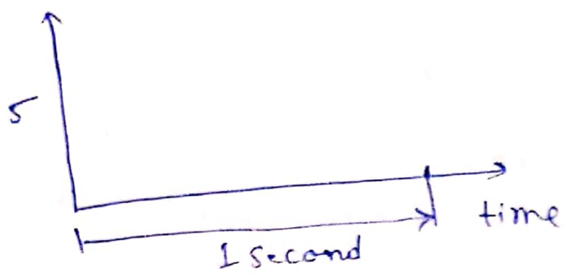
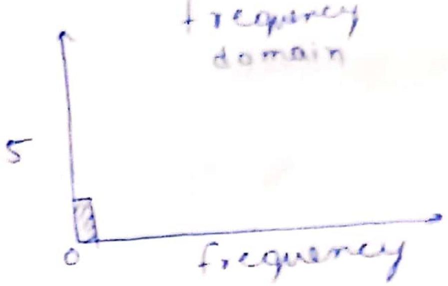
L-3

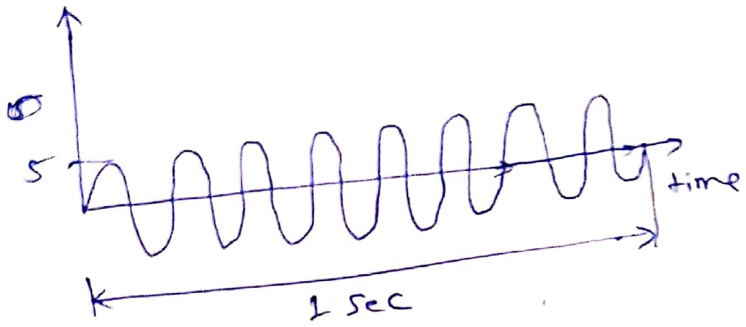
frequency and time domain

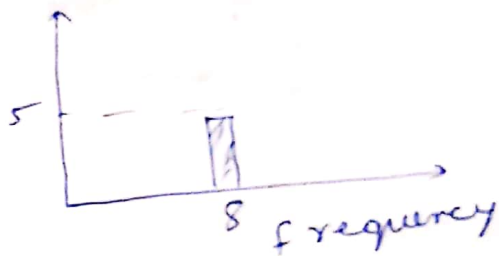
time domain

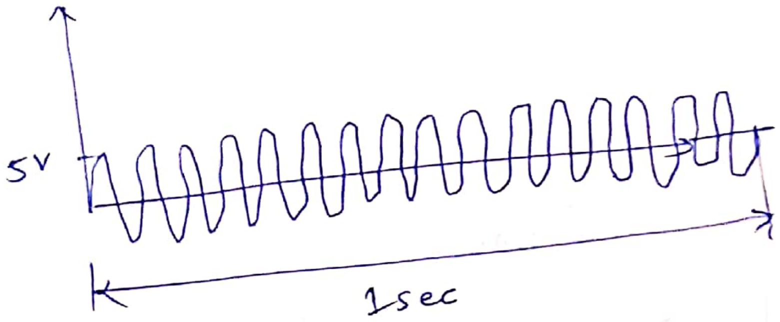
frequency domain

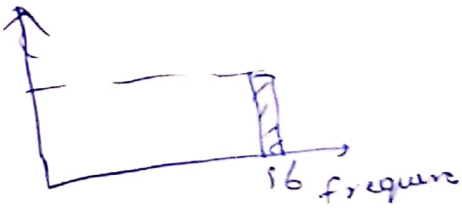










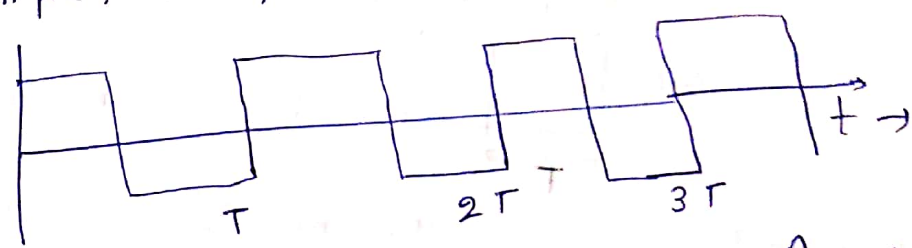


frequency Spectrum

- frequency sepectrum of a Signal is the range of frequencies a Signal contains

Example :- A square wave.

$f = \frac{1}{T}$



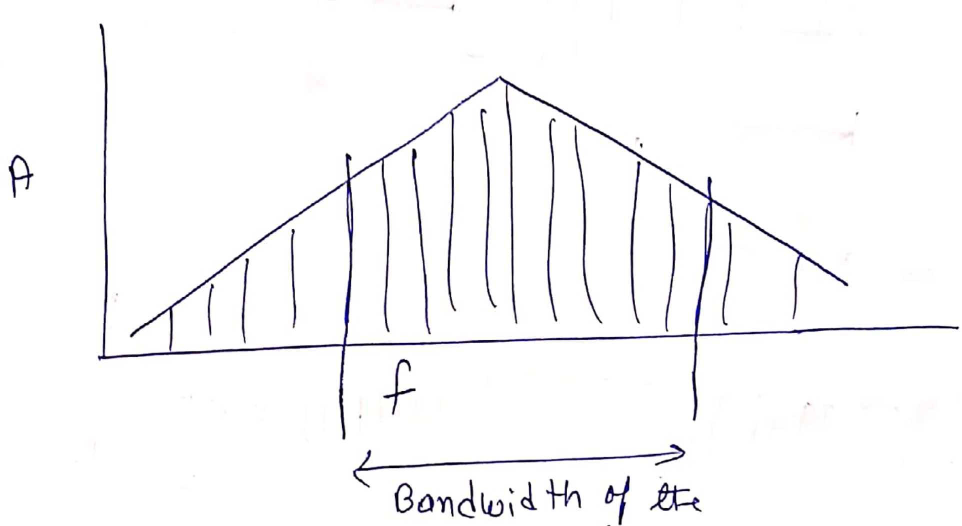
$$s(t) = \frac{A}{2\pi} \sin(2\pi f t) + \frac{A}{3\pi} \sin(6\pi f t) + \frac{A}{10\pi} \sin(2\pi 5 f t)$$

Harmonics — lower amplitude.

in case of signal frequency spectrum will be very large. Amplitude is lower.

Bandwidth

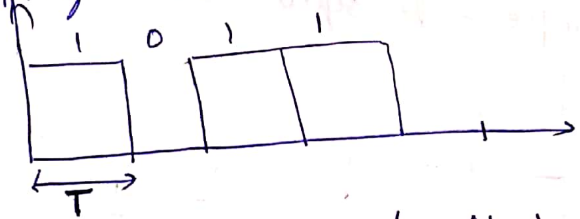
- Range of frequencies over which most of the signal energy of a signal is contained is known as bandwidth or effective bandwidth of the signal. The term 'most' is somewhat arbitrary



Digital signal → infinite no. of frequency.

Bit interval and Bit rate

Bit interval → It is the time required to send a single bit.



Bit rate :- It is the no. of bit intervals per seconds (bps)

kbps $= 10^3$ bps
mbps $= 10^6$ bps
Gbps $= 10^9$ bps

$$\boxed{\text{Bit rate} = \frac{1}{T}}$$

No. of symbol send in per sec.

Propagation time and wavelength

Propagation time :- time required for a signal to travel from one point of transmission medium to the other.

propagation time = distance/propogation speed.

wavelength :- Distance occupied in space by single period

wavelength = propagation speed × period.

= propagation speed/frequency.

Example

Speed of electromagnetic signal in free space → 3×10^8 m/s

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

wavelength of red light ⇒ 4×10^{14} Hz → frequency.

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

transmission impairments and channel capacity

impairments

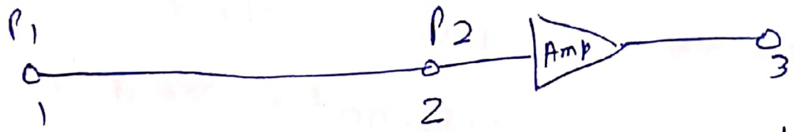
- To send data we have to send signal through a communication medium
- A medium is not ideal. The imperfections causes impairment in the signals

impairment
- Attenuation
- Distortion
- Noise.

Attenuation :- Attenuation leads to loss of energy expressed in decibel.

$$dB = 10 \log_{10}(P_2/P_1)$$

- It decides how far a signal can be sent without amplication.



An amplifier can be used to compensate the attenuation of the medium.

Decibel (dB) is a measure of the relative strengths of two signals. If P_2 and P_1 are signal strengths at two different points 2 and 1 respectively, then relative strength at the second point with respect to the first point in dB is $dB = 10 \log_{10}(P_2/P_1)$

How fast data can be sent?

It depends on three factors

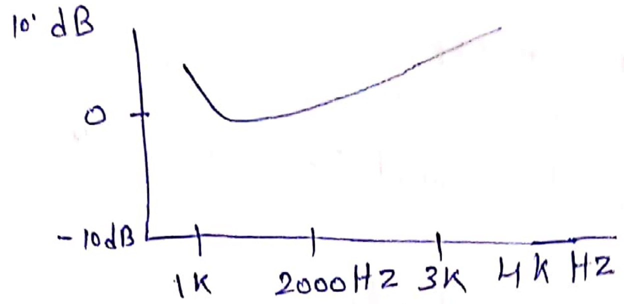
1) Bandwidth of the channel
2) No. of levels used in the signal
3) Noise level in the channel.

Distortion :- Some frequencies are passed without attenuation, some are weakened and some are blocked. This leads to distortion.

L-3(2)

Attenuation Distortion

- Attenuation varies as a function of frequency. This is known as Attenuation distortion
  Example:- voice grade telephone line.



Nyquist Bit Rate

Noiseless channel

max bit rate $C = 2 \cdot B \cdot \log_2 L$

$C \rightarrow$ Channel capacity.
$B \rightarrow$ Bandwidth of the channel
$L \rightarrow$ No. of signal levels used

Baud Rate

No. of distinct symbols transmitted per second, irrespective of the form encoding.

for baseband digital transmission $L = 2$

maximum Baud Rate $= \dfrac{1}{\text{Element width}} = 2B$.

0V
1V
0V
0.5V
1.0V
2.0V

Bit rate or information rate (I)

No. of bits transmitted per second.

No. of bits transmitted per second
No. of bits per Baud

I = Baud Rate X Bits per Baud
$= \text{Baud Rate} \times N = \text{Baud Rate} \times \log_2 M$

for binary encoding, the bit rate and the baud rate are the same i.e

I = Baud Rate

Noise

It Causes to interpreted as a signal of greater level if it is in positive phase or a smaller level if it is negative phase.

Signal to noise Ratio

P = average Signal power

N = Avg noise power.

$$\frac{S}{N} = \frac{\text{average Signal power}}{\text{Avg noise power}} = \frac{P}{N}$$

$$\left(\frac{S}{N}\right)_{dB} = 10 \log\left(\frac{S}{N}\right)$$

Shannon Capacity (Noisy Channel)

Shannon Capacity gives the highest data rate for a noisy channel

$$C = B \times \log_2 (1 + S/N)$$

where S/N is the signal to noise ratio.

In Case of extremely noisy Channel C = 0

Noise ~~nois~~ types

~~ter~~ thermal ⇒ $N = K.T.B$ ~~vot~~

Intermodulation → signals of different frequencies share the same medium

crosstalk → unwanted coupling.

impulse noise →