DEPARTMENT OF ELECTRICAL ENGINEERING

GOVERNMENT COLLEGE OF ENGINEERING
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Lecture Notes on Basic Electronics

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Disclaimer

MODULE 5

Principles of Communication Systems :-

→ Communication is the process of establishing connection or link between two points for information exchange.

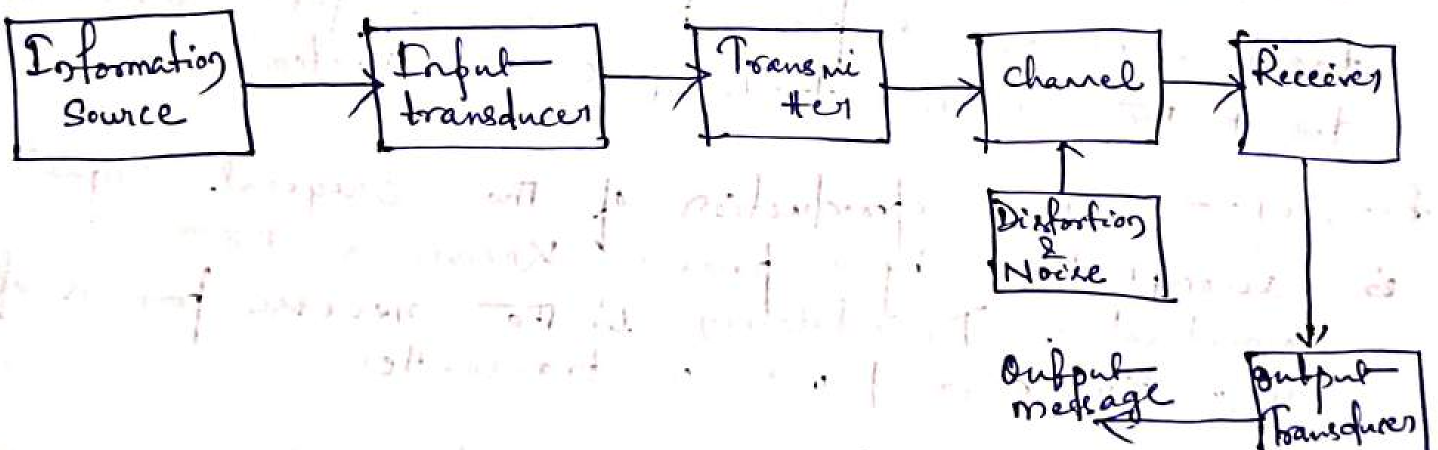
→ It is the basic process of exchanging information.

Typical examples of communication system are :

Eg:- telephony, line telegraphy, radio broadcasting, point-to-point communication, mobile communication, radar communication, television broadcasting

Basic Communication System :-

The purpose of a communication system is to transmit an information signal from a source located at one point to a user or destination located at another point some distance away.



(Block diagram of a basic communication system)

The essential components of a basic communication system are information source, transmitter, communication channel and receiver.

Information Source :- The function of information source is to produce required message which has to be transmitted.

Input Transducer :- A transducer is a device which converts one form of energy to another form. When the message produced by the information source is not electrical in nature, an input transducer is used to convert it into an electrical signal.

Transmitter :- The transmitter modifies the message signal for efficient transmission. Modulation is the main function of the transmitter.

The channel and the Noise :- The channel provides the medium through which the message travels from the transmitter to the receiver. During the process of transmission and reception the signal gets distorted due to the noise introduced in the system.

Receiver :- The reproduction of the original signals is accomplished by a process known as the demodulation. Demodulation is the reverse process of modulation carried out in transmitter.

Output Transducer :- It is the final stage which is used to convert an electrical message signal into its original form.

Modulation :-

→ Modulation is defined as the process by which the characteristic of a signal called carrier is varied in accordance with the instantaneous value of the modulating signal.

→ Signal containing information or message is referred as modulating signal/ baseband signal.

Need for Modulation :-

→ Long distance transmission
→ Practicality of Antenna
→ Remove interference
→ Reduction of Noise.

Amplitude Modulation :-

→ Amplitude Modulation is defined as a system in which the maximum amplitude of the carrier wave is made proportional to the instantaneous value (amplitude) of the modulating or baseband signal.

→ The signals containing information to be transmitted are called modulating signal.

→ These modulating signals containing information are called baseband signals.

→ The carrier frequency is greater than the modulating frequencies.

→ The signal results from the process of modulating is known as modulated signal.

Let us consider a sinusoidal carrier wave c(t) which is given as

$$c(t) = A_c \cos w_c t$$

A = maximum amplitude of the carrier wave

w_c = carrier frequency

Let x(t) denotes the modulating or baseband signal.

According to amplitude modulation, the maximum amplitude A of the carrier will is to be made proportional to the instantaneous amplitude of modulating signal x(t).

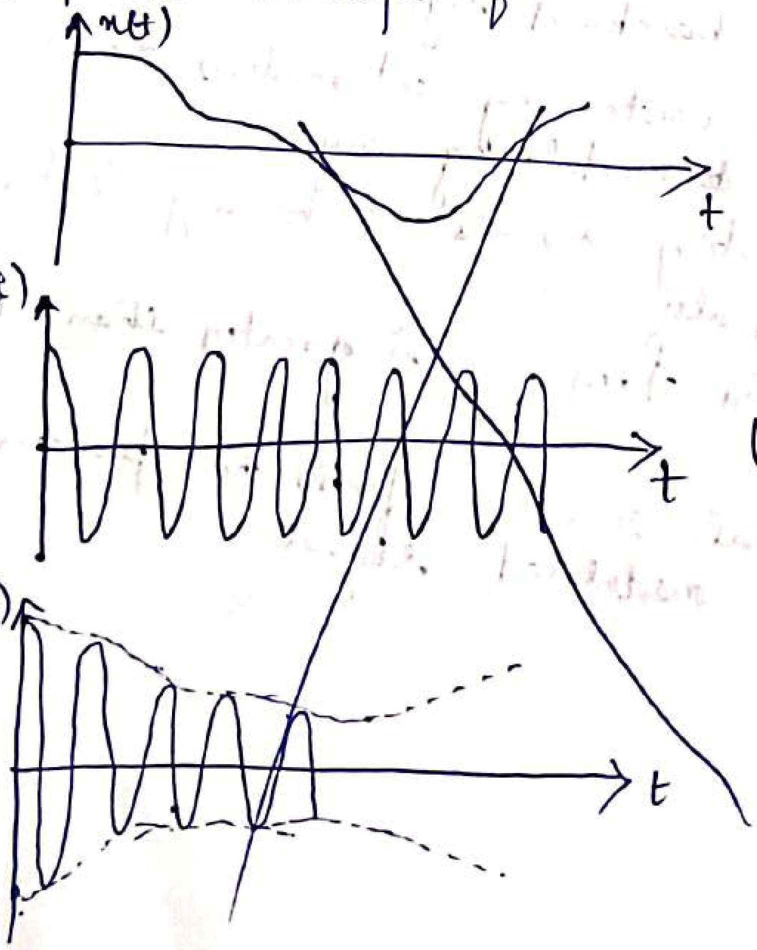
Hence, the amplitude modulated (AM) wave may be expressed as

$$S(t) = ~~x(t) \cos~~ [A_c + x(t)] \cos w_c t$$

$$\boxed{\begin{aligned} S(t) &= E(t) \cos w_c t \\ E(t) &= A_c + x(t) \end{aligned}}$$

$x(t) = A_m \cos w_m t$

E(t) is called the envelope of AM wave.



(a) modulating signal

(b) carrier signal

$$s(t) = [A_c + m(t)] \cos \omega_c t$$
$$= A_c \cos\omega_c t + m(t) \cos \omega_c t$$

Substituting the value of m(t)

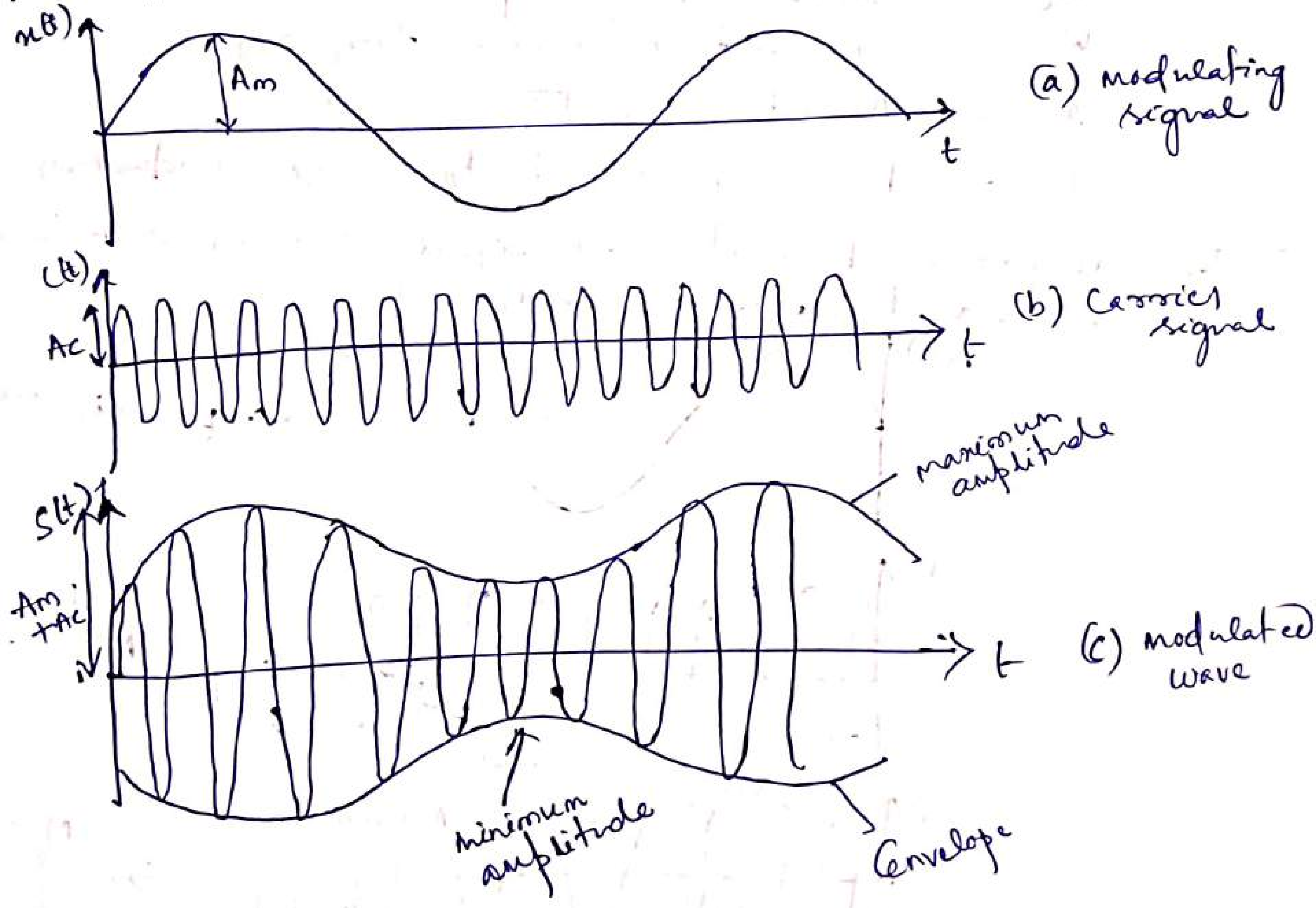
$$s(t) = A_c \cos \omega_c t + A_m \cos \omega_m t \cos \omega_c t$$
$$= A_c \cos \omega_c t \left[1 + \frac{A_m}{A_c} \cos \omega_m t\right]$$

where $\frac{A_m}{A_c}$ is known as modulation index μ.

Hence, s(t) can be written as

$$\boxed{s(t) = A_c \cos\omega_c t \left[1 + \mu \cos \omega_m t\right]}$$

The diagrams of information signal, carrier wave and amplitude modulated wave are given below



Frequency Modulation

In frequency modulation, the frequency of the carrier signal is varied in accordance with the instantaneous amplitude of the modulating signal.

The general expression for FM wave is given as

$$s(t) = A_c \cos\left[w_c t + K_f \int_0^t x(t)\,dt\right]$$

or

$$s(t) = A_c \cos\left[w_c t + m_f \sin w_m t\right]$$

Where

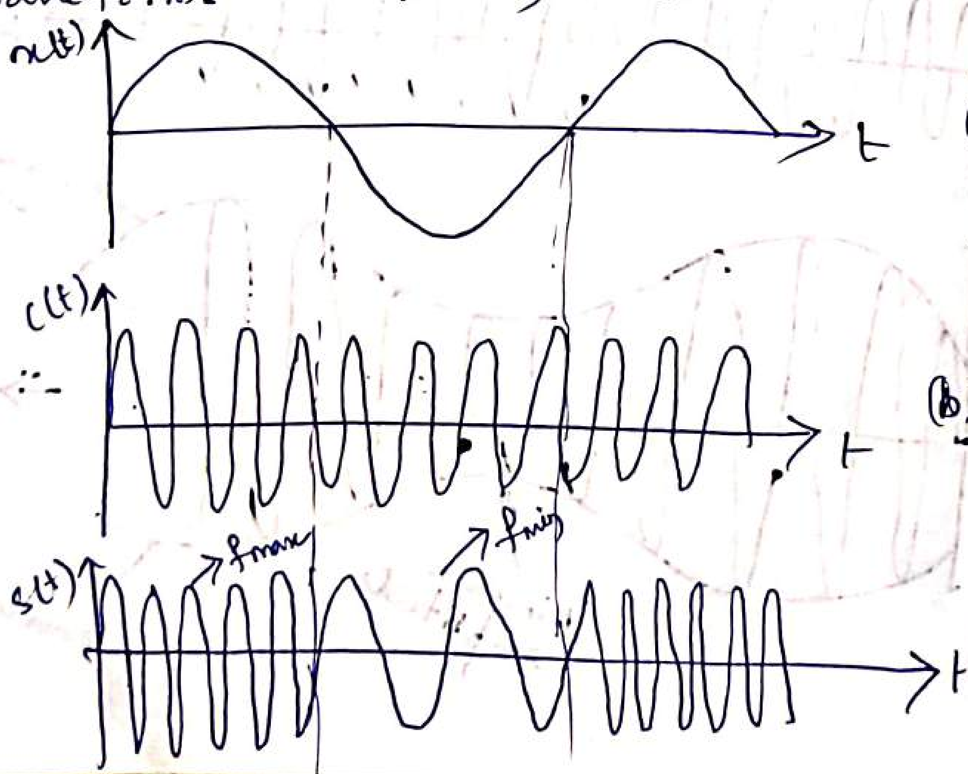
w_c = carrier frequency

w_m = modulating signal frequency

A_c = Amplitude of the carrier wave

K_f = frequency sensitivity m_f = modulation index

The diagrams of modulating signal, carrier signal and FM waveforms are shown below



(a) modulating signal

(b) carrier signal

(c) FM waveform

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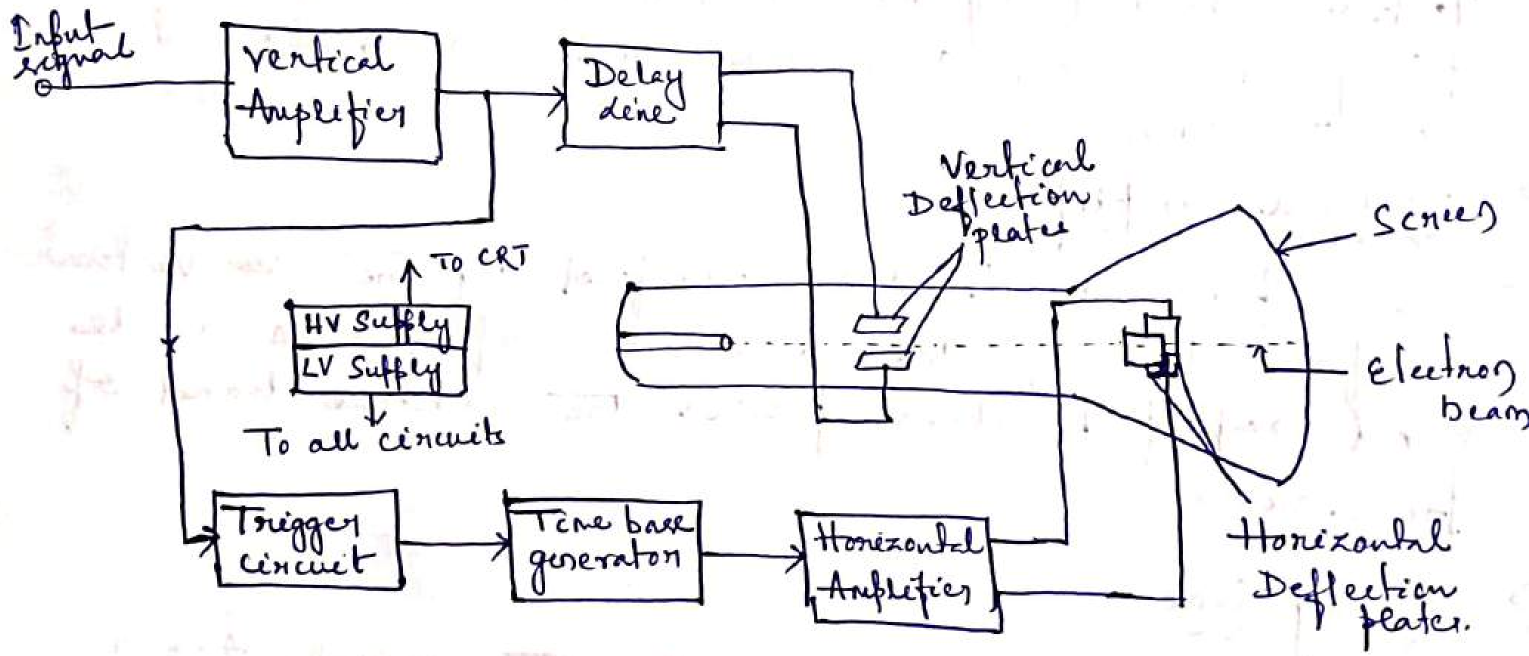
Cathode Ray Oscilloscope

The cathode Ray Oscilloscope (CRO) is an electronic device used for giving the visual indication of a signal waveform. It is an extremely useful and the most versatile instrument in the electronic industry.

Using a CRO, the wave shapes of alternating currents and voltages can be studied. It can also be used for measuring voltage, current, power, frequency and phase shift.

Figure shows the basic block diagram of a general purpose CR oscilloscope.



(Block diagram of general purpose CRO)

The general purpose oscilloscope consists of the following parts:

⟨i⟩ Cathode ray tube
⟨ii⟩ Vertical amplifier
⟨iii⟩ Delay line
⟨iv⟩ Time base generator
⟨v⟩ Horizontal amplifier
⟨vi⟩ Trigger circuit
⟨vii⟩ Power supply

i) Cathode Ray Tube :-

It is the heart of the Oscilloscope. When the electrons emitted by the electron gun strikes the phosphor screen, a visual signal is displayed on the CRT.

ii) Vertical amplifier :-

The input signal are amplified by the vertical amplifier, Usually, the vertical amplifier is wide band amplifier which passes the entire band of frequencies.

iii) Delay line :-

The circuit is used to delay the signal for a period of time in the vertical section of CRT. The input signal is not applied directly to the vertical plates.

(iv) Time Base (Sweep) Generator :-

Time base circuit uses a Unijunction transistor, which is used to produce the sweep. The saw tooth voltage produced by the time base circuit is required to deflect the beam in the horizontal section.

(v) Horizontal Amplifier :-

The saw tooth voltage produced by the time base circuit is amplified by the horizontal amplifier before it is applied to horizontal deflection plates.

vi) Trigger Circuit :-

The signals which are used to activate the trigger circuit are converted to trigger pulses for the precision sweep operation whose amplitude is uniform.

vii) Power Supply :-

It is classified into two types

(a) Negative high voltage supply (−1000 v to −1500 v)
(b) Positive low voltage supply (300 v to 400 v)

* Lissajous Figures

→ This is the simplest method to determine the frequency relation of two sine wave voltages.

→ One voltage is used to produce vertical deflection, while the second is used to give the horizontal deflection.

→ If the ratio of the two frequencies can be expressed by an integer, or by a ratio of integers the pattern obtained on the CRO is dependent on the relative phase of the two signals.

Electronic Instruments

Cathode Ray Oscilloscope (CRO)

The Cathode Ray Oscillo-scope is an electronic test instrument, which is utilized to get waveforms when the different information signals are given. It is used to

- visualize electric signal
- Measure signal characteristics (voltage, time, frequency)
- Analyze signal behaviour

A CRO contains a cathode ray tube (CRT) and necessary power equipment to make it operate.

Cathode Ray Tube

→ A cathode ray tube (CRT) is the heart of the oscilloscope. It is a vacuum tube of special geometrical shape and converts an electrical signal to visual one.

→ A CRT makes available plenty of electrons which are accelerated to high velocity and are brought to focus on the ~~flue~~ fluorescent screen.

→ The electron beam produces a spot of light wherever it strikes.

→ By deflecting the electron beam over the screen in response to the electrical signal, the electrons can be made to act as an electrical pencil of light which produces a spot of light wherever it strikes.

The various parts of CRT are

(1) Glass envelope :-

It is conical highly evacuated glass housing and maintains vacuum inside and supports the various electrodes.

→ The inner walls of CRT between neck and screen are usually coated with a conducting material, called aquadag.

→ The coating is electrically connected to the accelerating anode so that electrons which accidentally strike the walls are returned to the anode. This prevents the walls of the tube from charging to high negative potential.

(ii) Electron gun assembly :-

→ The arrangement of electrodes which produce a focussed beam of electrons is called the electron gun.

→ It essentially consists of an indirectly heated cathode, a control grid, a focussing anode and an accelerating anode.

→ The control grid is held at negative potential w.r.t cathode whereas the two anodes are maintained at high positive potential w.r.t cathode.

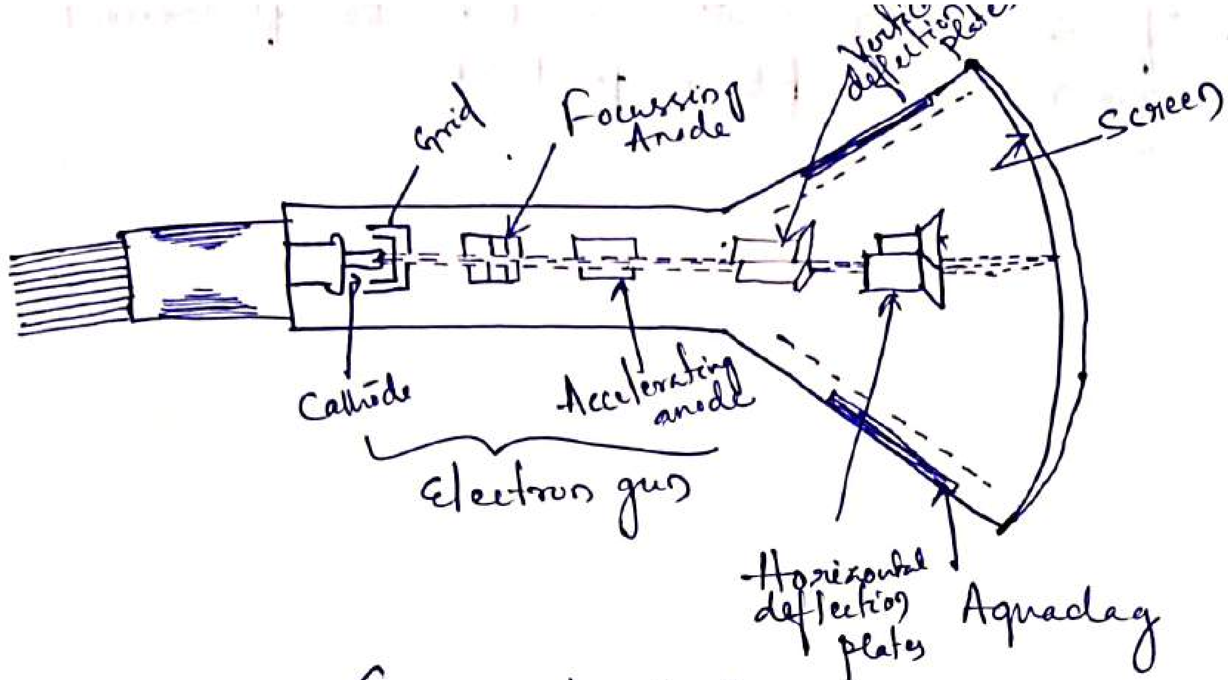
→ The cathode consists of a nickel cylinder ~~coat~~ coated with oxide coating and provides plenty of electrons.

→ The control grid encloses the cathode and consists of a metal cylinder with a tiny circular opening to keep the electron beam small size.

→ The focusing anode focuses the electron beam into a sharp pin-point by controlling the positive potential on it.

→ The positive potential (about 10,000 V) on the accelerating anode is much higher than on the focusing anode.

→ The anode accelerates the narrow beam to a high velocity which produces a spot of light when it strikes the screen.



(Various parts of CRT)

(iii) Deflection plate assembly :-

→ The deflection of the beam is accomplished by two sets of deflecting plates such as vertical deflection plate and horizontal deflection plate.

→ The vertical deflection plates are mounted horizontally on the tube. By applying proper potential to these plates, the electron beam can be made to move up and down vertically on the fluorescent screen.

→ The horizontal deflection plates are mounted in the vertical plane. An appropriate potential causes the electron beam to move right and left horizontally on the screen.

(iv) Screen :-

→ The screen is the inside face of the tube and is coated with some fluorescent material such as zinc orthosilicate, zinc oxide. etc.

→ When high velocity electron beam strikes the screen, a spot of light is produced at the point of impact.

→ The colour of the spot depends upon the nature of fluorescent material. If zinc orthosilicate is used as the fluorescent material, green light spot is produced.

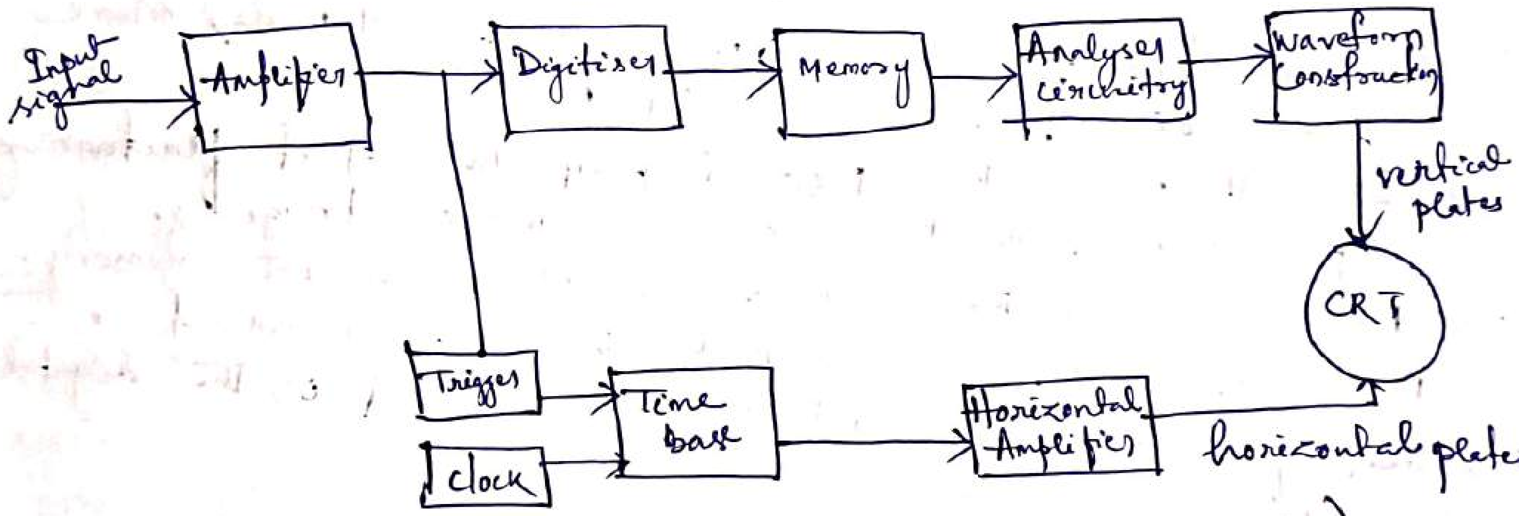
Digital Storage Oscilloscope

→ Digital storage Oscilloscope (DSO) is an electronic device that stores and analyses the signal in the digital format is known as Digital Storage Oscilloscope (DSO).

→ When the input signal is given to the DSO, then it is processed, stored in the memory, and displayed on the screen

→ The advanced features of DSO are triggering, storage and measurement. It uses digital processing technique to capture, analyze, process, store and display the signal on the screen.

Block Diagram :



(Digital Oscilloscope Block Diagram)

→ The analog input signal is digitized by the digital storage oscilloscope and is stored in the digital memory.

→ The Cathode Ray Tube (CRT) is employed to display the stored signal or data in the memory. As the stored data in the memory is in digital format, the signal is reconstructed into analog form and displayed

On the CRT.

→ The ~~real~~ analog input signal is amplified by the amplifier and its output is digitized by the digitizer stored in the memory. The analyzer circuit analyzes the digital output and it can be reconstructed to visualize the final waveform. The output is displayed on the CRT screen.

→ The function of the DSO depends on the sampling and the converter.

→ The statement of sampling theory is, The sampling rate of the signals should be twice as fast as per the received signal's highest frequency.

→ The use of a shift register reduces the converter cost and can operate up to 100 Mega samples/second.

→ DSO operates in 3 modes such as roll mode, store mode and save or hold mode.

→ In roll mode, the DSO displays the fast fluctuating input signals on the screen without triggering.

→ In store mode, the signals are stored in the memory.

→ In hold mode or save mode, the data is saved or held for a while until it gets stored in the digital memory.

→ The other modes used in the working of DSO are refresh mode, single-shot mode, and equivalent time mode.

Application :-

→ The signals are received, stored, and displayed by the DSO to calculate the frequency, amplitude and time period of a signal.

→ It is used in circuit debugging to test the voltage of the signal.
→ It is used to analyze the TV signal.
→ It is used to compute the V-I characteristics of transistor and diodes.
→ It is used in radio broadcasting to test the signal.

Waveform Reconstruction

→ According to the sampling theory, the input signal is sampled to avoid the aliasing effect.
→ But the aliasing effect can still occur in the signal because the output signal is obtained in the series of dots in response to the sample value.
→ A technique called interpolation is used by the DSO for final wave visualization. The technique that generates new data points by using a set of known discrete data points is known as interpolation.
→ In linear interpolation, the data points are connected to generate pulse or square wave. In sinusoidal interpolation, the dots are used to generate a sinusoidal waveform.