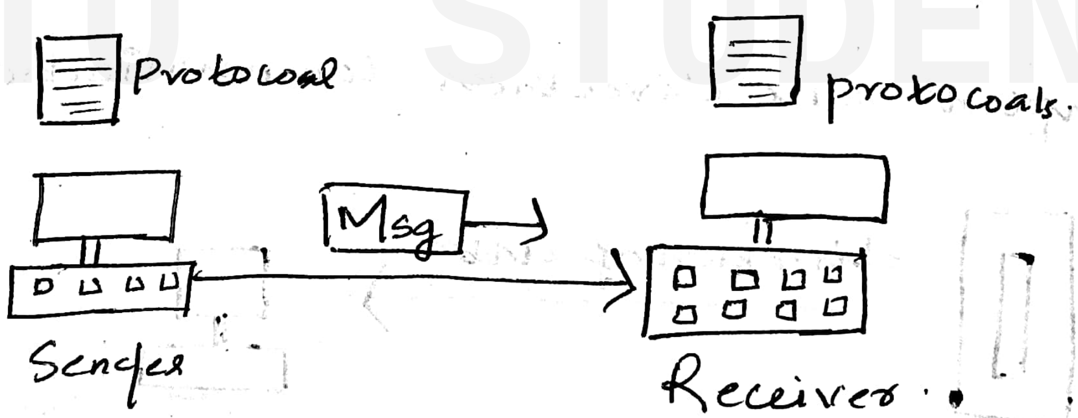
Module - 1

Effectiveness of communication

1. Delivery
2. Accuracy
3. Timeliness
4. Jitter - package variance.

Components

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



Data Representation:

1. ~~Bf~~ Text - binary numbers
   - ✓- ASCII code
   - Extended ASCII
   - ✓- Unicode
   - ISO-32

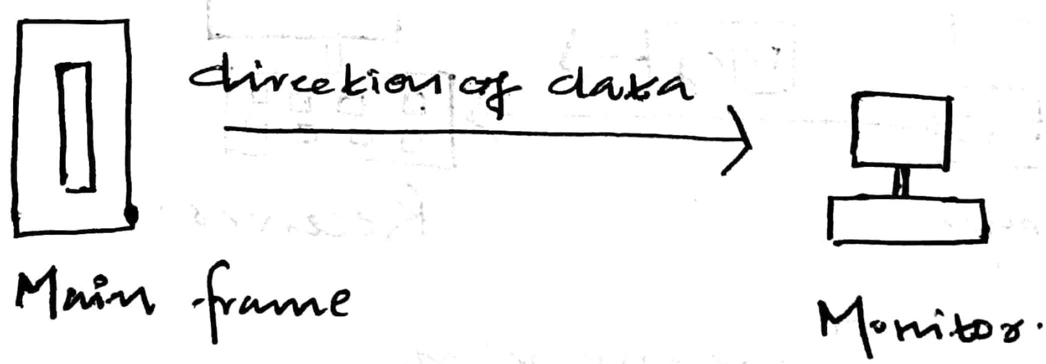
2. Audio } continous transmission.
3. Video }
4. Image - pixel is used represted.
- Grey Scale (2 bit)
- black and white (1 one bit)
- Colored (3 bit, RGB)

Communication Models

1. Simplex
2. Half duplex
3. Fullex duplex

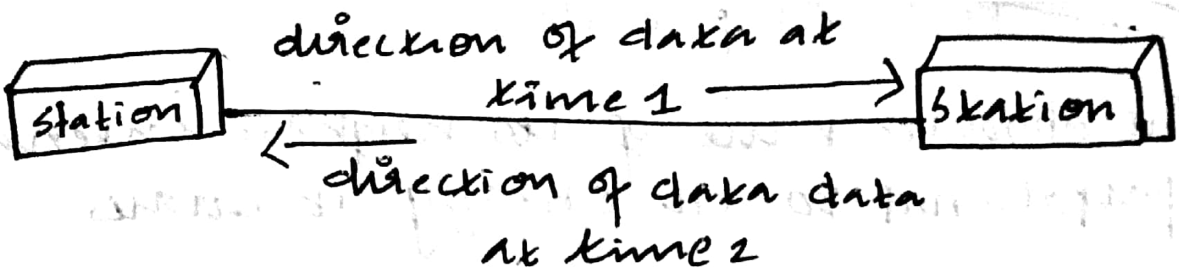
1. Simplex:- One direction communication onl

eg:1

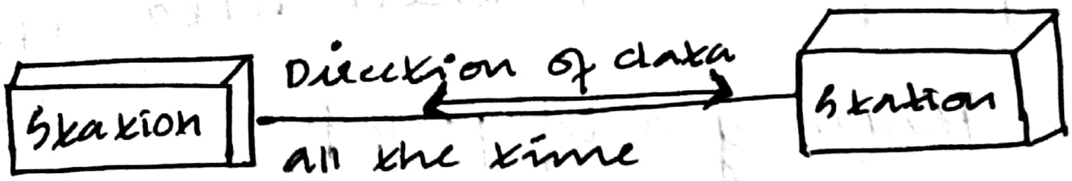


eg:2 keyboard.

2. Half duplex:- At a time only one direction communication can be done
eg: walkie talky



3. Fullex duplex / duplex :-

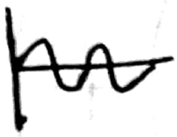


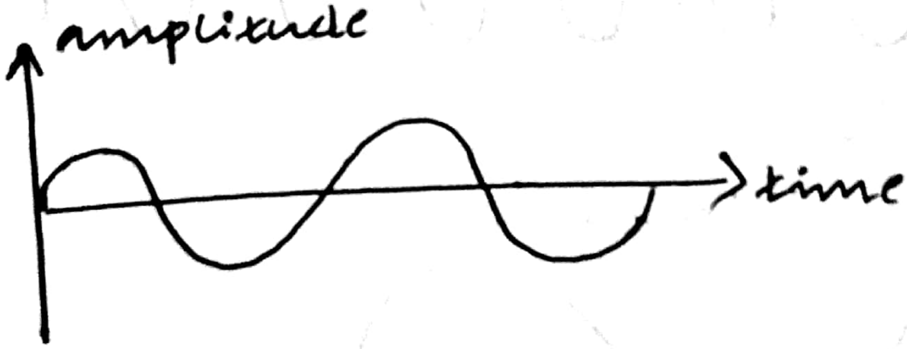
- eg: Telephone – bidirectional communication

Path can be shared.

Periodic Analog Signals.

1- simple
2- composite

1- simple – sine wave 



parameters:

- Peak amplitude
- Frequency
- phase

Peak Amplitude :-

The absolute value of its heighest intensity, proportional to the energy it carries

eg: if volt = 120 then peak amplitude $= 120 \times \sqrt{2}$
$= 170$

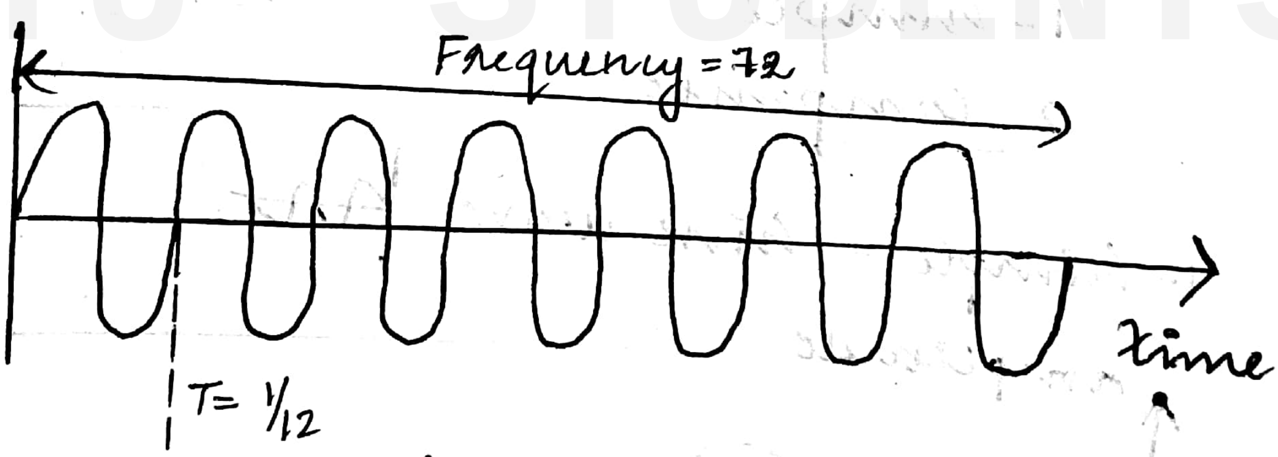
if amplitude = 170 then volto = $\frac{170}{\sqrt{2}}$

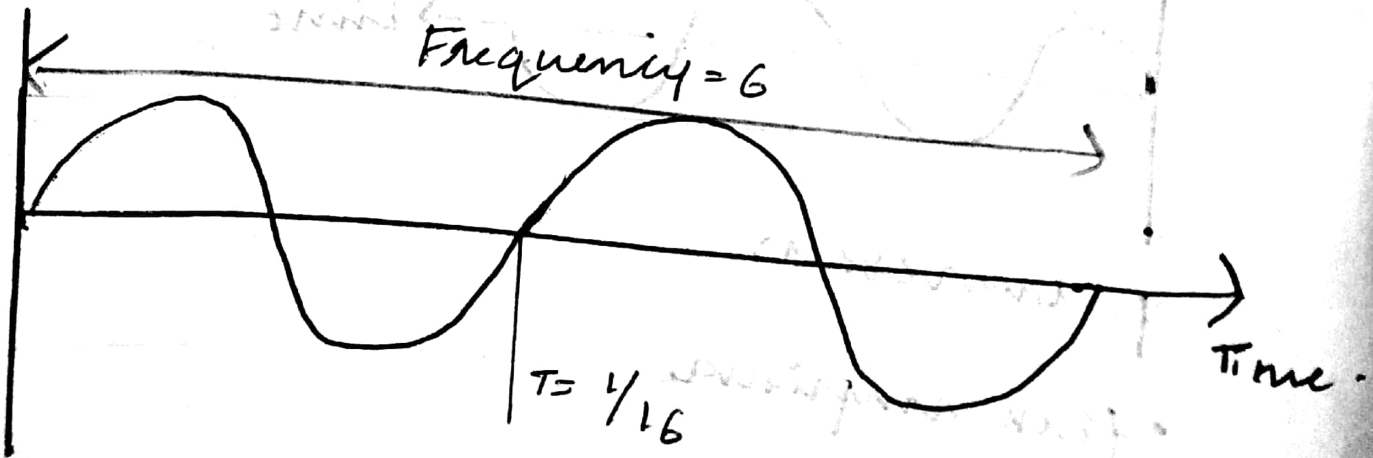
Frequency and period :-

period refers to time in second a signal needs to complete one cycle. ~~A signal acc~~

Frequency refers to the no: of periods in one cycle.

$$\boxed{F = \frac{1}{T} \;/\; T = \frac{1}{f}}$$





Q. Frequency = 16 find Period in milliseconds.

$f = 50 \quad T = \frac{1}{50}$ $\quad T = 1/16\times10^3 = 16.6\,ms.$

$= 0.2$

Q. Express a period of 100ms in microsecond.

$= 100\times10^{-3}\times10^{6}$

$= 100\times10^{3} = \underline{\underline{10^5}}$

Q. period of a signal is 100 ms what is the frequency in kilohertz

$T = 100\,ms = 100\times10^{-3}\,sec$

$f = \frac{1}{10^{-1}} = 10\,Hz = 10\times10^{-3}\,KHz.$

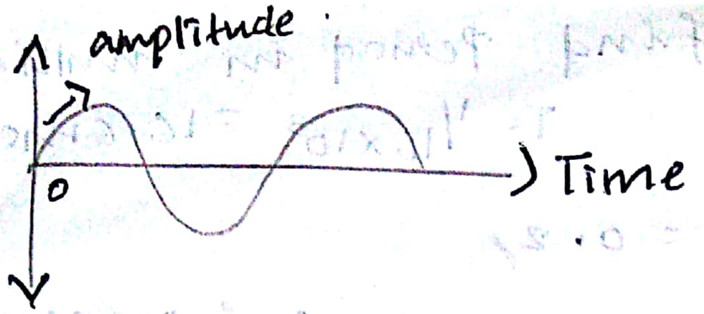
$= \underline{\underline{10^{-2}\,KHz}}$

✓ Frequency is the rate of change w.r.t time. change in short span of time is high frequency. Change over a long span of time is low frequency.

4/8/17 phase:-

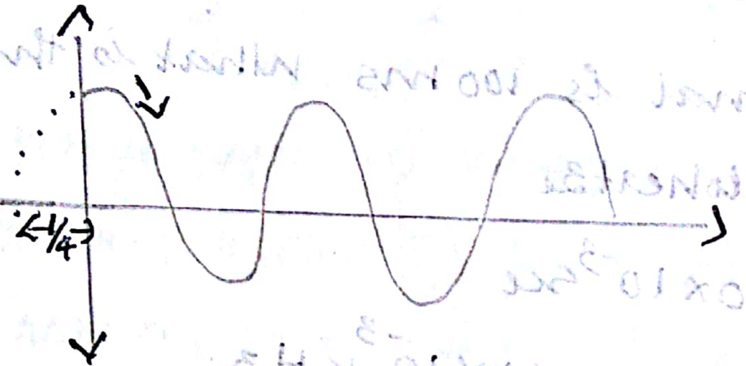
phase describes the position of the wave form relative to time '0'. Phase is the amount of forward / backward shift of wave along with time axis. Unit - Degree / radian

$360° / 2\pi$



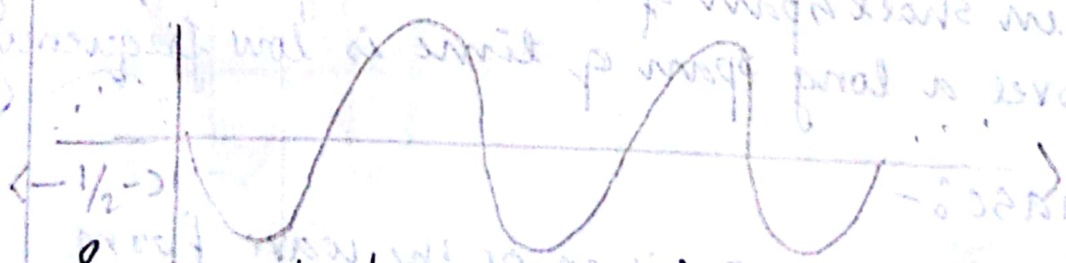
Phase = 0°

with phase 0° starts at time zero with zero amplitude and amplitude ↑ses.



Phase = 90°

with phase 90° at time zero with peak amplitude and amplitude decreases.



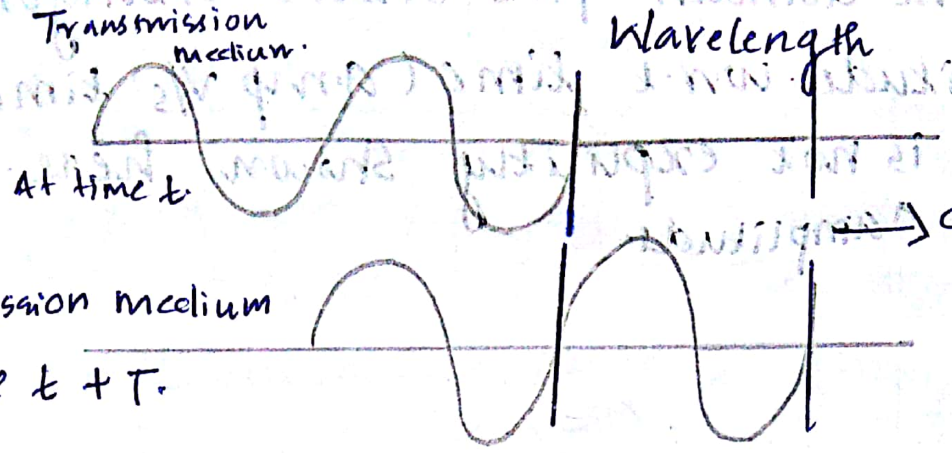
Ph

Starts at time 0 with zero amplitude and amplitude decreases.

Q A sin wave is offset 1/6 cycle w.r.t time=0 what is the phase in degrees and radians.

degree = 60° radian = $60 \times \frac{2\pi}{360}$ $\pi/3$

~~to~~ wavelength binds ~~&~~ the period or the frequency of a simple sin wave to the propogation speed.



wavelength is a distance a simple signal can travel in one second

Wavelength = Propogation Speed X Period

$$= \frac{\text{Propogation Speed}}{\text{frequency}}$$

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

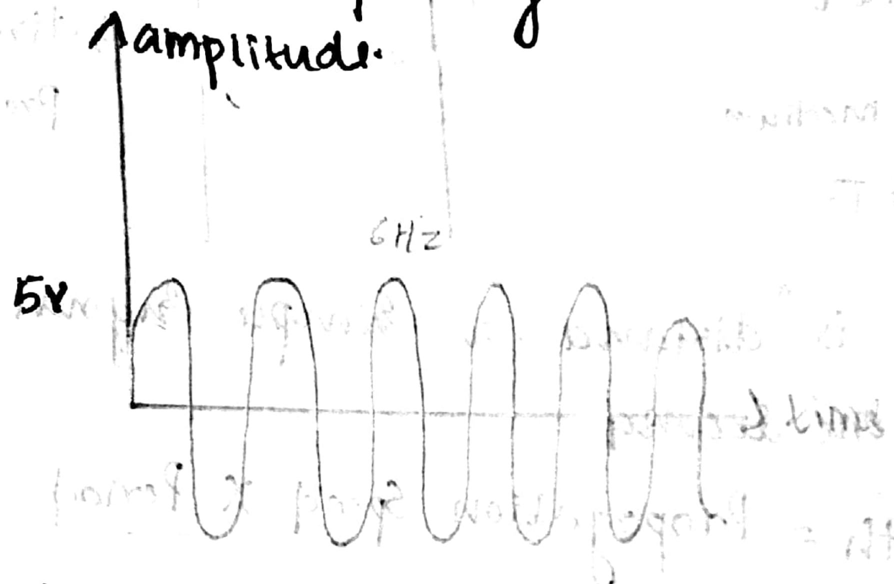
Q: ~~In vacuum wavelength of redlight~~ ~~f = 4 x 10^14~~. find λ of redlight ~~of redlight~~ in air if frequency is 4×10^{14}.

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

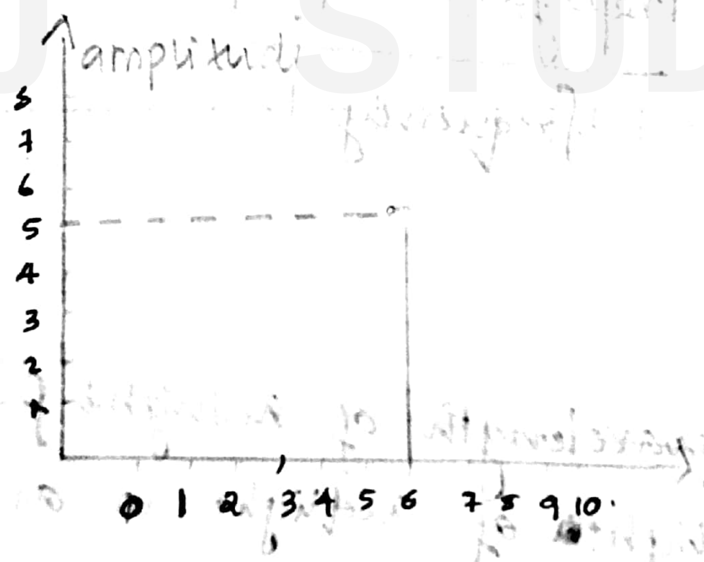
$\lambda = \frac{3 \times 10^8}{4 \times 10^{14}} = 0.75 \times 10^{-6}$ m.

Time and frequency domain.

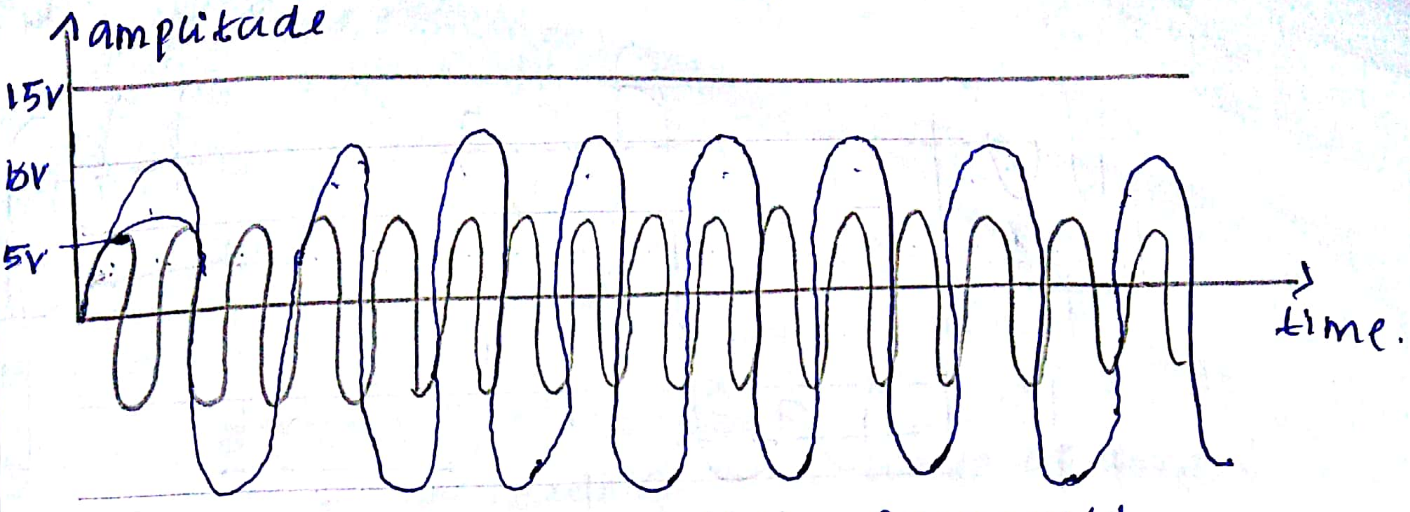
Time domain plot shows changes in signal amplitude w.r.t time (amp v/s time flow) Phase is not explicitly shown here.



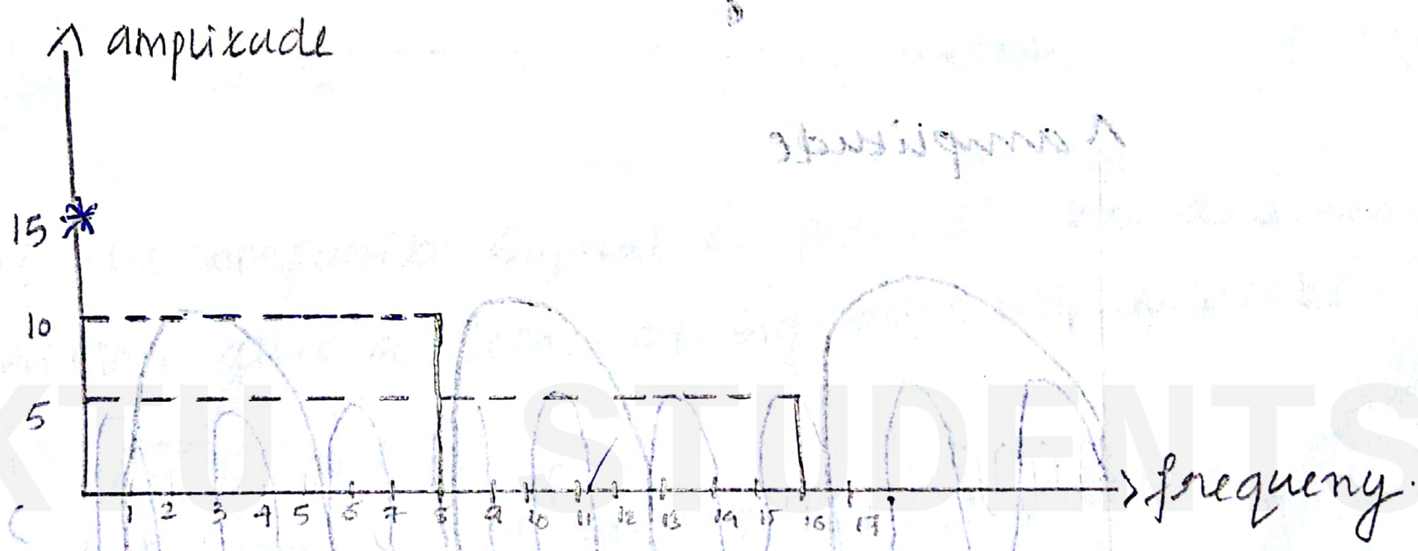
Frequency domain



A frequency domain plot is concerned with only the peak value and frequency. Changes of amplitude in one period are not shown here.

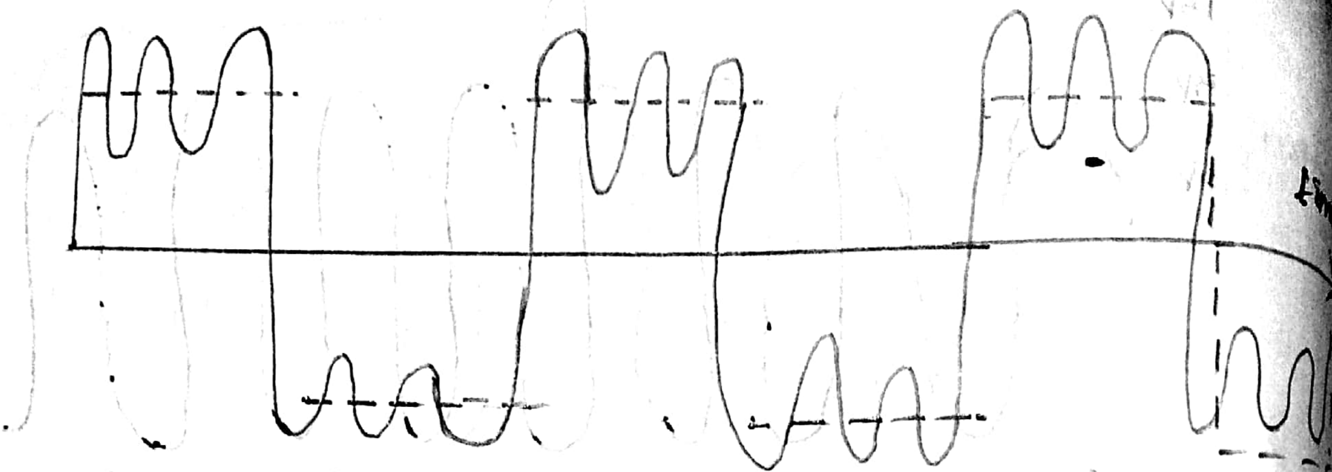


Sin waves with 0, 8, 16Hz frequency

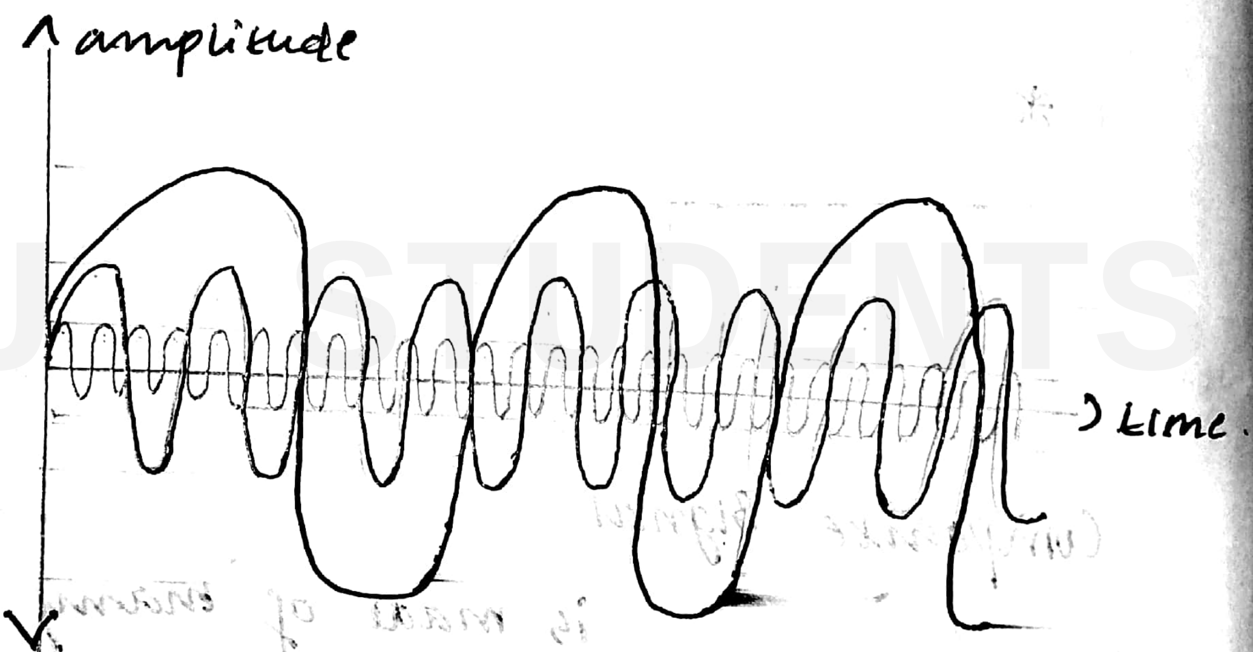


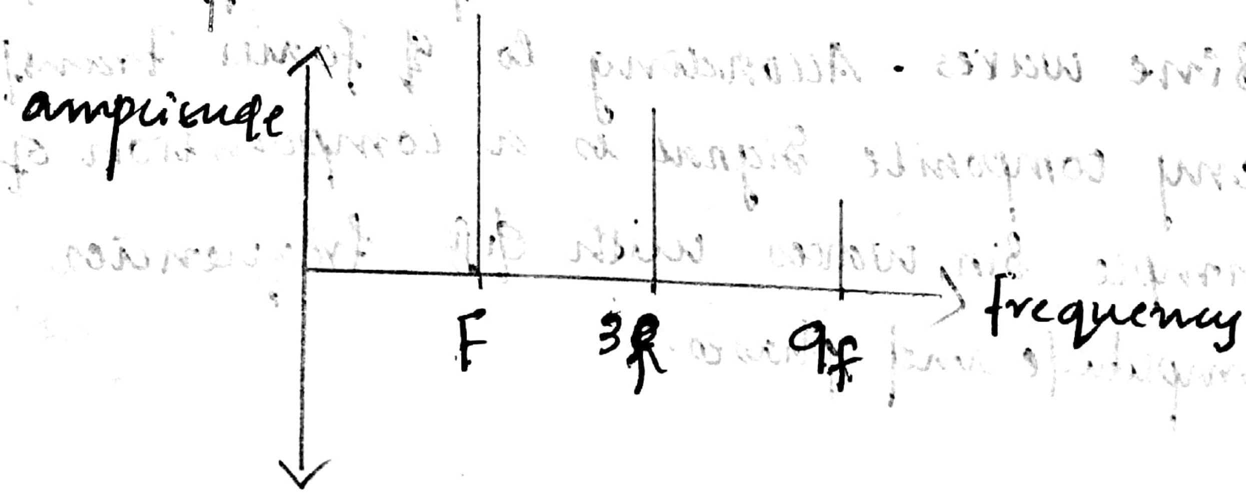
Composite Signal

is made of many simple sine waves. According to a Fourier transform, any composite signal is a composition of simple sin waves with diff frequencies, amplitude and phases.

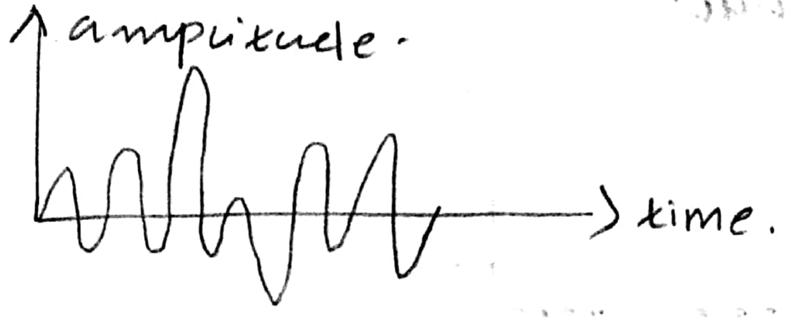


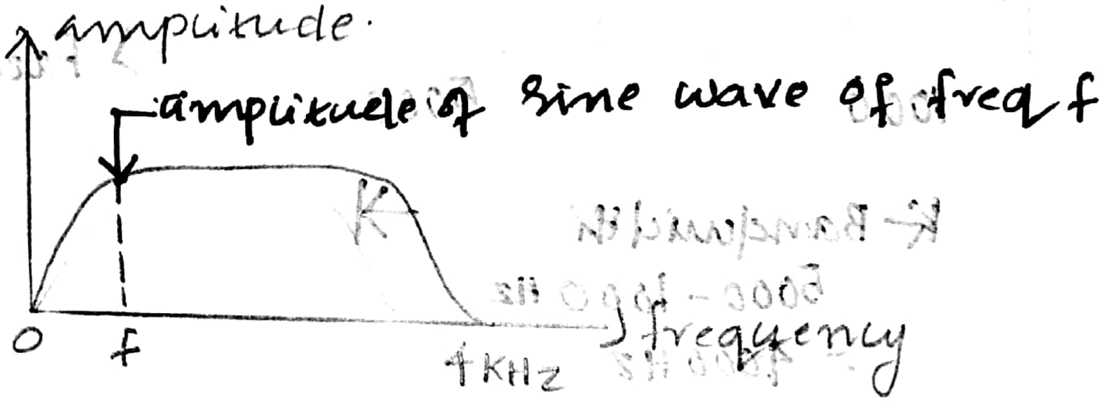
3 alarm system.





Human voice.

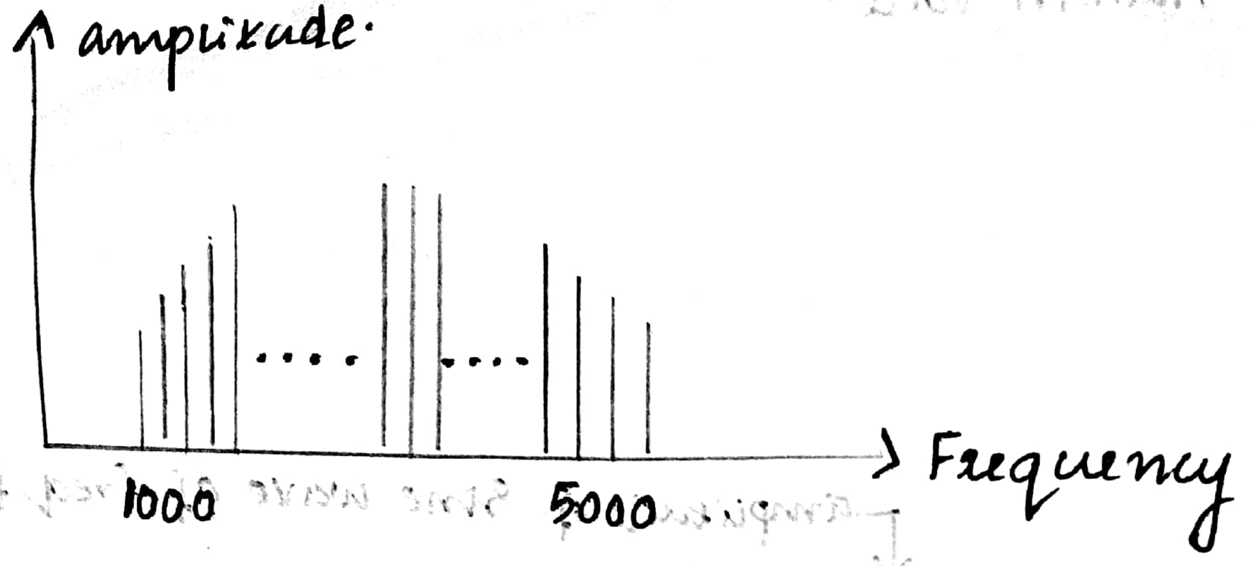




- If the composite signal is periodic the decomposition gives a series of signals with discrete frequencies
- If the composite signal is non periodic, the decompos^n gives a combination of sin wave with continous frequencies.

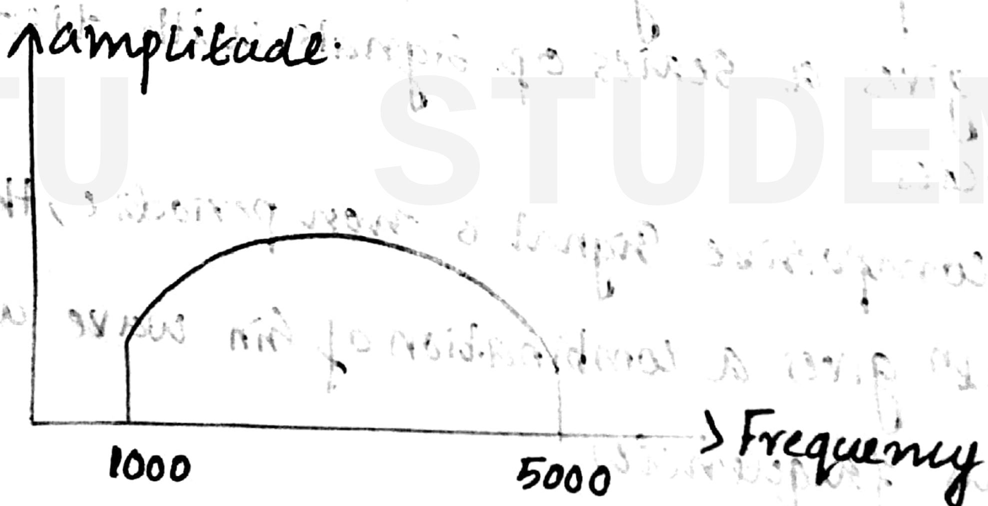
Band width.

Range of frequencies contained in a composite signal is its bandwith. The BW of " " is the diff b/w the heighest & lowest frequencies contained in that signal



K Bandwidth →
5000 - 1000 Hz
= 4000 Hz

BW of periodic Signal



K BW - 5000 - 1000 →
= 4000 Hz

Q If a periodic signal is decomposed into 5 sin wave with frequency of 100, 300, 500, 700 & 900 Hz

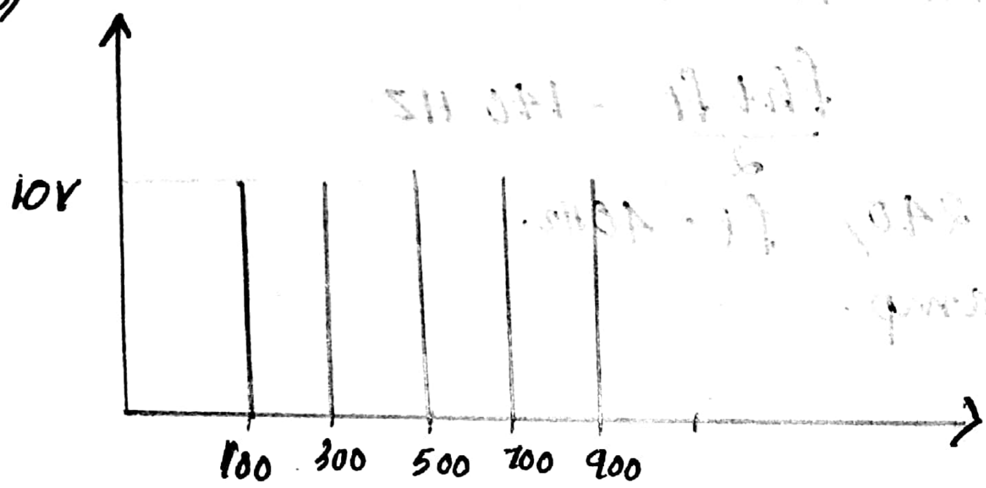
a) What is the bandwidth.

b) Draw the spectrum assuming all components have a max. amplitude of 10V.

A $BW = f_h - f_l$

a) $BW = 900 - 100 = 800\,Hz$

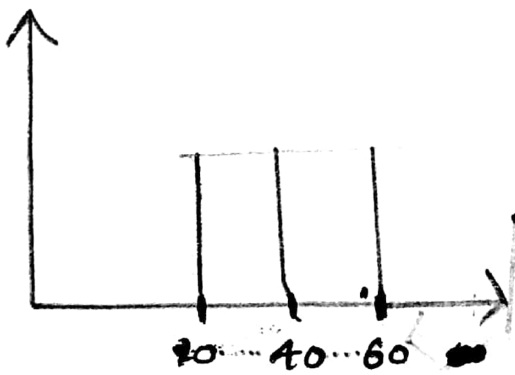
b)



Q A periodic signal has a BW = 20 Hz The hiegh[est] frequency = 60 Hz. Draw the spectrum of the contains all frequency with same amplit[ude]

A $BW = 60 - f_l$

$20 = 60 - f_l = 40$

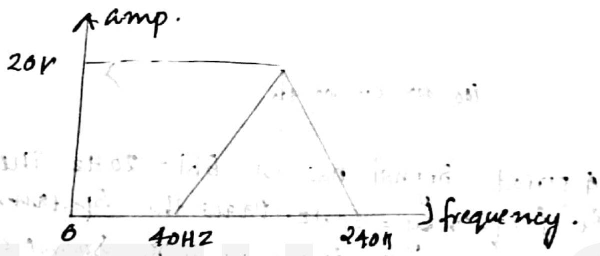


A non-periodic composite signal has a bandwidth of 200 Hz with a middle frequency of 140 KHz and peak amplitude of 20 V. The 2 extreme frequency have an amplitude of zero. Draw the frequency domain.

Bandwidth = $f_h - f_l = 200Hz$

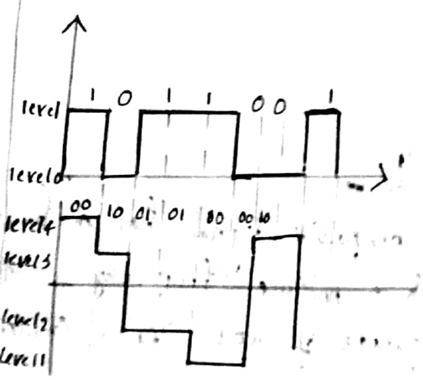
$\frac{f_h + f_l}{2} = 140 \, HZ$

$f_h = 240, \; f_l = 40Hz.$



DIGITAL SIGNALS

1 -> +ve , 0 -> -ve voltage.



- If a signal has L levels each level needs $\log_2 L$ bits
- Bit rate: The bit rate is the no: of bits send in one second. Expressed in bits per second.

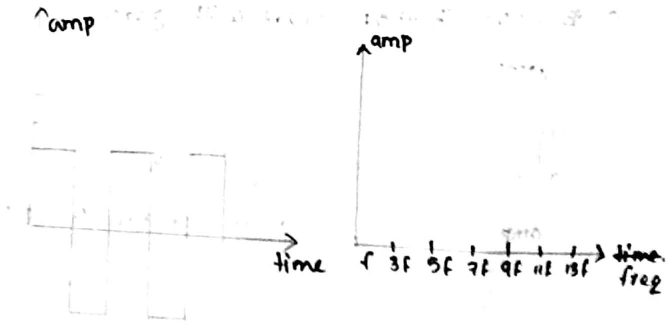
? Download a text document at the rate of 100 page per min. calculate the bit rate. The page has an avg 24 lines with 80 char each line assume one char required 8 bit.

Bit rate = 24 x 80 x 8 x 100.

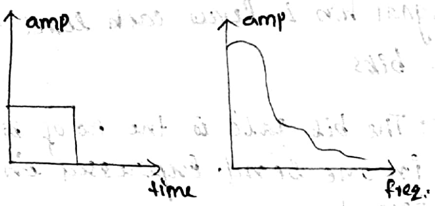
Bit length is the distance one bit occupies on the transmission period.

bit length = propagation speed x bit duration.

Digital signal as a composite analog signal.



· Periodic signal decomposed to discrete signal



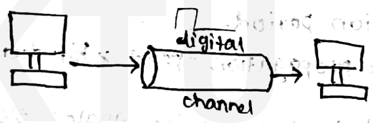
~~time~~ non-periodic digital signal.

Transmission of digital signal.

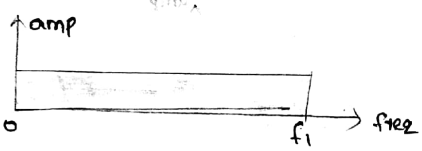
* Base Band Transmission. – digital as digital
* Broad Band " " – digital as analog.

Base Band Transmission

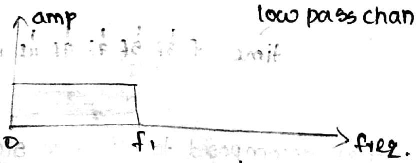
Sending a digital signal over a channel without changing digital signal to an analog signal.



it require low pass channel, a channel with a Bandwidth that start with zero.



low pass channel wide BW.



low pass channel, narrow BW.

case-i

low pass channel with wide BW.

To preserve the exact form of non-periodic digital signal we need a dedicated medium with an infinit BW b/w sender and reciever.

i/p signal BW supported by medium o/p signal BW.

i/p signal wide BW chanel o/p signal

case-ii

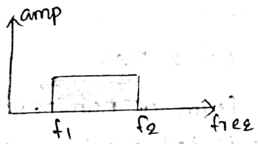
low pass channel with limitted BW.

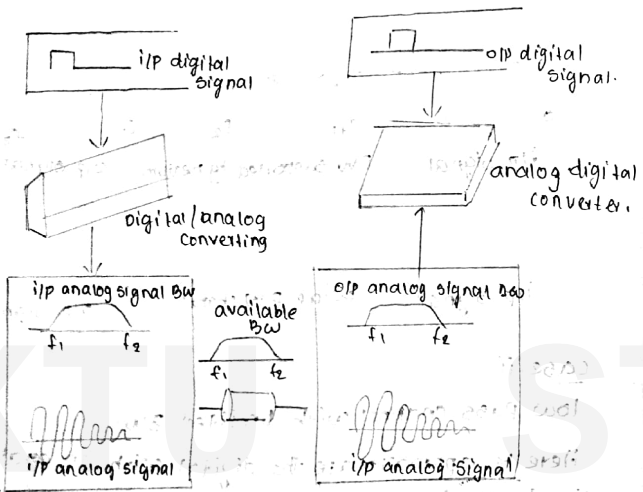
Here be approximate the digital with an analog signal The level of approximation depends on the BW available.

Broad Band Transmission (using modulation)

Broad band transmission or modulation means, changing a digital signal to a analog signal for transmission.

Band pass channel – a channel with BW that does not start from zero is used here.





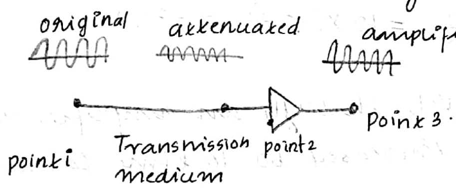
11/8/17.

Transmission empairments

issues arised during the transmission of signals.

① Attenuation - Energy loss of the transmitting signal. Using amplier we can strengthen the Signal.

Tr. a loss of energy a signal travels through a medium losses some of its energy in overcoming rresitances of the medium. To compensate for this ~~loss to~~ loss amplifiers are used to amplify the signal.



→ Decibel:- (dB)

To show that a signal has lossed / gained strength decibel is used. The Decibel measures the relative strength of two signal / one signal at two different point.

-ve → Energy lossed

+ve → Energy gained.

$$dB = 10\log_{10}\frac{P_2}{P_1}$$

In terms of Voltage $dB = 20\log_{10}\frac{V_2}{V_1}$

(Q) Suppose a Signal travels through a transmission and its power is reduced into one half attenuation is

A) $P_1 = P_1$ and $P_2 = \frac{P_1}{2}$.

$$dB = 10\log_{10} \frac{P_1/2}{P_1}$$

$$= 10\log_{10} \frac{1}{2} = 10 \times (-0.3) = -3dB$$

Q A signal travels through an amplifier and its power is increased to 10 time. Calculate its amplification.

$P_1 = P_1$

$P_2 = 10P_1$

$$dB = 10 \log_{10} \frac{10P_1}{P_1} = 10 \log_{10}(10)$$

$$= 10dB.$$

* dB can also be used to measure ~~dB~~ signal power in millivolts.

$$dB_m = 10\log_{10} P_m.$$

Q) Calculate the power of ~~dB~~ a signal if ~~its~~ the decibel is $dB_m = -30$

A) $dB_m = 10 \log_{10} P_m$

~~Pm = dBm~~

$10\log_{10} P_m = -30$

$\log_{10} P_m = -30/10 = -3$

$P_m = 10^{-3}$

Q The loss in a cable defined in dB/km. If the signal at the begining of a cable with -0.3 dB/km has a power of 2mvolt. What is the power of signal at 5km.

A) After 5 km $= 5 \times -0.3$
$= -1.5$

$$dB = 10\log_{10} \frac{P_2}{P_1}$$

$$dB = 10 \log_{10} \frac{P_2}{2}$$

$$-1.5 = 10\log_{10} \frac{P_2}{2}$$

$$\log\left(\frac{P_2}{2}\right) = -0.15$$

$$\frac{P_2}{2} = 10^{-0.15}$$

$$P_2 = 10^{-0.15} \times 2 \quad \cancel{= 2\times10}$$

$= 1.41$ mW

② DISTORTION: means that the signal changes it's form or shape. It can occur in a composite signal made of different frequen.

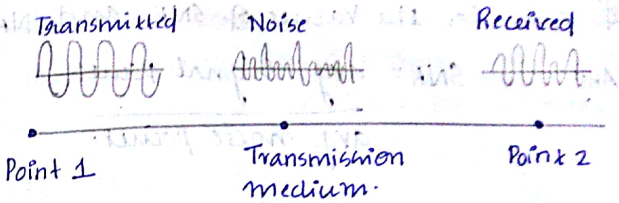
③ NOISE

Thermal Noise: random movement of electrons in transmission medium.

Induced Noise: Nearby appliance placed will disturb the transmitting signal.

Cross talk: Two signal placed near will exchange their data.

Impulse Noise: Sudden impulse to transmitting signal eg: lightening.



→ Signal to Noise Ration.

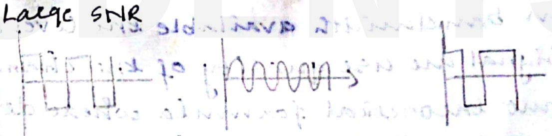
$$\boxed{SNR = \frac{\text{avg signal power}}{\text{avg noise power}}}$$

If SNR increases, signal power increases But noise power decreases.

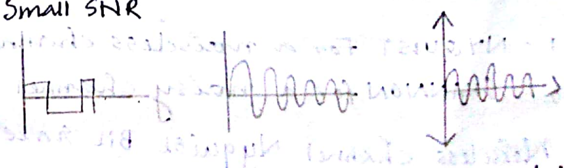
In terms of decibel,

$SNR_{dB} = 10 \log_{10} SNR$

- Large SNR



- Small SNR



Q) The power of signal is 10 mwatt and the power of noise is one microwatt. What are

~~Attenuation~~ the values of SNR and SNR_{dB}.

Ans) $SNR = \frac{\text{avg signal power}}{\text{avg noise power}}$

$= \frac{10 \times 10^3}{1} = 10000$

$SNR_{dB} = 10 \log_{10}(10000)$
$= 40$

Data Rate limits

Data rate limit can be defined as how fast we can send a data in bits per second over a channel. It depends on bandwidth available the level of the signal we use quality of the channel. The two theoretical formula where develop to calculate the data rate

1 - NYQUIST for a noiseless channel

2 - SHANNON for a noisy channel.

Noiseless channel: Nyquist Bit Rate.

$\text{Bit rate} = 2 \times BW \times \log_2 L$

L - Signal level.

Q Consider a noiseless channel with a bandwidth of 3000Hz transmitting a signal with two signal level. Calculate the max. Bit rate.

A) $\text{Bit rate} = 2 \times BW \times \log_2 L$

$= 2 \times 30000 \times \log_2 \times 2$

$= 6000$

Q we need to send 265KBS over a noiseless channel with bw = 20 KHz. How many signal level do we need?

A) $265 = 2 \times 20 \times \log_2 L$

$\frac{265}{40} = \log_2 L$

$6.625 = \log_2 L$

$2^{6.25} = L$

$= 98.711$

~~L=2~~

Noisy channel - Shannon.

Q Calculate the capacity of an extremely noisy channel where SNR is almost zero.