slide ever the buffer as data & acknowledgment sent are received. In all sliding window, protocols each out band frame contains a sequence number, ranging from 0 upto some maximum.

Q. 6. (a) Explain ISDN.

Ans. I.S.D.N. (Integrated digital subscriber time) :

It transmits data digitally on a regular twisted pair copper telephone line, across exciting I.S.D.N. at a rate at 144 kb/s, slightly higher than bonded dual changed ISDN connection at 196Fb/s. The digital transmission bypass the telephone company's central office equipment that handles analog signals.

There are two types of I.S.D.N :

(i) Basic rate interface (BRI) :

It consist of two 64-Fbps B-channels & one D-channel for transmitting control information.

(ii) Primary rate interface (PRI) :

It consists of 23 B-channels & one D-channel or 30 B-channels & one-channel.

The original version of ISDN employs base band transmission.

Q. 6. (b) Explain wave-division multiplexing. How it is different from TDM?

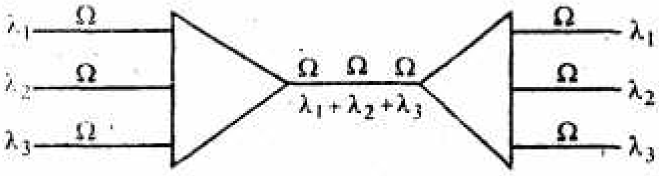
Ans. Wave-division multiplexing :

Wave-division multiplexing (WDM) is designed to use the high rate capability of fiber-optic cable. The optical fiber data rate is higher than he data rate of metallic transmission cable. Using a fiber-optic cable for one single line works the available bandwidth.

Multiplexing allows us to connect several lines into one.

WDM is conceptually the same as FDM, except that the multiplexing & demultiplexing involve optical signals transmitted through fiber-optic channels. The idea is the same; we are combining diff., signals at diff., frequencies. However, the difference is that the frequencies are any high.

Following figure shows a conceptual view of a WDM multiplexer & demultiplexer. Very narrow bands of light from diff., Sources are combined to make a wider band of light. At the receiver, signals are separated by demultiplexer.



WDM is an analog multiplexing technique to combine optical signals.

Q. 7. (a) Explain what are transmission errors? How they can be reduced? Suggest measures.

Ans. Transmission Error :

By-definition, transmission error is the difference between the actual position at the output gear & the position it would occupy if the gear drive were perfect. We would commonly state that transmission error is the amount by which ratio at a given point in a revolution departs from the correct ratio. While both statements are correct, the initial definition refers to any given point within a complete revolution, including & full revolution. This is a non-commulative error that appears over a complete revolution that reflects the gear parts & errors within the assembly that effect position. This can stem from the eccentricities in the planets, bearing errors, etc. The later part of definition refers more to single-cycle errors that appear during course of a revolution that create an incensitency in the output speed. Both are inclusive in the definition of transmission error.

Metrology of transmission error :

It can be measured with use of two high resolution encoders, one on the input side & one output side. The measurement set up would need to eliminate rotational compliance in the devices that couple the encodes to the gear head.

Q. 7. (b) What is Huffman encoding? Where it is used?

Ans. Huffman encoding :

The huffman encoding method leads to the lowest possible value of N for a given M, resulting in a maximum n. Hence, it is all known as minimum redundancy code.

The procedure is as follows :

(i) N-messages are arranged in an order of non-probability.

(ii) The probability of $[N - F[M - 1]]$ least likely messages are combined, where F is the highest integer that gives a possible value to the bracket & the resulting $[F(M - 1) + 1]$ probabilities are rearranged in an non-increasing manner.

This step is called reduction.

(iii) Encoding begins with the lost reduction, which consists of exactly M ordered probabilities. The first element of the encoding alphabet is assigned as first digit in codewards for all source messages.

Q. 8. (a) How we can compress any data? How it is helpful in cryptography?

Ans. Data compression :

Storing data in a format that requires less space than usual. Compressing date is same as packing data. Data compression is particularly useful in communication because it enables devices to transmit the same amount of data in fewer bits. There are a variety of data compression techniques but only a few have been standardised.

In computer science & information theory, data compression or source coding is the process of the process of encoding information using fewer bits than an unencoded could be encoded with fewer bits if we accept the convention that the word 'compression' be encoded as "camp", one popular instance of compression that many writer users are familiar with the zip file format which also provides compression.

Compression is useful because it helps reduce the consumption of expensive resource, such as disk space or transmission. On the downside, compressed date must be uncompressed to be viewed, & this extra processing may be determine to some applications. The design of data compression schemes therefore involve track-offs between various factors, including the degree at compression, the amount of distortion introduced, the computational resources required to compress & uncompress the data & hence, helps in cryptography.

Q. 8. (b) Explain error detection and parity check.

Ans. Error detection :

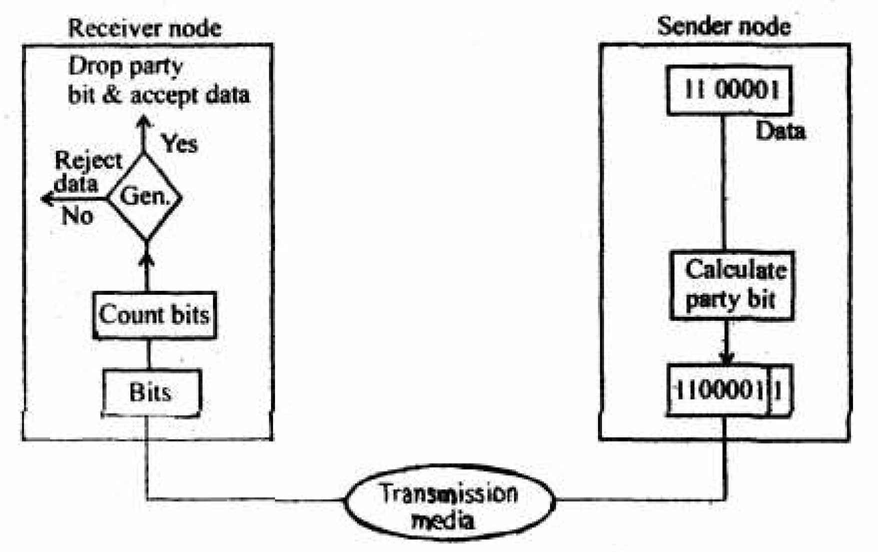
Error detection is the process of detecting the errors if any, in the communicating code from the sender to receiver. Error detection is simpler than error correction & is the first step in error correction process.

Error detection using concept of redundancy, which means adding extra bits for detecting errors at the destination.

Parity check :

The most common & least expensive mechanism for error detection is the purity check. It can be simple or two-dimensionals.

In this technique, a redundant bit, called a purity bit, is added to every data unit, so that total number of 1's in the unit (including the parity bit) becomes even (or odd). Suppose, we want to transmit the binary data unit 1/00001, as in fig., Adding no. of 1's gives as 3, an model number. Before, transmitting, we pass data unit through a parity generator. The parity generator unit through a parity generator. The parity generator counts the 1's & append parity bit to the end. The total number of 1's is now & an even number. The system now transmit. It to the receiver. The receiver checks if number at 1's is even & hence, the data is error-free.



Even parity concept