1/9/2021

Module 1

Data Communications

- Data : information presented in whatever form is agreed upon by the parties creating and using the data
- Telecommunication - communication at a distance
- Data Communications are the exchange of data between two devices via some sort of transmission medium

Characteristics of Communication

- Delivery - reach intended user
- Accuracy - no alteration
- Timeliness - real time transmission
- Jitter - variation in packet arrival time

Components of a data communication system

1. Message 2. Sender 3. Receiver
4. Transmission Medium 5. Protocol

Rule 1:
Rule 2:
Rule n:
Sender

— Message →

Rule 1:
Rule 2:
Rule n:
Receiver

Medium

I content to be transmitted

II one who sends the data

III one who receives the data

IV carrier of data

V set of rules / basic binding element of all other components

Data Representation

→ Text
- Bit Pattern
- Unicode

→ Numbers
- Bit Pattern

→ Images
- Pixels - bit pattern
- RGB / YCM

→ Audio
- continuous

→ Video (split to frames)
- continuous entity / combination of entity

Types of Data Flow

1) Simplex (radio)
   - flow of data is in only one direction

2) Half Duplex
   - flow of data can be in both directions but not at the same time (walkie talkie)

3) Full Duplex
   - flow of data can be in both direction at all times

Networks

- It is a set of devices (nodes) connected by communication links.
  - → Node: a computer, printer or any other device capable of sending and/or receiving data generated by other nodes on the network.
  - → Link: can be a cable, air, optical fibre or any medium which can transport a signal carrying information

Network Criteria

I Performance
- → depends on network elements
- → measured in terms of delay and throughput

II Reliability
- → failure rate of network components
- → measured in terms of availability / robustness

III Security
- → Data protection against corruption/loss of data due to:
  - → Errors → Malicious users

Types of Connections.

I Point-to-point

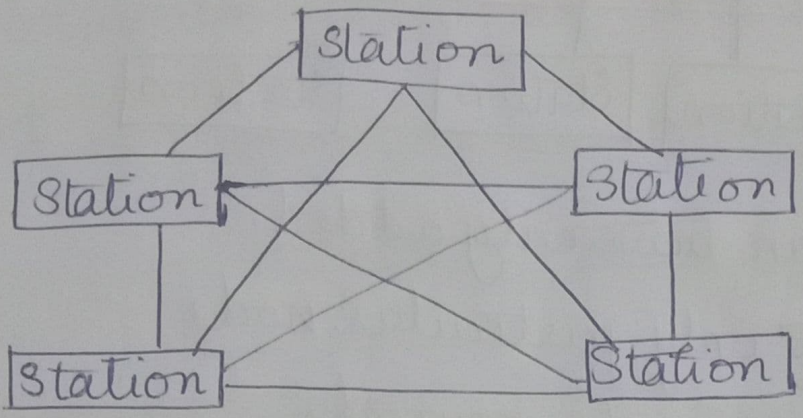
II Multipoint

Categories of Topology.

I Mesh II Star III Bus IV Ring

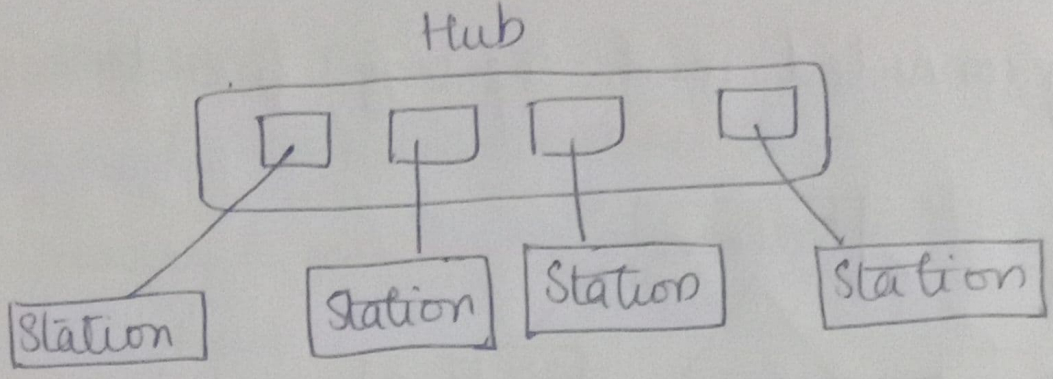
I Mesh

Fully connected mesh topology (five devices)



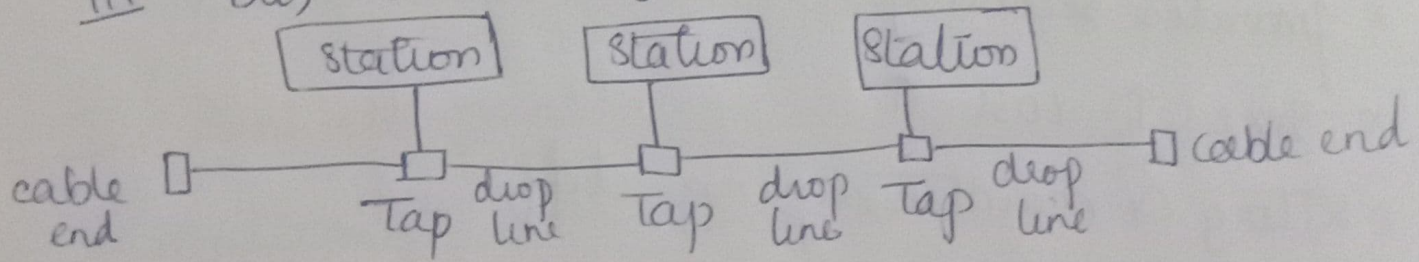
- x every station connected to every other station through dedicated channel.
- x no issue of data congestion
- x if one system fails, other s/m can comm. with others
- x provides security
- x size ↑ cost ↑
- x setting & maintaining diff.
- x more cabling
- x complicated & connections not fully utilized.

II Star Topology



- new node can be easily added.
- fault affects only particular node
- less cable than mesh required.
- if hub gets faulty entire connection gets affected
- traffic increased during simultaneous sending of data.

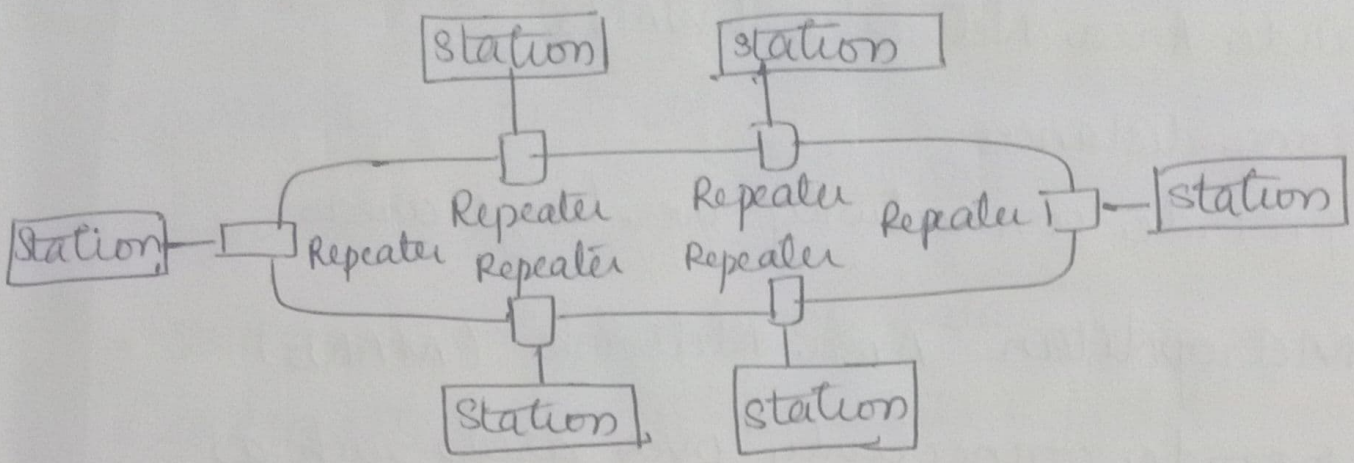
III Bus (connecting three stations)



- simplest to establish
- less cables than mesh
- central cable contains tap
- no need of special device like hub or switch

- entire network shuts down in case of faulty cable
- difficult to diagnose problem
- terminators required at both ends

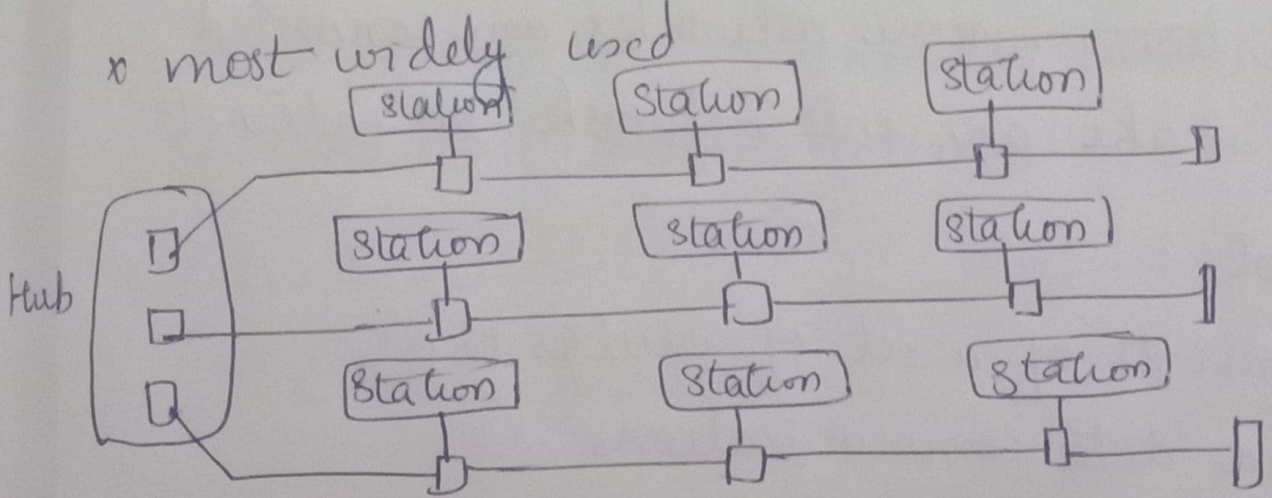
IV Ring (connecting six stations)



- unidirectional
- less chance of packet collision
- repeater - to boost signal
- more transmission time

V Hybrid Topology

- most widely used



Categories of Networks

I Local Area Networks (LANs)

- x short distances
- x designed to provide local interconnectivity

II Wide Area Networks (WANs)

- x long distances
- x provide connectivity over large areas

III Metropolitan Area Network (MANs)

- x provide connectivity over areas such as city or campus

x WANs of two types:

1) point-to-point WAN
2) switched WAN

The Internet

x when two or more networks are connected they make an internetwork or internet

Protocols

x It consists of a set of rules that govern data communications.

- It is synonymous with rule.
- It determines what is communicated, how it is communicated and when it is communicated.
- Key elements are
  1) syntax 2) semantics 3) timing

Elements of Protocol

I Syntax

- Structure or format of data
- indicates how to read bits - field delineation

II Semantics

- interprets the meaning of the bits
- knows which fields define what action

III Timing.

- when data should be send and what
- speed at which data should be sent or speed at which it is being received

Networks Models.

I The OSI Model

* Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international Standards.

* An ISO standard that covers all aspects of network communications is the open Systems Interconnection (OSI) model. It was first introduced in late 1970s.

* Seven Layers of OSI Model

7	Application	All
6	Presentation	People
5	Session	Seem
4	Transport	To
3	Network	Need
2	Data link	Domino
1	Physical	Pizza

I Physical Layer

* This layer is responsible for movements of individual bits from one hop (node)

to the next.

- data in form of bit stream

II Data Link Layer

- data in the form of frames.
- moving frames from one node to next.

III Network Layer

- Responsible for the delivery of individual packets from source host to destination host.
- which path needs to be taken to reach the destination.
- size of each packet

IV Transport Layer

- Responsible for delivery of message from one process to another.

V Session Layer

- responsible for dialog control and synchronization.

VI Presentation Layer

- responsible for translation, compression and encryption

VII Application Layer

- responsible for providing services to the user.

TCP/IP Protocol Suite

- The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport and application.
- However when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport and application
- ICMP - Internet Control Message Protocol
- IGMP - Internet Group Message Protocol
- RARP, ARP - address resolution

Frame header

Transport Layer

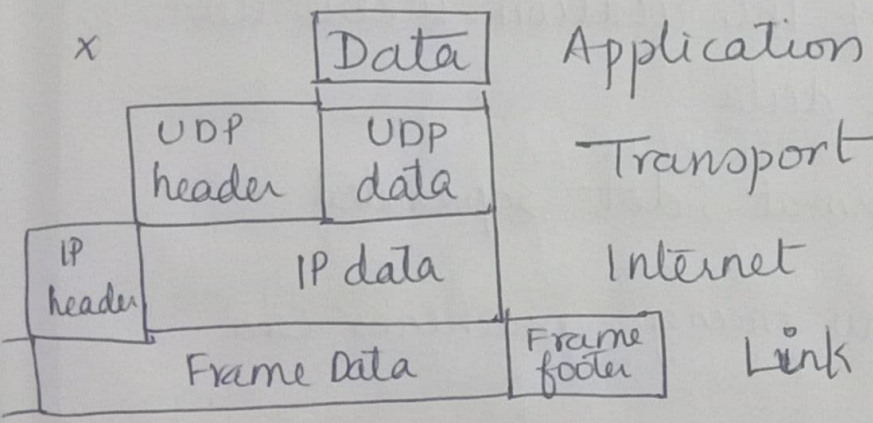
- unit that is being generated => segments.
- major protocol → TCP (Transmission Control Protocol)
  - takes care of connection establishment, flow control and error control
  - connection oriented protocol.

× UDP ⇒ User Datagram Protocol
↳ connectionless

Application Layer

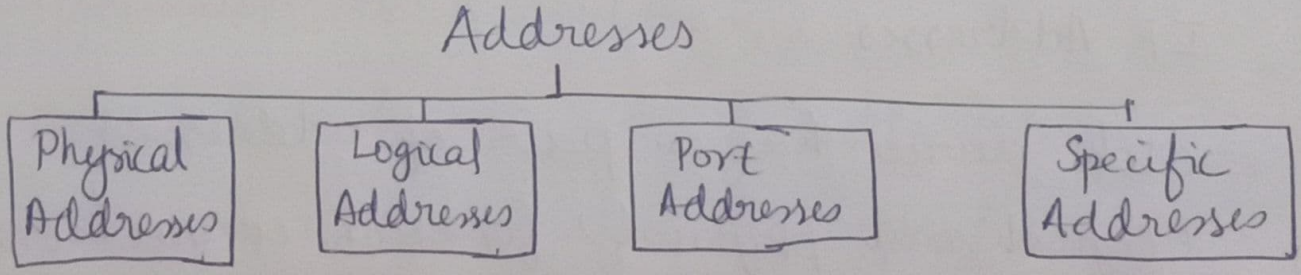
× FILE ⇒ FTP
email ⇒ SMTP
browsing ⇒ HTTP
getting connected to domain ⇒ DNS
establish connection with remote server } TELNET

Encapsulation and Decapsulation



× Sender ⇒ encapsulation
× Receiver ⇒ decapsulation

Addresses in TCP/IP



Relationship of layers and addresses in TCP/IP

- Application Layer → Specific Addresses
- Transport Layer → Port Addresses
- Network Layer → Logical Addresses
- Data Link Layer, Physical Layer → Physical Addresses

Physical Addresses

- physical address of the location where we have to send the data
- hexadecimal format ; dot separated
- Using 48 bits how many machines can be addressed
- Eg: A 6-byte (12 hexadecimal digits) physical address

07:01:02:01:2C:4B

IP Addresses

- each device has a pair of addresses (logical and physical) for each connection

- Logical address remains constant throughout communication.
- Physical address : diff acc to which device we send diff at diff points.
- During transmission, info of physical address in packet changes
- error ⇒ negative acknowledgement
- no error ⇒ +ve acknowledgement

Port Addresses

- multiple processes are running ⇒ we use port address
- Transport layer requests for port address or there is a standard port address.
- Although physical addresses change from hop to hop, logical and port addresses remain the same from source to destination

Application Specific Addresses

- Applications have user friendly addresses that are designed for that specific

application

- physical address - unique to particular device
- Logical address - used for communicating across diff s/ms

Multiplexing | Demultiplexing

- demultiplexing => one to multiple
- multiplexing => multiple to one
- TCP/IP performs multiplexing and demultiplexing.

OSI Model vs TCP/IP Model

- In OSI layers were designed first
- In TCP protocols were designed first.

Switching Techniques

I Circuit Switching

II Packet Switching

III Message Switching

I Circuit Switching

× circuit is set up b/w sender & receiver
× stream of data transmission takes place
× after transmission connection is released.

II Message Switching

× no setting up of connection between sender and receiver.
× msg moves to next node as such
× msg can be send or received at convenience
× need free resources to send data as a single chunk.

III ~~Messaa~~ Packet Switching.

× data split to standard size of units so that everyone has a chance to send data.
× At receiver's end msg will be ordered

:

→ call setup required in circuit but not in packet and message switching.
→ Circuit switching implemented at physical

layer.

Data and Signal

- Signal : form in which data is sent from sender end to receiver end.
- data can be transmitted in analog or digital form
- Analog data → Analog Signal Eg: Telephone
- Digital data → analog signal Eg: Modem
- Analog data → digital signal Eg: codec
- Digital data to digital signal Eg: digital transmitter
- Data manipulated in a form suitable to transmission channel
- To be transmitted, data must be transformed to electromagnetic signals

Analog and Digital Data

- Data can be analog or digital
- Analog => info that is continuous
- Digital => info that has discrete states

- Analog data take on continuous values
- Digital data take on discrete values

  ⇓

  binary voltage pulses
- Digital data → modem → Analog signal

  ⇓

  sequence of voltage pulses
- Analog Data (Analog signal) → Codec → Digital signal

Analog and Digital Signals

- Signals can be analog or digital
- Analog signals can have an infinite number of values in a range.
- Digital signal can have only a limited number of values.

Periodic vs Non-Periodic Signals

- A signal which repeats itself after a specific interval of time is called periodic signal

A signal which does not repeat itself after a specific interval of time is called aperiodic signal

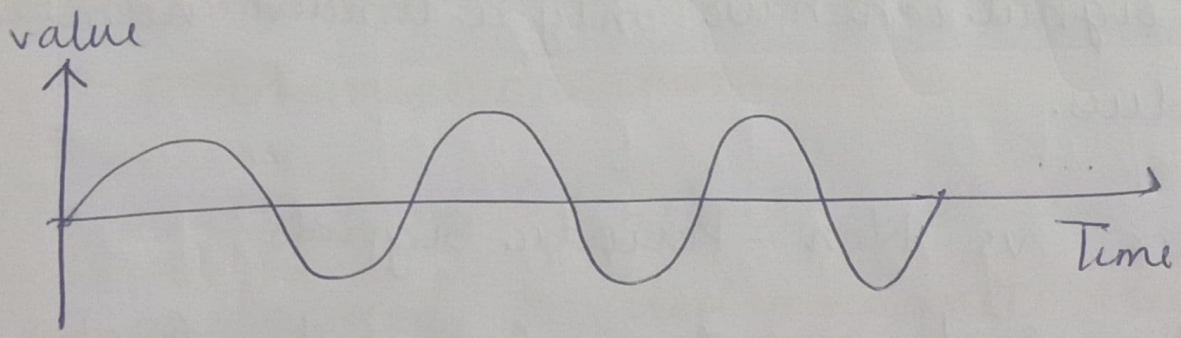
Periodic Analog Signals

- Periodic analog signals can be classified as simple or composite.
- A simple periodic analog signal, a sine wave, cannot be decomposed into simpler signals.
- A composite periodic analog signal is composed of multiple sine waves.

Digital Signals

- A digital signal can have more than two levels.
- Eg: 1 ⇒ +ve voltage
  0 ⇒ zero voltage

A sine wave

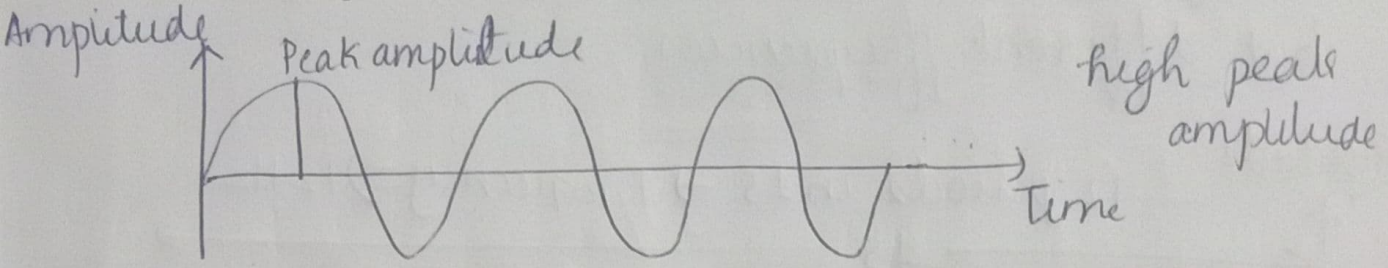


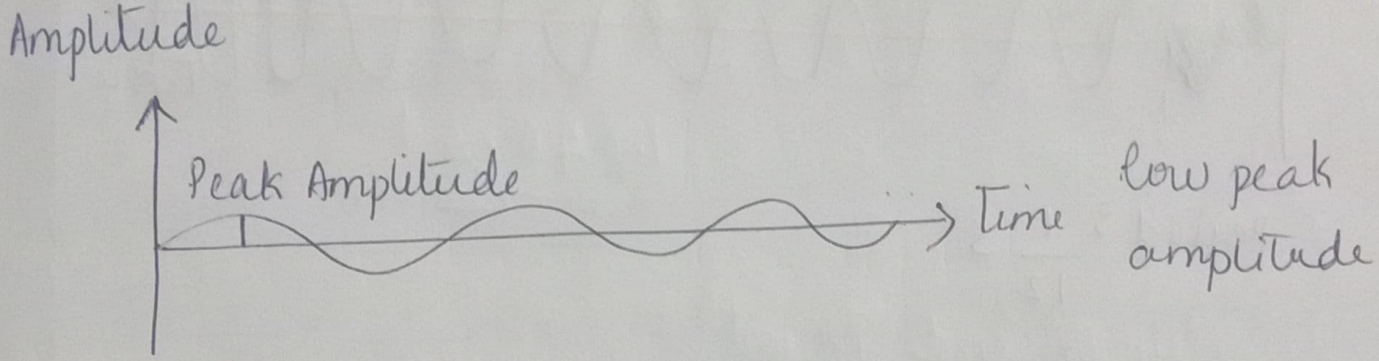
Parameters:

→ Peak Amplitude
→ Frequency
→ Phase

× Peak Amplitude of a signal is the absolute value of its highest intensity, proportional to energy it carries.

× Two signals with the same phase and frequency, but diff. amplitudes





~~Period~~ ⇒ value devoid of sign

× Absolute value of $-10 = 10$

" " " $52 = 52$

? volume of sound related with amplitude.

Period and Frequency.

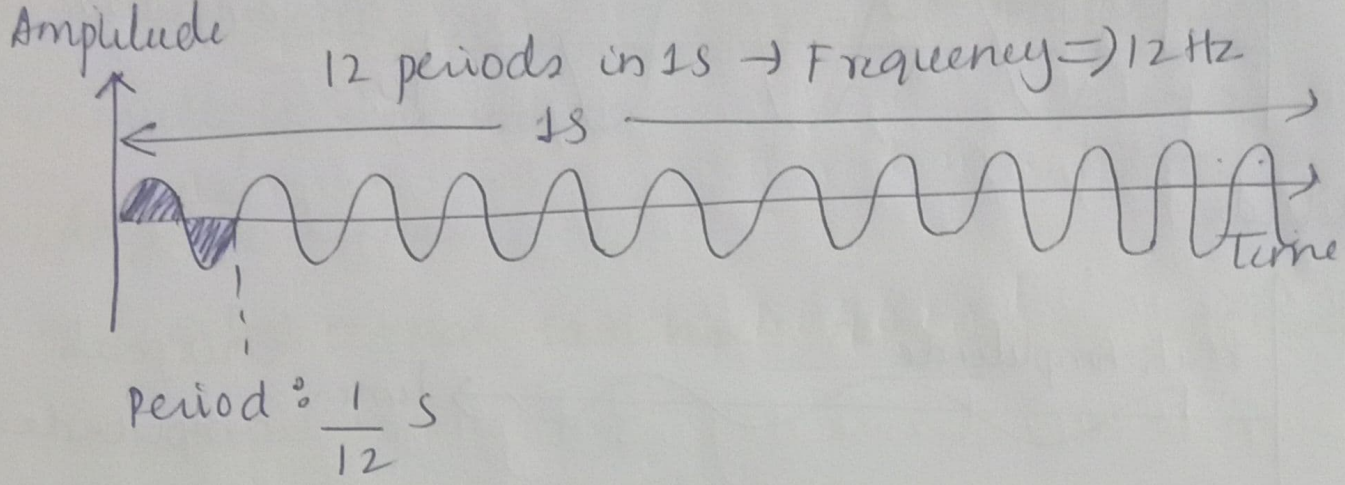
× Period - amount of time (in secs) a signal needs to complete 1 cycle

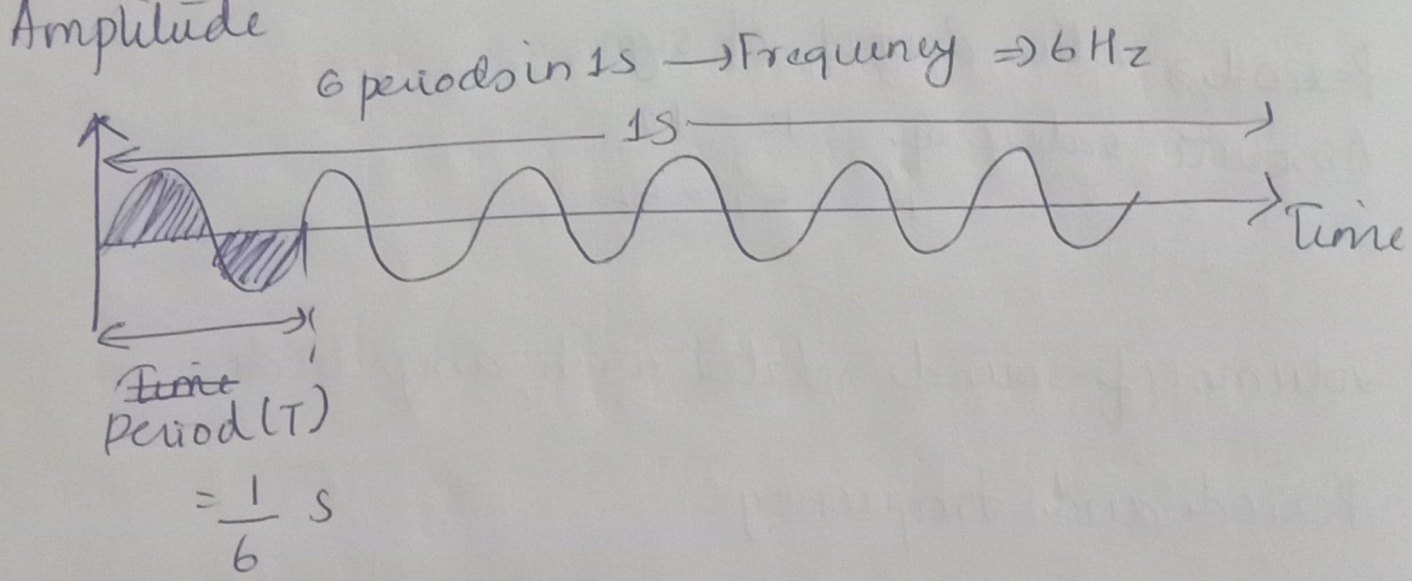
× Frequency - refers to number of periods in 1 sec (measured in Hz)

× Frequency and period are inverse of each other.

$$f = \frac{1}{T} \quad \text{or} \quad T = \frac{1}{f}$$

× Two signals with same amplitude and phase but different frequencies





× To cover one cycle it takes $\frac{1}{12}^{th}$ of a second

15/9/2021

Q) Power used at home has a frequency of 60 Hz. Period of sine wave?

Ans $T = \frac{1}{f} = \frac{1}{60} = 0.01665 = 0.0166 \times 10^{3}\ ms$

$= \underline{16.6\ ms}$

MCQ

Q) period of signal is 100ms. Frequency in kHz?

Ans $1\ Hz = 10^{-3}\ kHz$

$100ms = 100 \times 10^{-3}\ s = \underline{10^{-1}\ s}$

$f = \frac{1}{T} = \frac{1}{10^{-1}}\ Hz = 10Hz = 10 \times 10^{-3}\ kHz = \underline{10^{-2}\ kHz}$

Frequency

- rate of change w.r.t time
- change in short span ⇒ high frequency
- change in long span ⇒ low frequency
- If a signal does not change at all, its frequency is zero. (straight line)
- If a signal changes instanteously its frequency is infinite.