# NEPAL COLLEGE OF INFORMATION TECHNOLOGY

Balkumari, Lalitpur

*Affiliated to Pokhara University*

## ASSIGNMENT FOR DATA COMMUNICATION

## TUTORIAL 1


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Tutorial 1 (DC)

CHAPTER 1

1) Why data communication is important?

→ Data communication is vital in today's interconnected world because it facilitates the exchange of information between devices, systems, and people.

Data communication is essential for enabling collaboration, supporting automation, improving decision-making, enhancing customer experiences, and driving technological advancements. It connects people, devices, and systems, facilitating seamless information exchange and operational efficiency.

2) Draw and explain a generic data communication model. Explain in brief the basic signal processing operations at each block.

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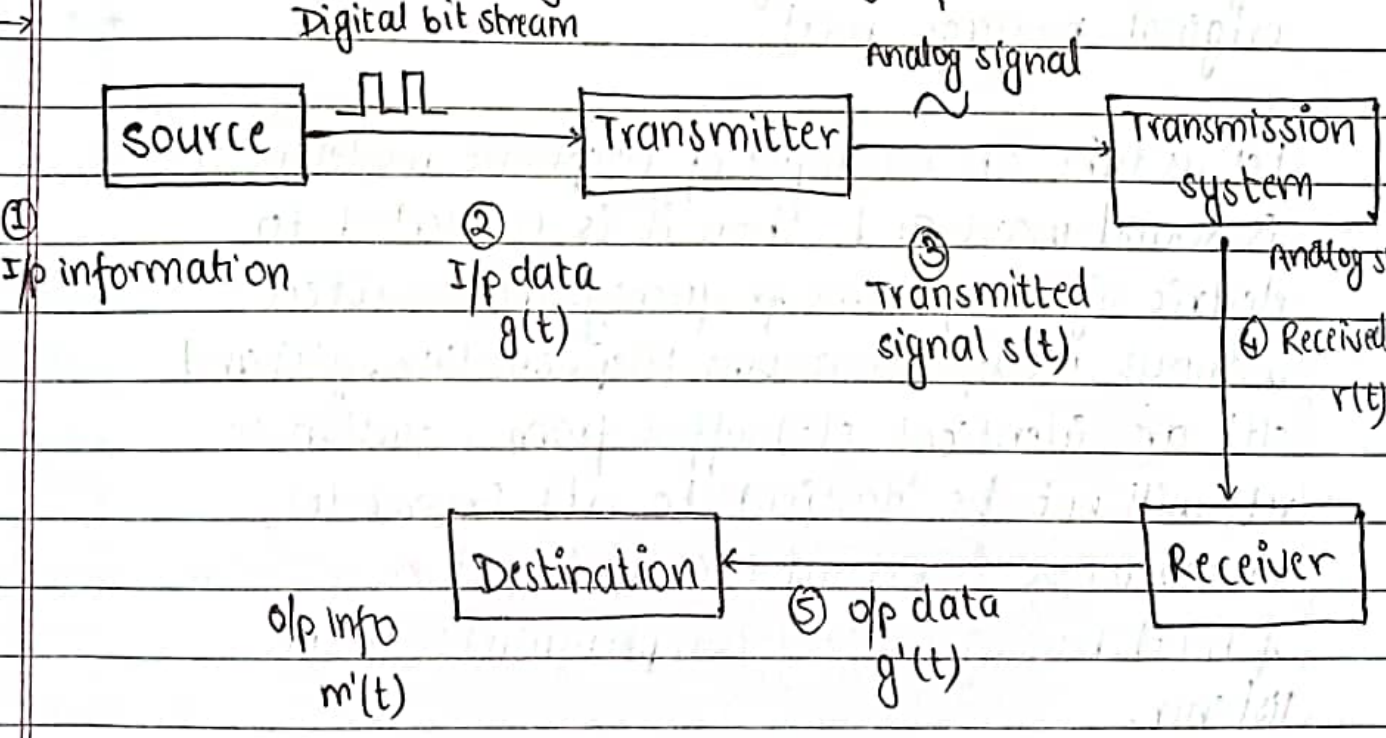


Fig. Data communication Model

I/p device & transmitter are component of personal computer. The user wishes to send a message email (m) to another user via PC. I/p data are transferred to binary i/p bit (g(t)). The incoming i/p stream g(t) are transferred into a transmitting analog signal s(t) suitable for transmission.

The transmitted signal s(t) presented to the medium is subject to a number of imperfection i.e. white noise, formal noise and interference before it reaches the receiver. The received signal r(t) may differ from s(t). The receiver will attempt to estimate the original s(t) based on r(t) and its knowledge of the medium producing a sequence of bits. The message m'(t) as viewed by the user will usually be an exact copy of original message m(t).

Let us take an example of telephone model, m(t) is sound wave and then it is converted to electric signal of same frequency. Transmitted without modification over telephone line. g(t) and s(t) are identical. s(t) suffers from distortion. so, r(t) will not be identical to s(t). From r(t), sound wave is extracted. m'(t) is not exact replica of m(t). But, generally comprehensible to the listener.

2) ~~Draw and explain a~~

Q3) How is digital transmission superior to analog transmission system?

→ Digital transmission is superior on the basis of following facts:

(i) Signal Quality
Digital signals are less affected by noise, maintaining their quality even over long distances.

(ii) Data compression
Digital transmission enables efficient data compression, saving significant bandwith.

(iii) Error detection
Digital systems use advanced error detection and correction methods, ensuring reliable communication.

(iv) Storage / Processing
Digital data can be easily stored and processed using modern computing devices.

(v) Bandwidth utilization
Digital transmission optimizes bandwidth through techniques like multiplexing.

(vi) Security
Digital systems support encryption, providing better security for sensitive data.

(vii) Integration
Digital transmission integrates well with computers, the internet, and other modern technologies

Q4) Explain digital communication system with its block diagram.

→

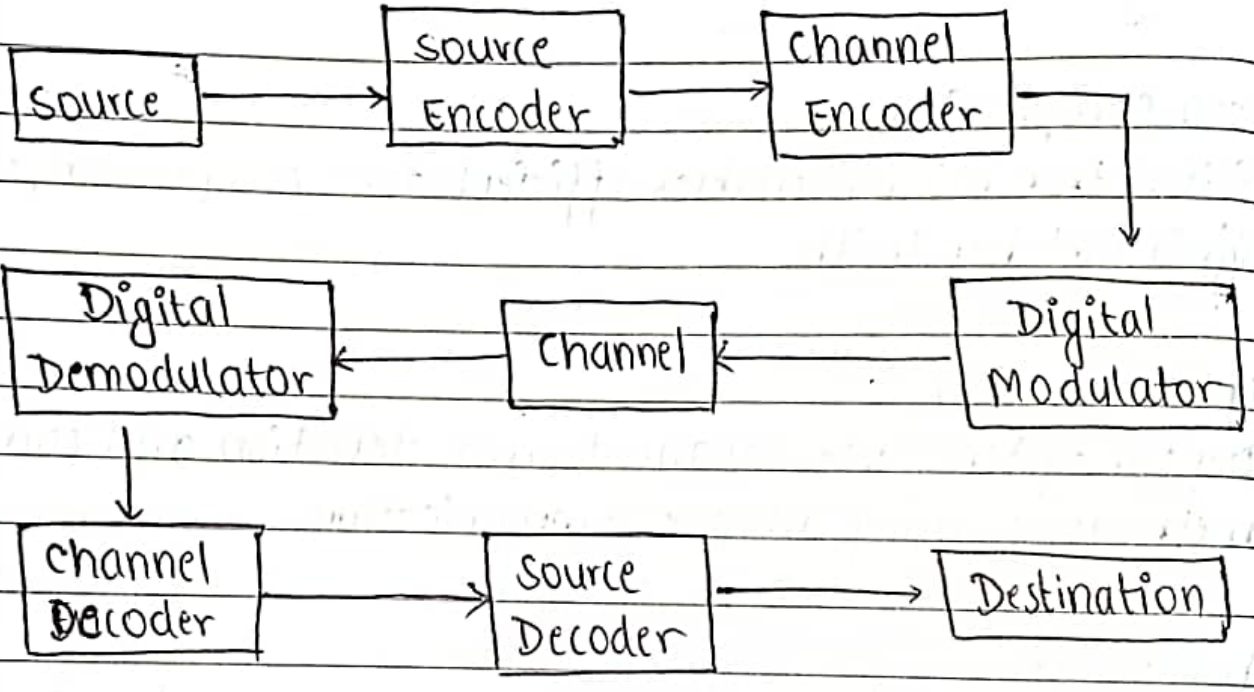


Fig. Digital communication system

1. Source
The origin of the information to be transmitted, such as text, audio or video.

2. Source Encoder
converts the source signal into digital binary format, reducing redundancy.

3. channel Encoder
Adds extra data to detect and fix errors during transmission.

4. Digital Modulator
Prepares the binary data for transmission by converting it into a form suitable for the communication channel.

5. Communication channel
The medium through which the signal travels, like cables, radio waves or fiber optics.

6. Digital Demodulator
Converts the received signal back into binary format.

7. channel Decoder
Removes errors that may have occurred during transmission.

8. Source Decoder
converts the binary data back to its original form

9. Destination
The final point where the information is received and used.

Q5) Explain the applications of data communication.

→

The applications are :-

1. Social Media
Platforms like Facebook and Instagram use data communication to share messages, images, and videos in real-time.

2. Voice Over Internet (VoIP)
Applications like Skype and WhatsApp enable voice and video calls by transmitting voice data over the internet

3. Text messaging in smartphones
Messaging apps like whatsapp and SMS use data networks to send and receive instant text messages.

4. Network Games
Multiplayer games like Fortnite rely on DC to sync player actions and interactions in real time.

5. Audio & Video Streaming
streaming services like Netflix and Youtube use data communication to deliver seamless audio & video content.

6. Peer-to-Peer Applications
File-sharing platforms like BitTorrent use data

communication to transfer files directly between devices without central servers.

## CHAPTER 2

Q6) Define Baud Rate. Explain RS 232C standards.

→

The baud rate is the number of signal changes or symbols transmitted per second in a communication channel.

$$\text{baud rate } s = \frac{\text{bit rate } R}{r}$$

RS-232C is a long-established standard that describes the physical interface and protocol for relatively low-speed serial data communication between computer & related devices.

Features:

(i) communication type
Supports serial communication

(ii) Voltage Level
Logical 1 (Mark) : -3V to -25V
Logical 0 (space) : +3V to +25V

(iii) Connector
The communication is done through the serial port of PC. This is male connector with 25 pins (old) or 9 pins (new PC computer).

(iv) Transmission distance
Short cables of less than 15m (50ft.) are recommended.

(v) Mode of communication
Asynchronous communication is commonly used, meaning there is no separate clock signal.

(vi) Baud Rate
Supports speed upto 115.2 kbps, though typical use is lower.

(vii) Full Duplex
Allows simultaneous two-way communication betn devices.

Q7) Explain data frame format of synchronous and asynchronous communication & differentiate them.

→

Asynchronous Communication :

- Transmits data one character at a time with start and stop bits, without needing a shared clock.

Frame format :

- Bit synchronization bet" two devices is made possible using start bit and stop bit.
- start bit indicates the beginning of data. A start bit usually 0 is added to beginning of each byte.
- Data bits : Actual data, usually group of 8 bits, in bytes
- Parity bit (optional) : Used for error checking
- stop bits : Marks the end of data. It is usually 1 of 1 or 2 bits.

Synchronous Communication:

sends data as a continuous stream, synchronized using clock signal.

Frame format :

- Synchronization Bits : sync characters or bits used to align sender and receiver clocks.
- Data bits : continuous stream of data, typically multiple bytes.
- ~~Error checking bits :~~
- In order to receive the data error free, the receiver and sender operates at the same clock frequency.

P.T.O. →

| Feature | Asynchronous | synchronous |
|---|---|---|
| clock | Each character contains its own start and stop bits, No clock | A common clock is shared by the transmitter and receiver to achieve synchronization while data transmission. |
| Transmission type | Data is sent in the form of bytes or characters. | Data is sent in frames or blocks. |
| Speed | It is slower as each character has its own start and stop bit. | It is faster, as a common clock is shared by sender and receiver. |
| Cost | Asynchronous is cheaper. | It is costlier. |
| Design complexity | It is complex in design. | It is easy to design. |
| Data gap in transmission | There is gap bet$^n$ the data due to start & stop bit feature. | No gap bet$^n$ data as they share common clock. |

Q8) Differentiate between serial and parallel transmission.

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| Feature | Serial Transmission | Parallel Transmission |
|---|---|---|
| Flow direction | Data flows in two directions, bit by bit. | Data flows in multiple directions; 8 bits at a time. |
| Cost | Cost is economical. | Cost is expensive. |
| Bit count | Number of bits transferred per clock pulse is 1 bit. | Number of bits transferred per clock pulse is 8 bits. |
| Speed | Speed is slower. | Speed is faster. |
| Usage | Used for long distance communication | Used for short distance communication. |
| Example | computer to computer | computer to printer |

Q9) Define channel capacity with necessary theorem. For a RF signal with bandwidth 6MHz and it is transmitted with average power 2W where 1.2mW noise signal is present on it. If the signal is digitized and sent, find the maximum data rate of the channel.

→

Channel capacity refers to the maximum data rate (bits per second) at which information can be transmitted over a communication channel without error, given the channel's bandwidth and noise levels.

For noiseless channel, Nyquist bit rate theorem can be used and for channel with noise, shannon capacity theorem is used.

## Nyquist Theorem:

B - Bandwidth of the channel
L - Number of signal levels used to represent data, then the maximum data rate R on this channel is given by,

$$R = 2B\log_2 L$$

## shannon capacity Theorem:

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

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

$$\text{SNR} = \frac{\text{signal Power}}{\text{Noise Power}}$$

Numerical:

Bandwidth (B) = 6MHz = $6 \times 10^6$ Hz
Signal Power (S) = 2W
Noise Power (N) = 1.2mW = $1.2 \times 10^{-3}$ W

Here,

$$SNR = \frac{S}{N} = \frac{2}{1.2 \times 10^{-3}} = 1666.67$$

Now,

$$C = B \log_2(1 + SNR)$$
$$= 6 \times 10^6 \log_2(1 + 1666.67)$$
$$= 6 \times 10^6 \log_2(1667.67)$$
$$= 6 \times 10^6 \times 10.70$$
$$= 64200000$$
$$= 64.2 \text{ Mbps}$$

Hence, the maximum data rate of channel is 64.2 Mbps. Ans

Q10) Explain different modes of serial transmission.

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Various modes are:

(i) simplex Mode
- Data flows in only one direction.
- The sender transmits, and the receiver only receives.
- No reverse communication is possible.

E.g. Television broadcasting, where signals are sent from a transmitter to multiple receivers.

(ii) Half-Duplex Mode
- Data flows in both directions, but only one direction at a time.
- Communication alternates between sending and receiving.
- A control mechanism ensures one device sends while the other receives.

E.g. walkie-talkies, where users take turn speaking

(iii) Full-Duplex mode
- Data flows in both directions simultaneously.
- Devices can send and receive data at same time.
- Requires two separate channels or a channel capable of bidirectional data flow.

E.g. Telephone systems, where both parties can talk and listen at the same time.

Q11) Explain the concept of bit rate, baud rate. Show their relationship.

→

Bit rate is the number of bits sent per second, in a communication channel.
Unit : Bits per second (bps)

Data rate is sometimes called the bit rate.

## Baud rate:

The signal rate / baud rate is number of signal elements sent in 1 second.
Unit : baud

Here, baud rate, $S = \frac{\text{bit rate } R}{r}$

where,
r is the number of data (bit) in signal or symbol.

$r = \frac{\text{number of bits (bit)}}{\text{number of signal elements (baud)}}$