Characteristics of the Physical Links.

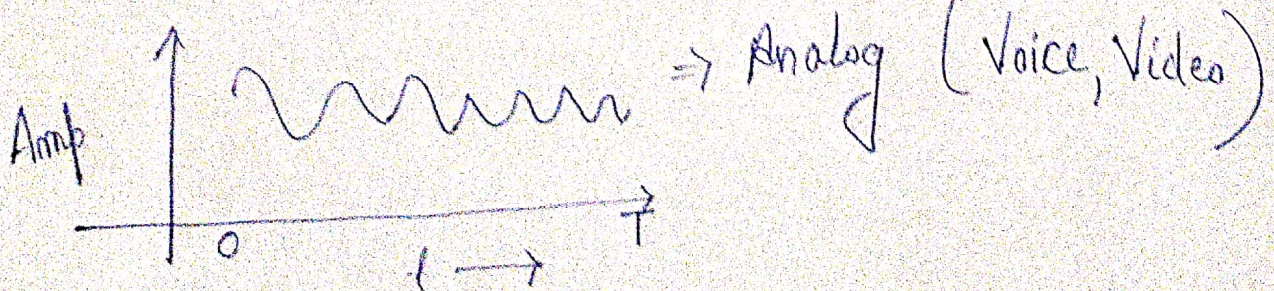
Data and Signals :→

Data : Data is an entity that conveys some Meaning based on some mutually agreed upon Rules/conventions betn a Sender and a Receiver.

Types: Analog : Continuous Values over time.
Digital

1000001 ASCII
('A')

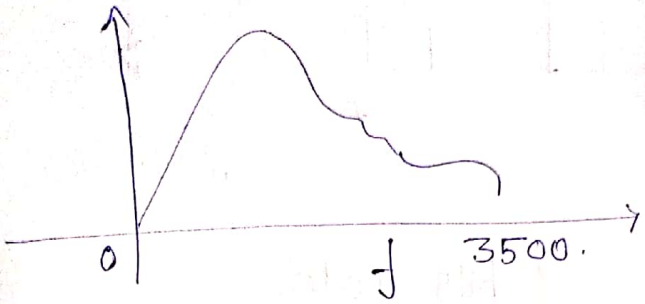
Data: What you can Interpret.



Audio or Acoustic Data:

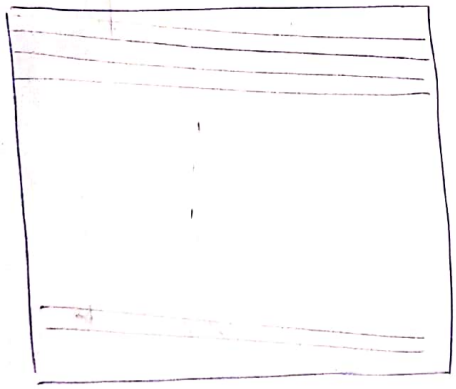
Voice → Ear

Mouth



20HZ — 20KHZ.

Video:



525 lines
483 lines
Interleaved.
30 times

Bandwidth = 4 MHZ (Excluding Colors)

Physical Parameters:

temp
Pressure
} Analog in nature

↓

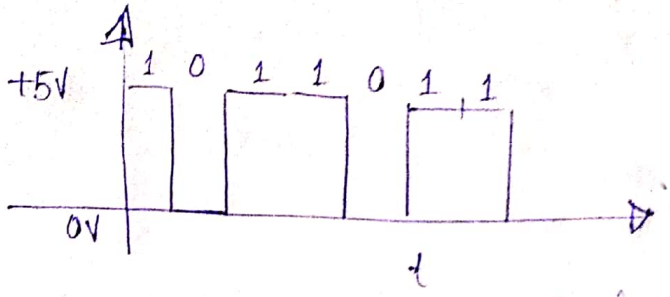
Transducer

↓

Analog in Nature → Electrical Signal (Voltage, current)

Digital Data:

Discrete Values



2-levels

Ex.

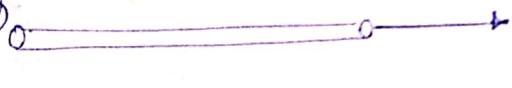
i) ASCII – 7 bits Code

A = 1001 0001

ii) Data Stored in the Memory

Signal :—

Data —transform→ Signals



Voltage, Current

⟶ pair of wires.

Optical Signal, light

⟶ Optical Fibre Cable.

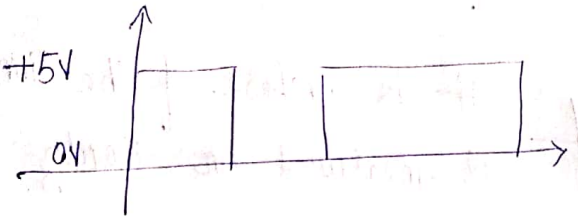
Magnetic

[Electrical, Optical, Electro-Magnetic]

Signal types:

Analog
Digital.

Digital data. ⟶ Digital Signals



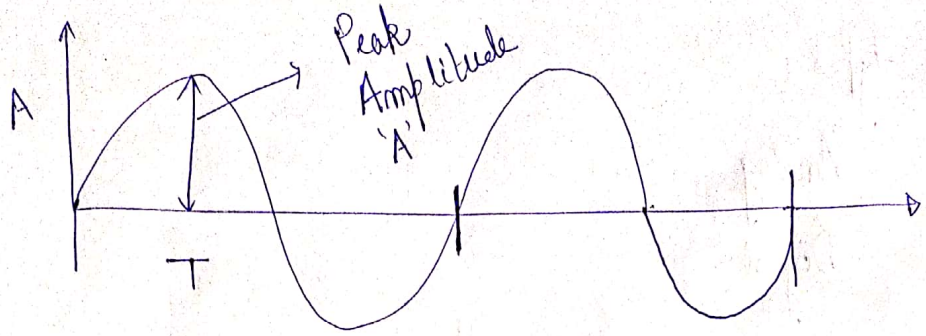
Analog Signal.

- Simple (Sine Wave)
- Composite (Mixture of Multiple Simple wave)

Periodic Signal: ⟶

A Signal is periodic if $s(t+T) = s(t)$, for $-\infty < t < \infty$, T: is the time period.

Parameters: Amplitude
Frequency
Phase.



T = time period.

$$f = \frac{1}{T}$$ → Frequency

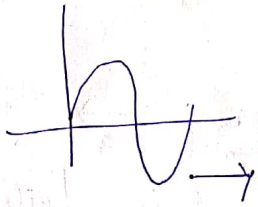
i) **Amplitude**: Value of signals at different instants of time. (in Volts)

ii) **Frequency**: It is inverse of the time period. It is measured in Hertz.

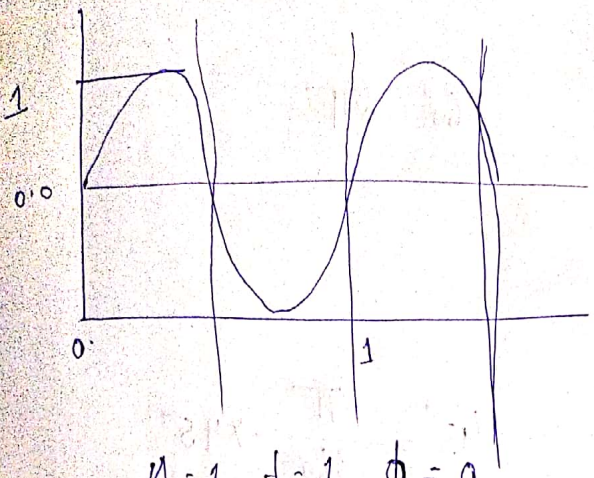
iii) **Phase**: It gives a measure of the relative position of two signals in time expressed in degrees or radian.

$$s(t) = A \sin(2\pi f t + \phi)$$

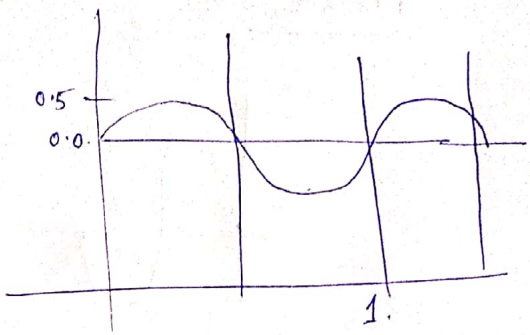
A ↓ P.A.



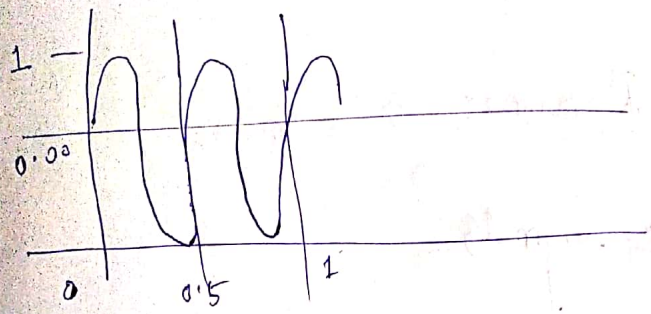
Amplitude Varying



$A = 1,\ f = 1,\ \phi = 0$



$A = 0.5,\ f = 1,\ \phi = 0.$



$A = 1,\ f = 2,\ \phi = 0$

$A = 1,\ f = 1,\ \phi = 45^\circ.$

Units of Parameters :—

Amplitudes : Volts, $mV = 10^{-3} V$

$KV = 10^{3} V$

Frequency : Hz, $KHz = 10^{3}$ H.

$MHz = 10^{6}$ Hz

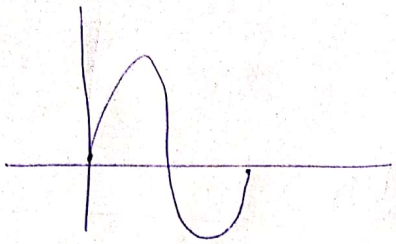
$GHz = 10^{9}$ Hz

$THz = 10^{12}$ Hz

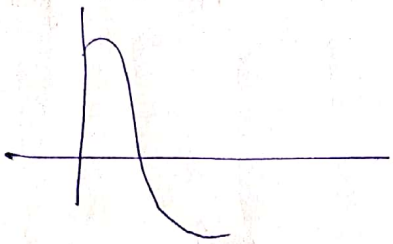
Time Periods : Second, $ms = 10^{-3}$ Sec, $\mu s = 10^{-6}$ s

$ns = 10^{-9}$ Sec., $ps = 10^{-12}$ Sec

Phase:



$360^\circ = 2\pi$



$45^\circ = \frac{2\pi}{360} \times 45$ Radian

Time and Frequency Domains: →

1) Electromagnetic Signals

↓

Composite Signals made up of many frequencies

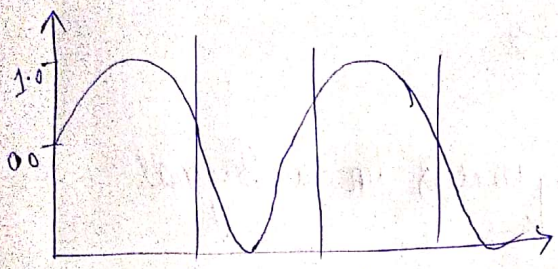
2) Vary the Amp, frequency or time

→ Composite Signals.

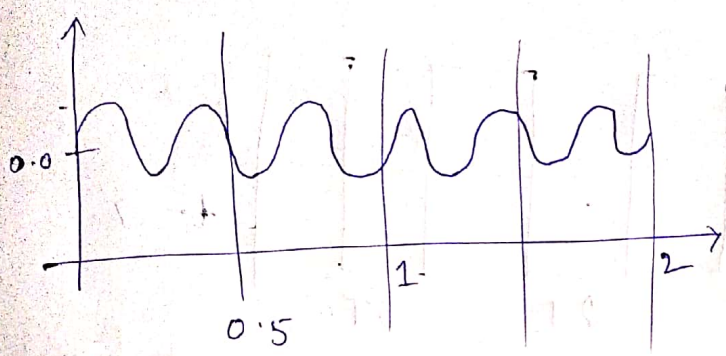
$$s(t) = A_1 \sin(2\pi f_1 + \phi_1) + A_2 \cdot \sin(2\pi f_2 + \phi_2)$$

Ex:

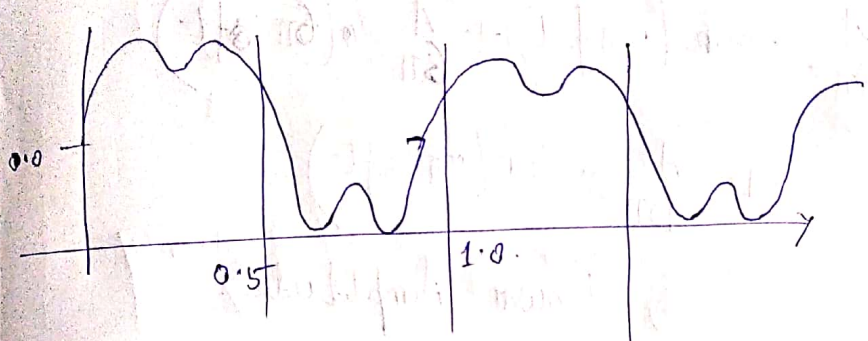
$$s(t) = \sin(2\pi f_1 t) + \frac{1}{3}\sin(2\pi(3f_1)t)$$



$\sin(2\pi f_1 t)$



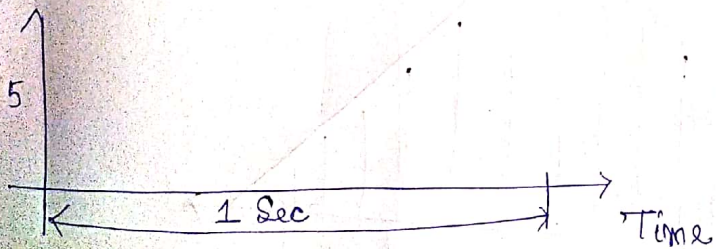
$\frac{1}{3}\sin(2\pi(3f_1)t)$

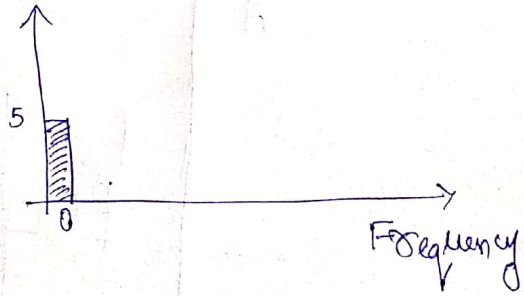


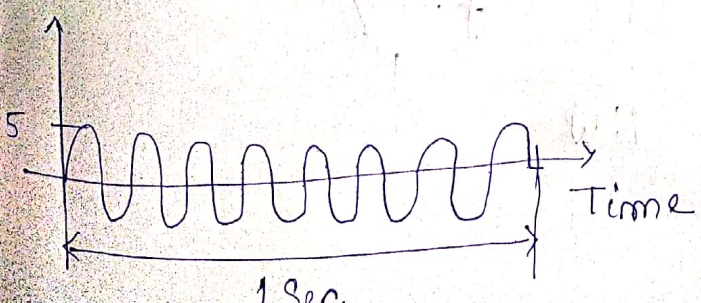
$$\sin(2\pi f_1 t) + \frac{1}{3}\sin(2\pi(3f_1)t)$$

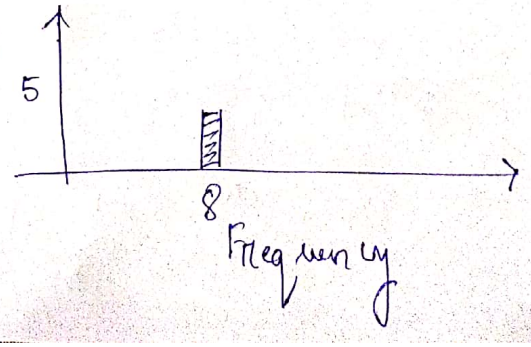
Time Domain

Frequency Domain





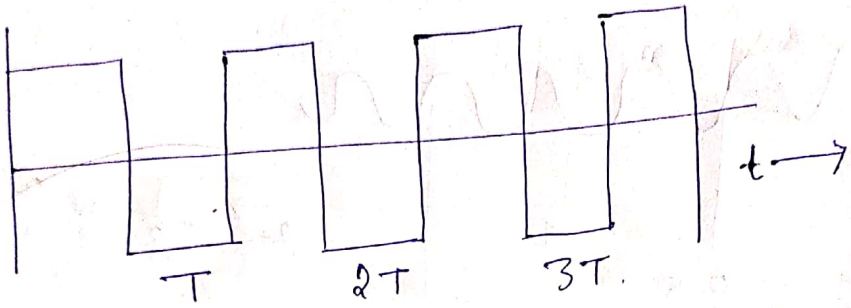




Frequency Spectrum :→

↳ Range of frequencies in a Signal

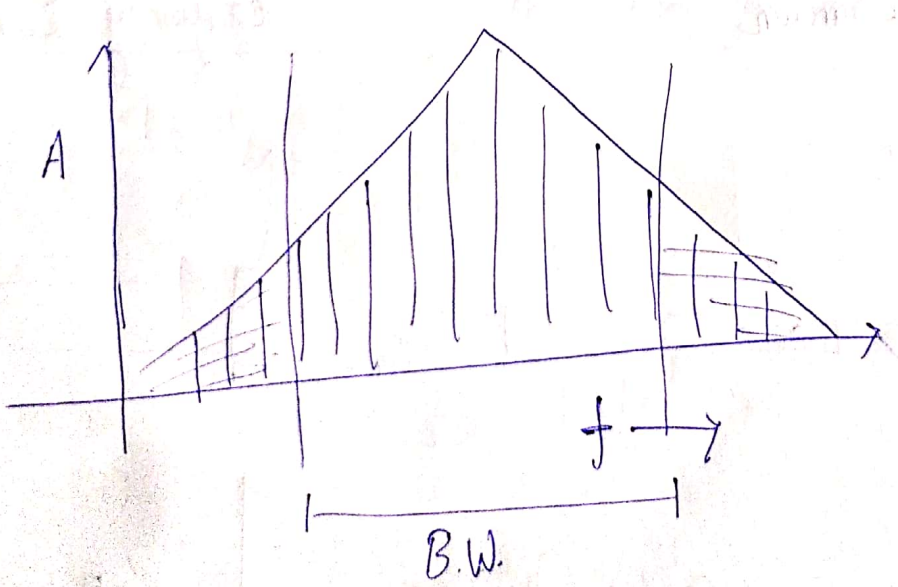
Ex: A Square Wave



$$s(t) = \frac{A}{2\pi} \sin(2\pi f t) + \frac{A}{6\pi} \sin(6\pi f t) + \frac{A}{10\pi} \sin(2\pi 5 f t)$$

→ Lower Amplitude

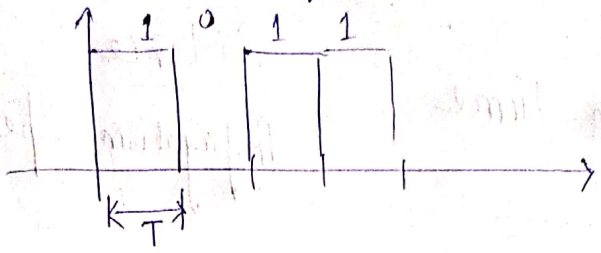
Bandwidth :→



Digital Signals:

Bit Interval:

Time required to send a single bit



Bit Rate:

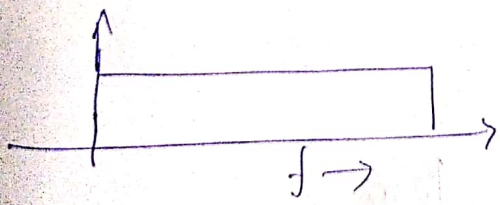
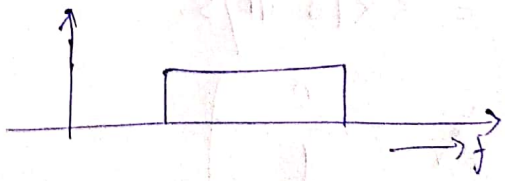
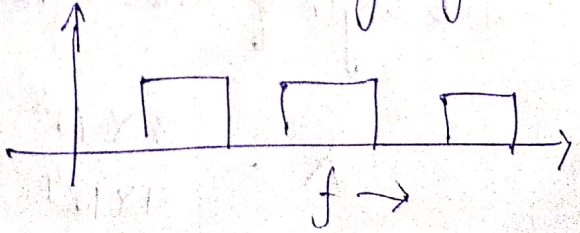
It is the no. of bit intervals per sec (bps)

$$\text{Bit Rate} = \frac{1}{T}$$

Kbps $= 10^3$ bps

Mbps $= 10^6$ bps

Gbps $= 10^9$ bps.

Digital Signal	Analog Signal
i) Low Pass Channel 	i) Band Pass Channel. 
ii) Only one Digital Signal	ii) Multiple Analog Signal. 

Propagation time:

Time required for a signal to travel from one point of transmission to the other in the Medium.

$$\text{Propagation time} = \frac{\text{Distance}}{\text{Propagation Speed}}$$

Wavelength:

Distance occupied in space by a single period.

$$\text{Wavelength} = \text{Propagation Speed} \times \text{Period}$$

$$= \text{Propagation Speed} / \text{Frequency}$$

Example:

1) Speed of Electromagnetic Signal in free space

$c = 3 \times 10^8$ m/s.

$$\lambda = \frac{c}{f}$$

Wavelength of Red light = 4×10^{14} Hz (Freq.)

$$\therefore \lambda = \frac{3 \times 10^8}{4 \times 10^{14}} = 750 \text{ nm}.$$