B.Tech.

Third Semester Examination, 2010-2011

Digital Analog Communication (EE-217-F)

Note : Attempt any five questions. All questions carry equal marks.

Q. 1. (a) Effect of limited Bandwidth on Digital Signal. Explain.

Ans. Bandwidth :

(i) Bandwidth is defined as the portion of the electromag spectrum occupied by a signal.

(ii) We may also define the bandwidth as the frequency range over which an information signal is transmitted.

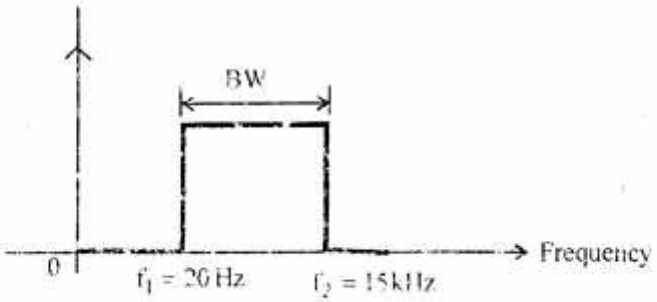
(iii) Bandwidth is the difference the upper and lower frequency limits of the signal.

(iv) We already know different types of baseband signals such as voice signal, music signal, TV signal etc.

(v) For example the range of music signal is 20 Hz to 15 kHz. Therefore, as shown the figure, the bandwidth is $(f_2 - f_1)$.

$$\therefore \quad BW = f_2 - f_1$$
$$= 15000 - 20$$
$$= 14980 Hz$$

Ans.



Bandwidth of Music Signal

The bandwidth of different signals are as listed in table.

S. No.	Type of Signal	Range of Frequency in Hz	Bandwidth in Hz
(i)	Voice signal (speech) for telephony	300–3400	3,100
(ii)	Music signal	20–15000	14,980
(iii)	TV signals (picture)	0–5 MHz	5 MHz
(iv)	Digital data	300–3400	3100

Q. 1. (b) Explain Shannon limit.

Ans. The algorithm deals with text compression. It takes a stream of characters in the form of text or message and produce the code which when decompressed, produces the input text. The coded form of input text requires lesser number of bytes and thus it will require less disk space to store. It would also enable faster processing and minimum time to communicate. Whenever the input text has to be reproduced the coded input text may be decompressed to generate input text.

Shannon fano limit algorithm are as follows :

(i) Frequency of occurrence of all symbols in the text is not the same. There are few symbols which have a high probability or their frequency of occurrence is higher in the text.

(ii) The high frequency symbols may be identified by statistical analysis of sample data.

(iii) The high frequency symbols must be represented by a smaller code. Different codes will have different numbers of bits

Thus, codes for symbols with high frequencies will have fewer number of bits and codes for low frequency, symbols will have a higher amount of bits.

(iv) Although all of the codes are of different size i.e., each code may have different numbers of bits, but they will all be unique and will identify a symbol uniquely.

(v) Shannon fano limit a uses binary tree, called Shannon-fano tree, to generate the different codes.

Q. 1. (c) Explain different communication modes.

Ans. Basic Modes of Communication :

There are two basic modes of communication :

(i) Broadcasting

(ii) Point to point communication.

(i) Broadcasting :

(i) In broadcasting a single powerful transmitter is used which transmits information in all the directions.

(ii) There are several expensive receivers which receive this information.

(iii) In broadcasting mode, the flow of information is always from the transmitter to receivers it means one way shown in fig. (1).

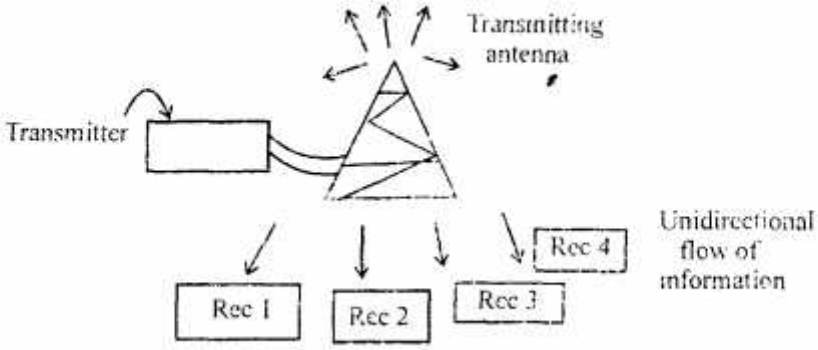


Fig. 1. Broadcasting

(ii) Point to Point Communication :

(i) Here the communication takes place over link between only one transmitter and one received shown in figure. (2).

(ii) The flow of information is generally bidirectional.

(iii) To facilitate this, transmitters and receivers are used on both the ends.

(iv) Example of point to point communication is the communication between two telephone subscribers.

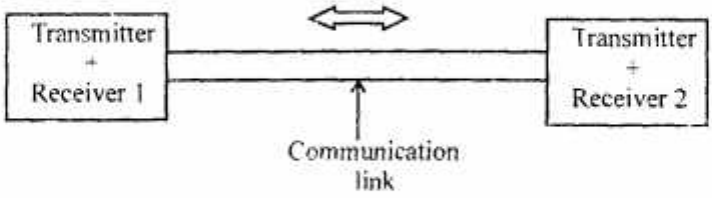


Fig. (2) Point to Point Communication

Q. 1. (d) Difference between Secret Key Cryptography and Public Key Cryptography.

Ans. Secret Key Cryptography : In secret key cryptography, both the sender and receiver of a message possesses the same 'secret password' (key). The sender uses the key to encrypt the message, rendering it unintelligible. The message cannot be deciphered without the key. The receiver will also the same key to decrypt the message.

These type of cryptographic system are also known as symmetric cryptographic systems. Secret key cryptographic system shown in the diagram below :

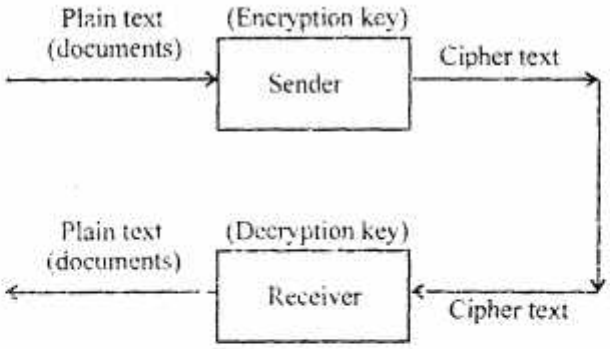


Fig. Secret Key Cryptography

Public Key Cryptography : In public key cryptography, the sender and receiver use two different keys called public key and private key.

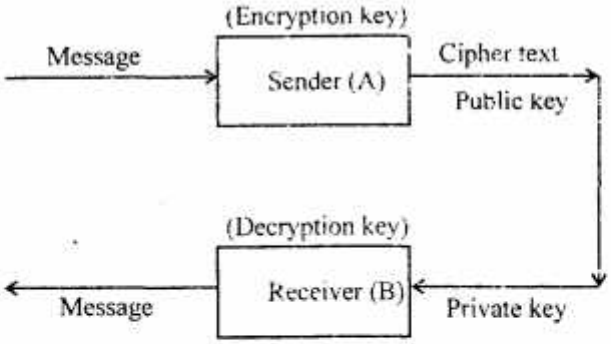
Following are the main features for encryption and decryption of ciphertext in public key cryptography :

(i) The sender uses one key (sender key) to encode the message and the receiver uses another key (receiver key) to decode the message.

(ii) The receiver publishers the sender keys, so that everyone who wants to send him a secret message can do so, but he keeps the receiver-key secret. This enables the receiver to ensure that only he can decode any of the messages.

(iii) Since sender key is known to all the senders it is called a public key and the receiver key is called the

private key.



Where,

EK_b = Encryption Key

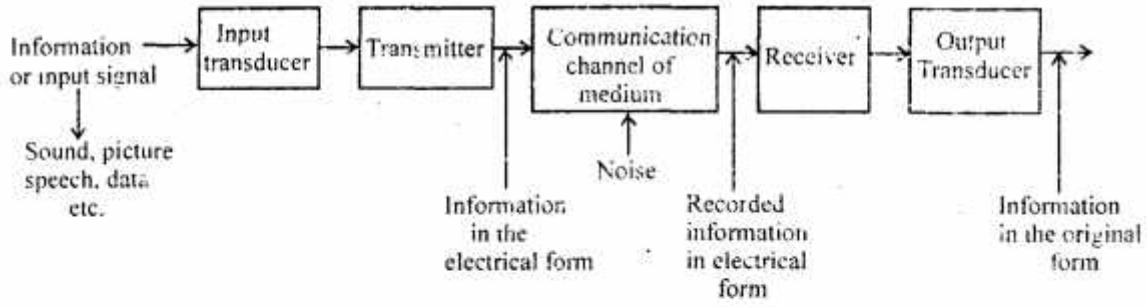
DK_b = Decryption Key

(Public Key Cryptography)

Q. 2. (a) Explain with diagram different components of a Communication system.

Ans. Components of Communication System :

(i) The block diagram of the simplest possible communication system is as shown in figure.



(Fig. Block Diagram of the Basic Communication System)

(ii) As seen from the fig. the elements of a basic communication system are transmitter, a communication medium and the receiver.

(iii) When the transmitted signal is travelling from the transmitter to the receiver noise gates added to it.

(iv) The element of basic communication system are as follows :

(a) Information or input signal

(b) Input transducer

(c) Transmitter

(d) Communication channel or medium

(e) Noise

(f) Receiver

(g) Output transducers.

(i) Input Signal :

(i) The communication systems have been developed for communicating useful informal from to the other.

(ii) This information can be in the form of sound signal like speech of music.

(ii) Input Transducer :

(i) The information in the form of sound, picture or data signals cannot be transmitted, as it is.

(ii) First it has to be converted into a suitable electrical signal.

(iii) Transmitter :

(i) The function of the transmitter is to convert the electrical equivalent of the information to a suitable form.

(ii) In addition to that it increases the power level of the signal. The power level should be increased in order to cover a large range.

(iii) The transmitter consists of the electronic circuits such as amplifier mixer, oscillator and power amplifier.

Communication Channel or Medium : The communication channel is the medium used for transmission of electronic signal from one place to other.

Depending on the type of communication medium, two types of communication system will exist. They are :

(i) Wire communication or line communication.

(ii) Wireless communication or radio communication.

Noise :

Noise is an unwanted electrical signal which gets added to the transmitted signal when it is travelling towards the receiver.

Output Transducers :

(i) The output transducer converts the electrical signal of the output of the receiver back to the original form i.e., sound or TV pictures etc.

(ii) The typical examples of the output transducers are loud speakes, picture tubes, computer monitor etc.

Q. 2. (b) State and explain various properties of 'Fourier Transform."

Ans. Fourier Transform Properties :

(i) Linear Property : If $F_1(s)$ and $F_2(s)$ are Fourier transform of $f_1(x) f_2(x)$ respectively, then

$$F\left[af_1(x)+bf_2(x)\right]=aF_1(s)+bF_2(s)$$

Where a, b are constants.

(ii) Change of Scale Property : If F(s) is the complex Fourier transform of f(x), then $F\left\{F(a,x)\right\}$

$$=\frac{1}{a}F(s/a)$$

(iii) Shifting Property : If F(s) is the complex Fourier transform of f(x), then.

$$F\{f(x-a)\} = e^{isa}F(s)$$

(iv) $$F\{e^{iax}f(x)\} = F(s+a)$$

(v) Modulation Theorem : If F(s) is the complex Fourier transform of f(x), then

$$F\{f(x)\cos ax\} = \frac{1}{2}[F(s+a)+F(s-a)]$$

(vi) If $F\{f(x)\} = F(s)$, then $F\{x^n f(x)\}$

$$= (-i)^n \frac{d^n}{d_s^n}F(s)$$

(vii) $F\{f'(x)\} = is\ F(s)$ if f(x)

$\to 0$ as $x \to \pm\infty$

(viii) $$F\left\{\int_0^x f(x)dx\right\} = \frac{F(s)}{(-is)}$$

Q. 3. If f(t) – F(w) is Fourier transform pair find the Fourier transform (F. T) of the following :

(i) f(t) coswot **(ii)** $f^2(t)$ **(iii)** f(–2t).

Ans. (i) $f(t)\cos w_0 t$

$$F(w) = F_s\{f(t)\} = \frac{1}{2\pi}\int_{-\infty}^{\infty} e^{-w'}f(t)dt$$

$$F_s\{f(t)\cos w_o t\} = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{iwt}f(t)\cos w_o t\,dt$$

$$= \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{iwt}f(t)\frac{e^{iw_o t}+e^{-iw_o t}}{2}dt$$

$$= \frac{1}{2\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{iwt}f(t)e^{iw_o t}dt$$

$$+\frac{1}{2\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-iwt}f(t)e^{-iw_o t}dt$$

$$= \frac{1}{2}\frac{1}{2\pi}\int_{-\infty}^{\infty} e^{i(w+w_o)t}f(t)dt$$

$$+\frac{1}{2\sqrt{2\pi}}\int_{-\infty}^{\infty}(w-w_o)t\,f(t)dt$$

$$= \frac{1}{2}F(w + w_0) + \frac{1}{2}F(w - w_0)$$

$$\frac{1}{2}\left[F(w + w_0) + F(w - w_0)\right]$$

(ii) We have

$$f(t) * g(t) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(u)\,g(tu)\,du$$

Taking Fourier both sides.

$$F_s\{f(t) \times g(t)\} = F_s\left\{\int_{-\infty}^{\infty} f(u)\,g(t-u)\,du\right\}$$

$$= \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty}\left[\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(u).g(t-u)\,du\right]e^{iwt}\,dt$$

$$\Rightarrow \quad \frac{1}{2\pi}\int_{-\infty}^{\infty} f(u)\,du\,\frac{1}{\sqrt{2\pi}}\left\{\int_{-\infty}^{\infty} g(t-u)e^{iwt}\,dt\right\}$$

$$\Rightarrow \quad \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(u)\,du\,F\left[g(t-u)\right]$$

$$= \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(u)e^{iwt}G(w)$$

$$= G(w)\frac{1}{2\pi}\int_{-\infty}^{\infty} f(u)e^{iwu}\,du$$

$$= G(w)\frac{1}{2\pi}\int_{-\infty}^{\infty} f(u)e^{jwu}\,du$$

$$= G(w).F(w)$$

Now Fourier

$$f(t) = g(t)$$

$$F_s\{f(t)f(t)\} = F(w).F(w) = (F(w))^2$$

Q. 4. (a) Explain the two physical layer interfaces i.e. Rs. 232 and X.21.

Ans. X.25 : Connection oriented network is X.25 which was the first public data network. It was deployed in the 1970s at a time when telephone service was a monopoly everywhere and the telephone company in each country expected there to be one data network per country theirs. To use X.25, a computer first established a connection to the remote computer, that is placed a telephone call. This connection was given a connection number to be used in data transfer packets.

Data packets were very simple, consisting of a 3-byte header and upto 128 bytes of data. The header

consisted of a 12-bit connection number, a packet sequence number, an acknowledgment number and a few miscellaneous bits. X 25 networks operated for about a decade with mixed success.

Lightwave Transmission : (Interfaces) : Unguided optical signalling has been in use for centuries. Paul Reverse used binary optical signaling from the old north church just prior to his famous ride. A more modern application is to connect the LANs in two building via lasers mounted on their root tops. Coherent optical signaling using lasers is inherently unidirectional, so each building needs its own raser and its own photodetector.

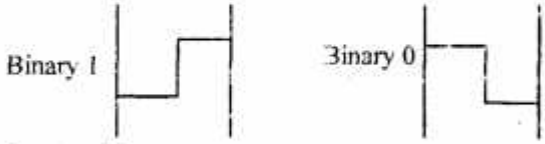
This scheme offers very high bandwidth and low cost. It is also relatively easy to install and, unlike microwave, does not require an FCC license.

The laser's strength, a very narrow bean is also its weakness here. Aiming a laser beam 1mm wide of a target the size of a pin head 500 meters away requires the marks manship of a latter day, Annie Oakley. Usually lenses are put into the system to defects the beam slightly.

A disadvantage is that laser beams cannot penetrate rain or thick fog, but they normally work well on sunny days. However, the author once attended on conference at a modern hotel in Europe at which the conference organizers thoughtfully provided a room full of terminals for the attendees to read their e-mail during boring presentation. Since the local PTT was unwilling to install a large number of telephone lines for just 30 days, the organisers put a laser on the roof and aimed it at their university's computer science building a few kilometers away. They tested it the night before the conference and it worked perfectly. At 9 a.m. the next morning on a bright sunny day, the link failed completely and stayed down all day. That evenings organizers tested it again very carefully and once again it worked absolutely perfectly.

Q. 4. (b) Explain with diagrams, what is binary encoding (NRZ), Manchester encoding and differential Manchester encoding.

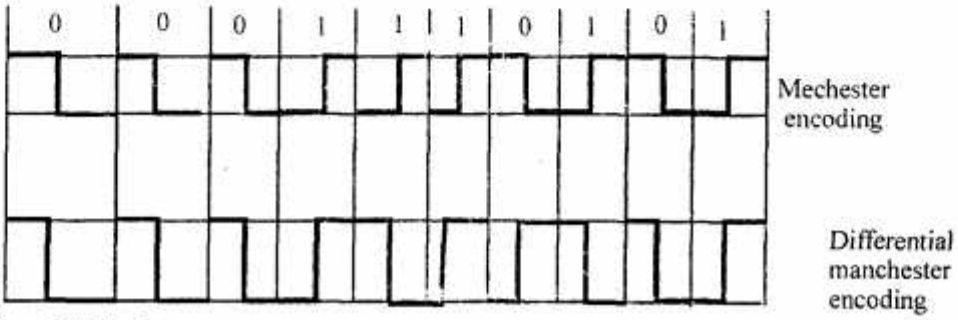
Ans. Manchester Encoding : A negative to positive transition represents :



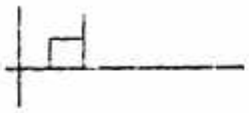
And A positive to negative transition represents.

Bit Stream :

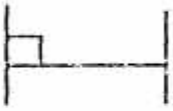
0001110101



Differential Manchester
A transition means binary = 0
No transition means binary = 1



And binary 1 is



Binary 0 is

Q. 5. (a) Explain two different transmission media :

(i) Twisted pair **(ii) Co-axial cables**

Ans. (i) Twisted Pair : One of the oldest and stilimost common most transmission media is twisted pair. A twisted pair consists of two insulated copper wires, typically about 1mm thick. The wires are twisted together in a helical form, Just like a DNA molecule.

Twisting is done because two parallel wires constitute a fine antenna. When the wires are twisted, the waves form different twists cancel out, so the wire radiates less effectively.

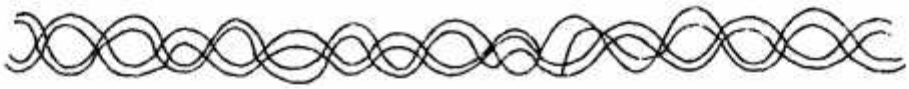
The most common application of the twisted pair is the telephone system.

Twisted pair can be used to transmitting either analog or digital signals. The band width depends on the thickness of the wire and the distance travelled but several megabits/sec can be achieved for a few kilometers in many cases.

Twisted pair cabling comes in many varieties, two of which are important for computer networks.

Category 3 : Twisted pair consist of two insulated wires gently twisted together.

Category 5 : Twisted pair are similar to category 3 pairs, but with more twists per centimeter which results in less cross talk and a better quality signal over longer distances.



(a) (Category 3 UTP)

(b) (Category-5 UTP)

(ii) Co-axial Cables : Another common transmission medium is the coaxial cable. It has better shielding than twisted pair, so it can span longer distance at higher speeds.

A coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material.

The insulator is encased by a cylindrical conductor, often as a closely-woven braided mesh.

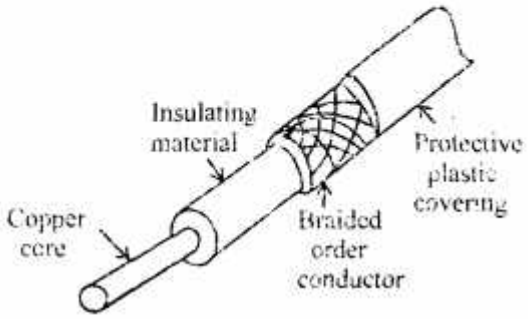
The outer conductor is covered in a protective plastic sheath.

The construction and shielding of the coaxial cable give it a good combination of high bandwidth and excellent noise immunity. The bandwidth possible depends on the cable quality, length and signal to noise ratio

of the data signal.

Modern cable have a bandwidth of close to 1 GHz.

Coaxial cables used to be widely used within the telephone system for long distance lines but have now largely been replaced by fiber optics on long-haul routes.



A Coaxial Cable

Q. 5. (b) Explain following terms :

(i) Nyquist rate **(ii) Shannon limit.**

Ans. (i) Nyquist Rate : The minimum sampling rate of "2W" samples per second for a signal x(t) having maximum frequency of "W" H_2 is called as "Nyquist Rate."

The reciprocal of nyquist rate i.e., 1/2W is called as the Nyquist interval.

Nyquist rate $= 2\,WHz$

Nyquist interval $= \frac{!}{2} W$ seconds

(ii) Shannon limit : The algorithm deals with text compression. It takes a stream of characters in the form of text or message and produce the code which when decompressed, produces the input text. The coded form of input text requires lesser number of bytes, and thus it will require less disk space to store. It would also enable faster processing and minimum time to communicate. Whenever the input text has to be reproduced the coded input text may be decompressed to generate input text.

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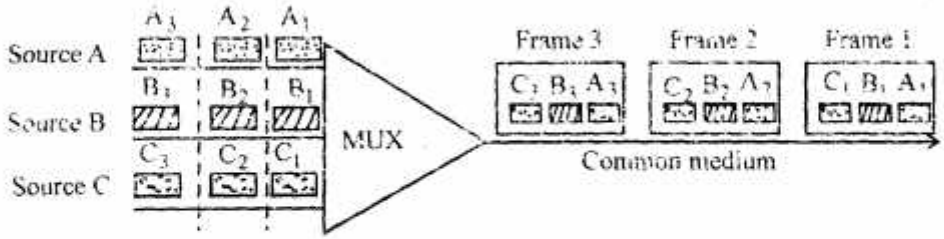
(iv) Although all of the codes are of different size i.e., each code may have different numbers of bits, but they will all be unique and will identify a symbol uniquely.

(v) Shannon fano limit a uses binary tree, called Shannon-fano tree, to generate the different codes.

Q. 6. (a) Differentiate between TDM and WDM.

Ans. TDM : (Time Division Multiplexing) : The TDM system can be used to multiplex analog or digital signals, however it is more suitable for the digital signal multiplexing.

The concept of TDM will be more clear in the following diagram :



TDM System

(i) The data flow of each source (A, B or C) is divided into units (say A_1, A_2, B_1, C_1 etc.)

(ii) Than one unit from each source is taken and combined to form one frame. The size of each unit such as A_1, B_1 etc. can be 1 bit or several bits.

(iii) From the diagram, Frames of TDM signal. For 3 input being multiplexed, a frame of TDM will consist of 3 units i.e., one unit from each source.

(iv) Similarly for n number of input each TDM frame will consist of n units.

(v) The TDM signal in the form of frames is transmitted on the common communication medium.

Comparison of TDM and WDM :

S. No.	WDM	TDM
(i)	The signals which are to be multiplexed are added in the time domain. But they occupy different slots in the frequency domain.	The signals which are to be multiplexed can occupy the entire bandwidth but they are isolated in the time domain.
(i)	WDM is usually preferred for the analog signals.	TDM is preferred for the digital signal.
(i)	Synchronization is not required.	Synchronization is required.
(iv)	WDM requires a complex circuitry	This is not very complex.

	at the transmitter and receiver.	
(v)	It suffers from the problem of crosstalk due to imperfect band pass filter.	In TDM the problem of cross talk is not severe.
(vi)	Due to wideband fading in the transmission medium all the FDM channels are affected.	Due fading only a few TDM channels will be affected.

Q. 6. (b) Explain the telephone system 'ISDN.'

Ans. ISDN : Integrated service digital network is the most powerful tool for various services such as voice, images and video and multimedia data communication over the telephone network. ISDN may be viewed a logical extension to the digitalization of telephone network and has became very common in the Western Countries. In India too the various mail network service provides as well as DOT. VSNL, & MTNL are providing the service to users. In ISDN the voice, image and multimedia is transmitted over the telephone line in digital form. The ISDN works in the following modes :

(i) BRI (Basic Rate Interface)

(ii) PRI (Primary Rate Interface)

Users cannot opt for a BRI connection from the local ISP or users can opt for PRI connection in BRI, also called, 2B+D, two 64 kbps channels are available to the user. The other PRI is used for ISDN compatible EPABX etc. With the induction of state-of-art digital technology. In the telecom network in India. These services are being offered by the new technology. Exchange laid down by DOT or MTNL. The ISDN connection is provided at the user's premises located within permissible distance for digital exchange.

ISDN Services : The following four services are offered by ISDN or dial up basis between any two ISDN subscribers :

(i) High speed data transmissions at 64 KBPS.

(ii) High quality voice transmissions at 64 KBPS

(iii) Desk top video conferencing using single ISDN line at 128 KBps (two B channel).

(iv) High quality conferencing on dial-up basis between any two ISDN users by three ISDN line (3*/28) = 384 KBPs.

The advantage of video conferencing is that user may talk to each other at distant places thus saving time and money. This is done by transmission of void and video images of both users as well as by transmitting images, drawing text or still produces of document at a high speed. Data files on the PC may be transmitted at a very high speed of 64 KBPS.

Terminal Adopter : Devices such as 44 Fax, answering machine, push button telephone, cordless phone may be connected to ISDN line through a terminal adopter, any PC with RS 232C port (serial port) can be

connected to ISDN line. In such cases data communication may take place in 9600 KBPS. In this communication the PC does not require modem.

Q. 7. (a) Differentiate between circuit switching and packet switching systems.

Ans. Circuit Switching : (Connection Oriented Service) : This service is modeled after the telephone system. "To talk to someone you pickup the phone, dial the number, talk and than hang-up. Similarly, to use a connection oriented network service the service user first establishes a connection, uses the connection and then release the connection." The essential aspect of a connection is that it acts like a tube the sender pushes objects in at one end and the receiver takes them out at the other end. In most cases the order is preserved so that the bits arrive in the order they were sent. In some cases when a connection is established, the sender, receiver and subnet conduct a negotiation about parameters to be used.

Packet Switching : (Connectionless Service) : In contrast, connectionless service is modeled after the postal system. Each message carries the full destination address, and each one is routed through the system independent of all the others. Normally, when two messages are sent to the same destination the first one sent will be the first one to arrive. However, it is possible that the first one sent can be delayed so that the second one arrives first.

Summarized the types of services are below :

	Service	Example
Connection oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection less	Unreliable datagram	Electronic junk mail
	Acknowledged diagram	Register mail
	Request–Replay	Database Query

(Six Different Types of Services)

Q. 7. (b) Explain sliding window protocol in detail.

Ans. Sliding Window : In the sliding window method of flow control, the sender can transmit several frames before needing an acknowlement.

Frames can be sent one night after another, meaning that link can carry several frames at once and its capacity can be used efficiently. The receiver acknowledge only some of the frames using a single ACK to conform the receipt multiple data frames.

Different Sliding Window Protocol :

(i) One bit sliding window protocol.

(ii) A protocol using Go back n.

(iii) A protocol using selective repeat.

One Bit Sliding Window Product :

```
# define MAX_SEQ.1
```

```
typedef enum {frame_arrival, chksum_err, timeout} event_type
#include "Protocol 4 (void)
{
        seq_nr next_frame_to_send;
        seq_nr frame_expected;
        frame r, s;
        packed buffer;
        event_type event;
        next_frame_to_send = 0
        frame_expected = 0;
        from_network_layer (s buffer);
        s = info = buffer;
        s = next_frame_to_send
        s.ack = 1-frame_expected;
        to_physical_layer (ss);
        start_time (s.seg),
        while (true) {
                wait_for_event (servent);
                if (event = = frame arrival)
                from_physical_layer (sr)
                if (r.seg = = frame_expected_
                to_network_layer (sr.info);
                inc (frame_expected);
        }
        if (r.ack = = next_frame_to_send)
        from_network_layer (s.buffer);
        inc (next_frame_to_send);
    }
}
s.info = buffer;
s.seg = next_frame_to_send;
s.ack = 1-frame_expected
to_physical_layer (ss);
start_timer (s.seg);
```

Q. 8. (a) Explain Huffman encoding using suitable example.

Ans. Huffman Coding : Huffman coding generates variable length code in such a way that high frequency symbols are represented with a minimum number of bits and low frequency symbols are represented by

relatively higher number of bits. The decoding of the Huffman codes is done by using Huffman decode tree. Major difference in Shannon-fano and Huffman algorithm, is that in SF algorithm, the tree is built on the top down approach while Huffman Tree is built using the bottom up approach.

All the symbols in Huffman Tree are assigned leaf nodes similar to Shannon-Fano Tree.

Steps for Huffman Coding :

Step 1 : Compute or collect the total no symbols and their relative frequencies.

Step 2 : Arrange all the symbols in decreasing order of their frequencies.

Step 3 : Construct Huffman Tree from the list of symbols.

Step 4 : Assign the code.

Example : The symbols and their frequency are given below :

Symbol	Frequency
A	30
B	30
C	15
D	15
E	10

Construct Huffman Tree and Code

Solution : The Huffman Tree may be constructed in the following steps :

(i) Find the shortest list of symbols in decreasing order of frequency. The list will be (A, B, C, D, E).

(ii) Pick up two symbols with minimum frequency. These symbols are 'D' and 'E'. Assign them two free nodes as shown below :

This subtree is called 'D/E'.

Combined frequency of 'D/E' is 25.

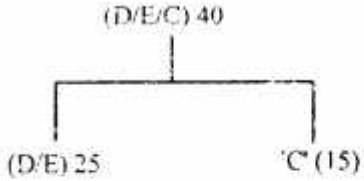
(iii) Update shorted list as shown below :

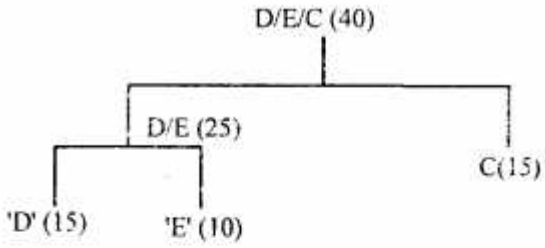
(A, B, (D/E), C)

Pickup two symbols with the minimum frequency.

These symbols are 'D/E' and 'C'.

Assign them free nodes as under.





This subtree is called 'D/E/C'.

Combined frequency of 'D/E/C' is 40.

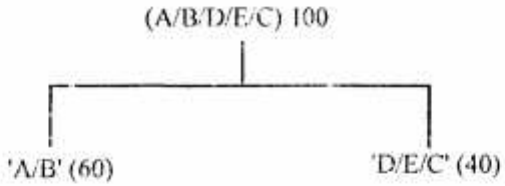
(iv) Update sorted list as shown below ('D/E/C' 'A' 'B')

Pickup two symbols with minimum frequency

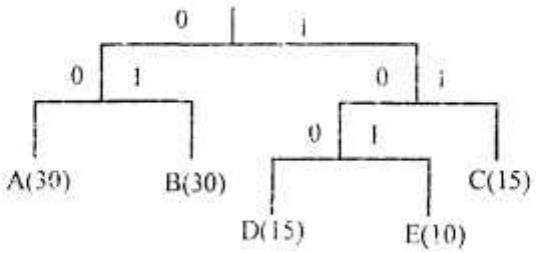
(v) Update shorted list as shown below :

(('A/B'), ('D/E/C'))

Pickup two symbols with minimum frequency. These are (A/B) and (D/E/C). Assign them free node as under :



(vi) Update shortest list now it will contain only 'A/B/D/E/C' and no individual symbol is left. Therefore the process halts and final Huffman Tree is shown below :



(vii) Assign the bit '0' and '1' to left and right subtree to obtain Huffman code.

Using Huffman code, the total number of bits required to represent a text of 100.

$= 30*2 + 30*2 + 15*2 + 15*3 + 10*3 = 225$.