Chapter review Questions:

1 Define Rectifier & state its use.
2 Explain P-type and N-type semiconductor junction .
3 Define PN junction Barrier voltage, depletion region, Junction Capacitance.
4 Draw Forward biased & reversed biased junction Diode
5 Draw symbol, circuit diagram for characteristics (Forward & reversed) Characteristics PN junction diode.
6 Define Forward voltage drop, Reversed saturation current, maximum forward current ,power dissipation Package view of diodes of different power ratings
7 Explain Construction (reference to doping level),Symbol ,circuit diagram for characteristics (forwarded & reversed) of Zener Diode
8 Explain Avalanche & Zener breakdown and its comparison.
9 Define Zener voltage, power dissipation, breaks over current, dynamic resistance & maximum reverse current.
10 Explain Construction ,Symbol ,circuit diagram for characteristics of Schottky diode
11 Explain Construction ,Symbol ,circuit diagram for characteristics of Tunnel diode
12 Define Optical Diodes
13 Explain Construction ,Symbol ,circuit diagram for characteristics of LED,
14 Explain IR LED & its working principle.
15 Explain Construction ,Symbol ,circuit diagram for characteristics of photodiode

Chapter-3 Rectifiers & Filters.

3.1 Rectifier: Definition- A semiconductor device which converts of an alternating current (AC) into direct current (DC **).**

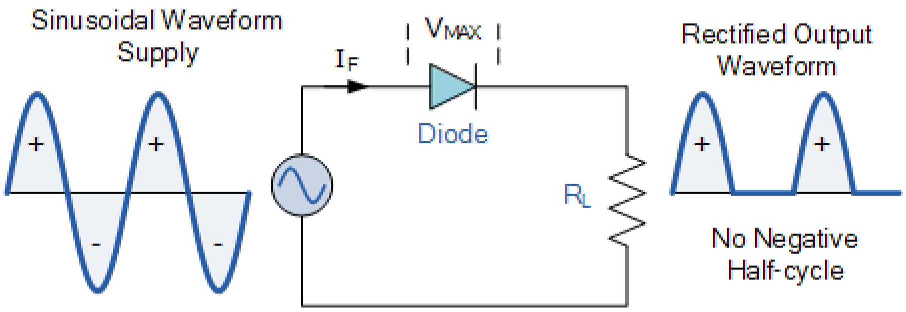
Example : Semiconductor Diode.

Need of Rectifier: To provide continuous voltage (DC Voltage) required to run almost all electronic devices & circuits.

3.1.1 Types of Rectifier : Half Wave Rectifier.

In this type the rectifier conducts current only during the + ve half cycles of the a.c. supply.

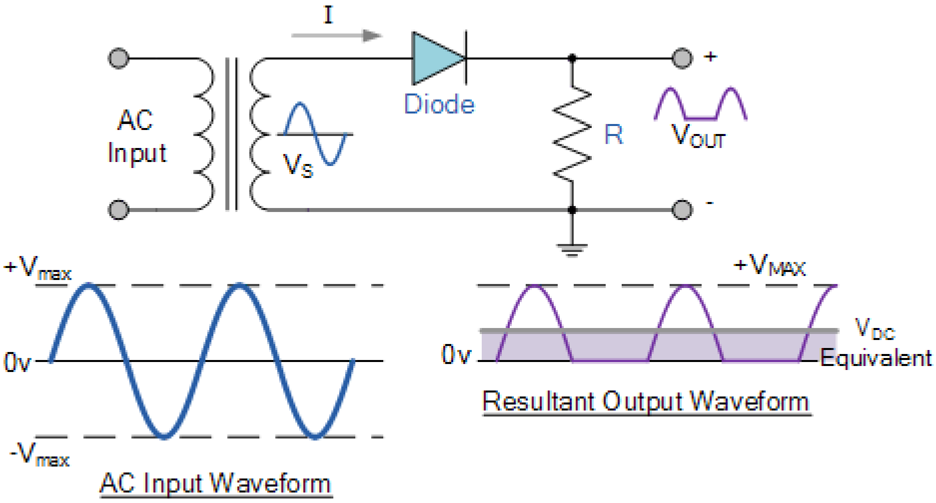
Simple Circuit:



Here – ve half cycles are suppressed i.e. during –ve half cycle no current passes through the diode hence no voltage appears across the load.

Max. rectifier Efficiency= Max. d.c.output power/ a.c. input power =40.6%

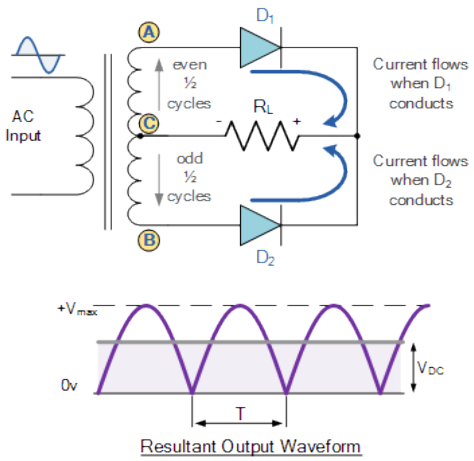
Schematic Diagram:



Full Wave Rectifier:

In this type , the rectifier utilises both half cycles of a.c. input voltage to produce the d.c output.

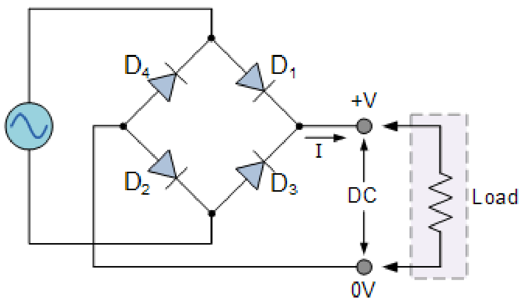
Full Wave Rectifier(Centre Tapped Type)



During the positive half cycle of the supply, diodeD1 conducts , while diodeD2 is reverse biased and the current flows through the load as shown .

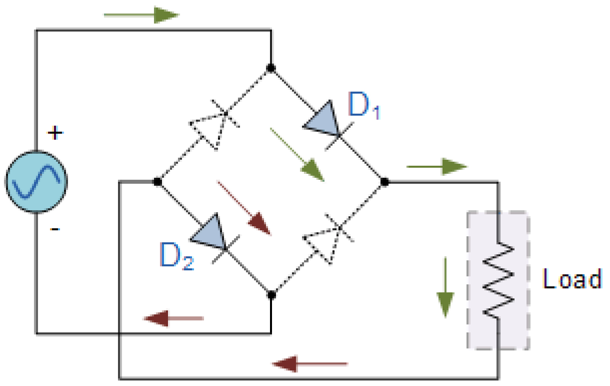
Similarly ,during the negative half cycle of the supply, diodeD2 conducts , while diodeD1 is reverse biased and the current flows through the load as shown .

Full Wave Rectifier(Bridge Type) : <u>The Diode Bridge Rectifier</u>



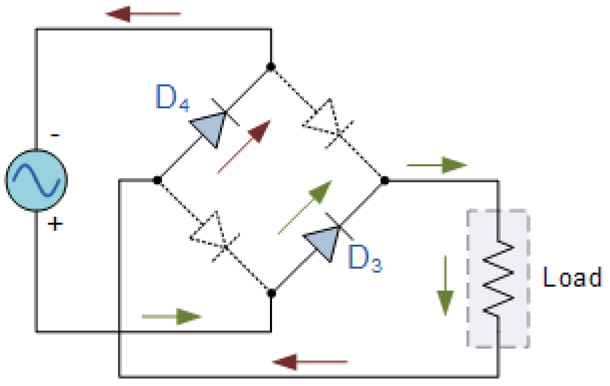
During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

<u>The Positive Half-cycle</u>



During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before.

The Negative Half-cycle



Max. rectifier Efficiency= Max. d.c.output power/ a.c. input power=ή =81.2 %

3.1.2 Ripple: Ripple is the output of a rectifier that contains both dc & ac component.

Ripple Factor :The ratio of r.m.s value of ac component to the dc component in the rectifier output is known as ripple factor.

Ripple Factor= r.m.s value of ac component/ value of dc component.

For Half wave rectification ripple factor =1.21

For Full wave rectification ripple factor =.48

PIV (Peak Inverse Voltage) : It is the maximum reverse voltage that a diode can withstand without destroying the junction.

TUF(Transformer Utility Factor): Defined as the ratio of power delivered to the load to the ac rating of the transformer secondary.

TUF = dc power delivered to the load/ac rating of transformer secondary

$$= P_{dc} / P_{ac\ .rated}$$

$$= P_{dc}/P_{in.rated}$$

Rectifier Efficiency: The ration of dc power output to the applied input ac power is known as rectifier efficiency.

Rectifier Efficiency = dc power output / input ac power

3.1.3 Comparison of Three types of Rectifier.

Sl . No.	Particulars	Half wave	Centre-Tap FWR	Bridge FWR
1.	No. of Diodes	1	2	4
2.	Max. Efficiency	40.6%	81.2%	81.2%
3.	Ripple Factor	1.21	0.48	0.48
4.	Output Frequency	50Hz	100Hz	100Hz
5.	PIV(Peak Inverse Voltage)	Vm	2Vm	Vm

3.2 FILTERS:

Definition: A filter circuit is a device which removes the ac component (ripple) of rectifier output but allows the dc component to reach the load.

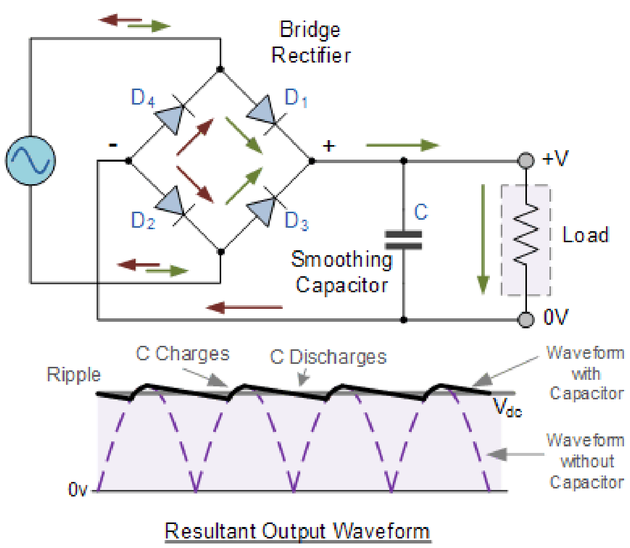
Need of Filter: To provide smooth DC output to the load.

Types of Filter:

i) Shunt Capacitor: It is also called Capacitor Filter. It offers low reactance to ac &a very high reactance to the dc component.

The capacitive reactance is $X_C=1/2\pi fc$,for d.c , f=0 Then, $X_C=\infty$

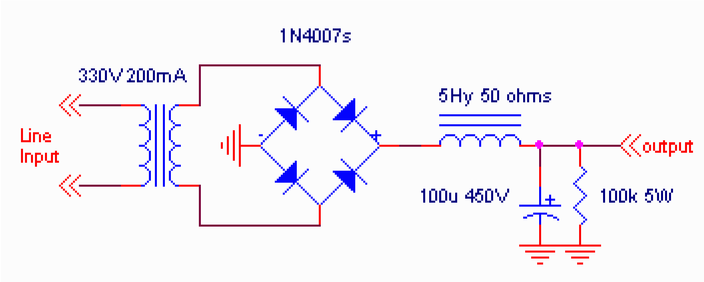
Hence a capacitor does not allow the d.c to pass through it.



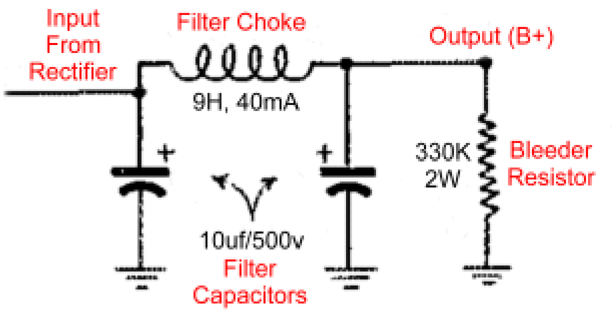
ii) <u>Choke input filter :</u>In this filter one inductor & one capacitor is used.

The inductive reactance is $X_L=2\pi fL$, for d.c , f(frequency)=0 Then, $X_L=0$, Hence inductor allows the d.c to pass through it.

It offers high reactance to the ac component but offers almost zero reactance to the dc component. That means it allows only dc component to flow through it.



iii) Capacitor input filter: It is also called π -Filter.



In this filter one inductor & two capacitors are used.

Here pulsating output from rectifier is applied across 1st capacitor which offers zero reactance to a.c& infinite reactance to d.c. Hence d.c component continues to reach across L(Choke Filter) .

The filter choke then allows the d.c component easily by blocking a.c component if any.

Finally the 2nd capacitor across load bypasses the a.c component if any which the choke(L) failed to block by making d.c component to reach across load.

Chapter Review Questions:

1. Define rectifier.
2. Draw the circuit of centre tap FWR & Bridge FWR.
3. State PIV of a diode.
4. Define TUF.
5. State the full wave rectifier efficiency.
6. Compare HWR &FWR.
7. Need of filter in power supply.
8. State different types of filters .
9. Define ripple & ripple factor.
10. Define rectifier efficiency.

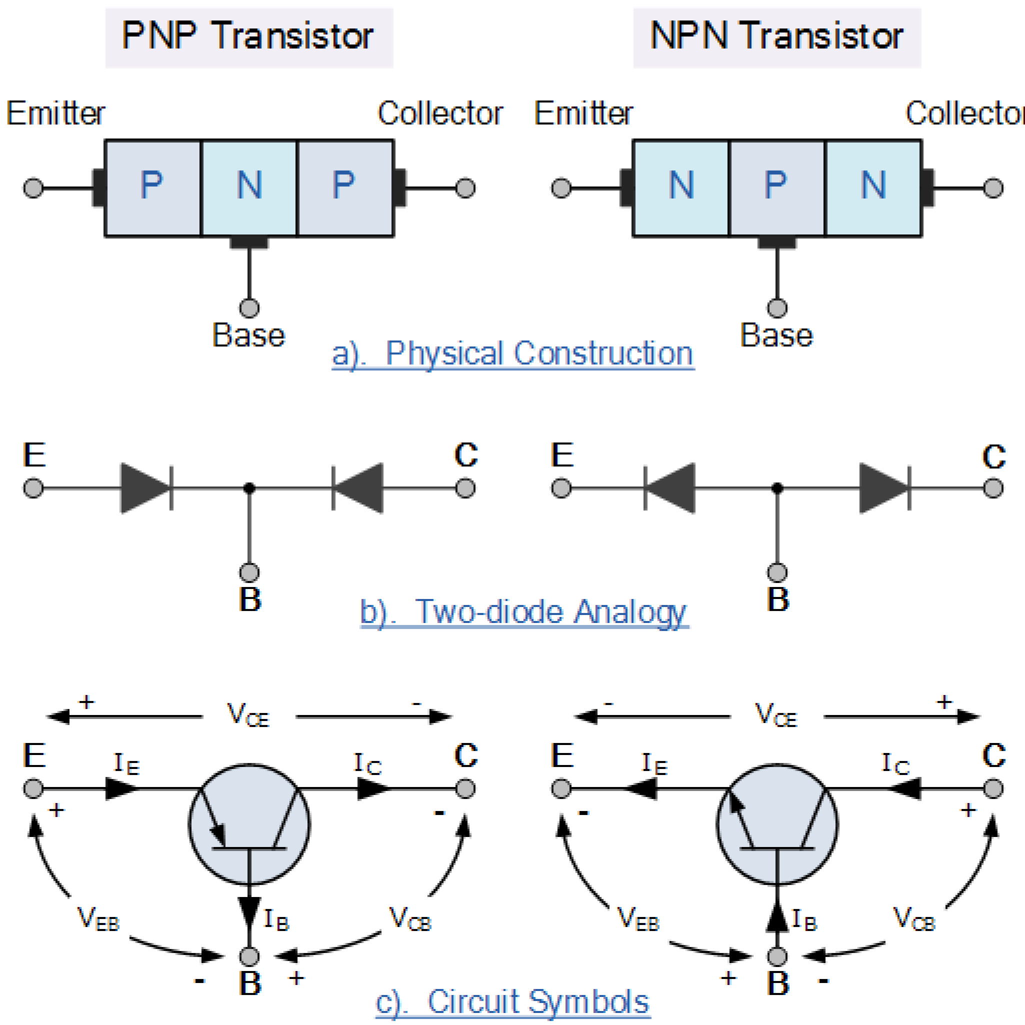
Chapter-4 Transistors

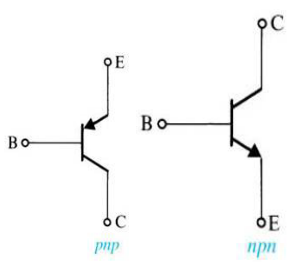
4.1 *Definition: A semiconductor device which transfers a signal from a low resistance to high resistance.*

Construction: A transistor consists of two pn junctions formed by sandwiching either p-type or n-type semiconductor between a pair of opposite types.

Accordingly there are two types of transistors namely ;

i) p-n-p transistor ii) n-p-n transistor





The direction of emitter arrow indicates direction of current flow.

Advantages: Small size ,Light weight ,Low supply voltage, No heating, High voltage gain ,Mechanically strong.

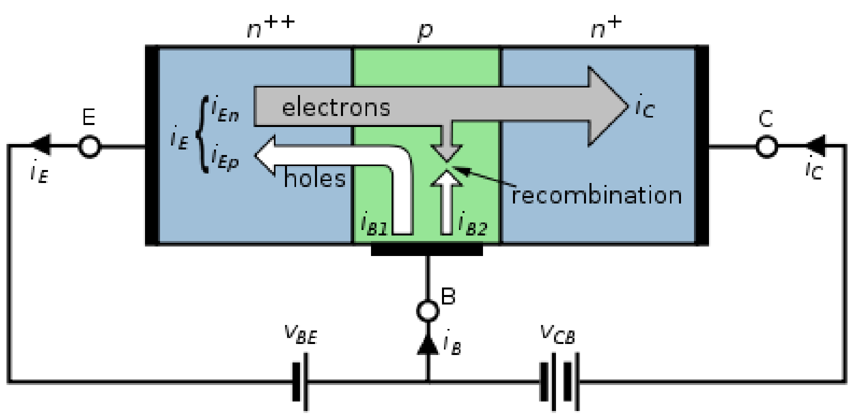
Bipolar Junction Transistor (BJT): A BJT consists of two pn junctions formed by sandwiching either p-type or n-type semiconductor between a pair of opposite types.

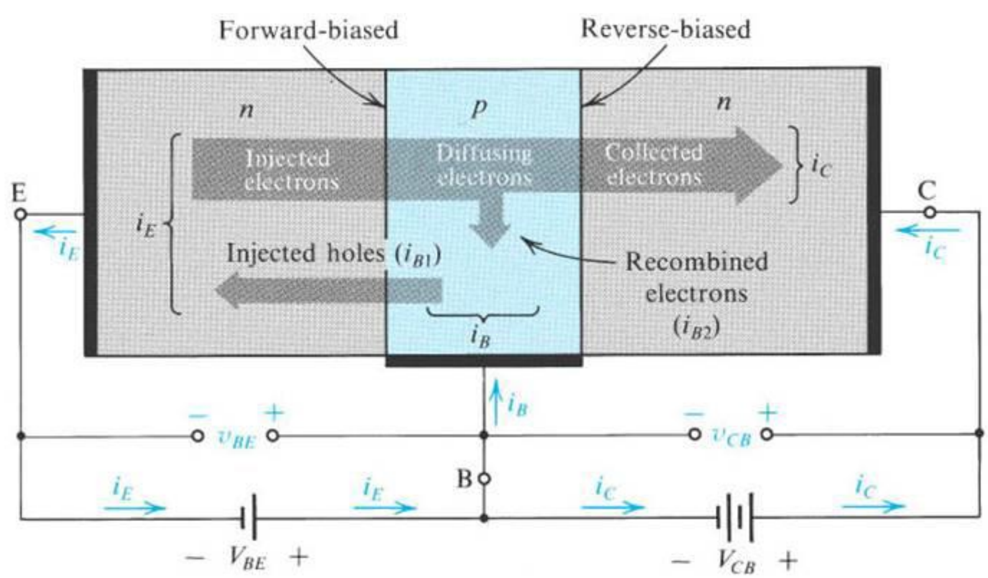
4.1.1 Types of Transistor (BJT) Basic concept:

NPN transistor.

It has three sections of doped semiconductors.

- Emitter: The section on one side that supplies carriers(Electrons/Holes) is called Emitter. The emitter is always forward biased w.r.t. base so that it can supply large no of majority carriers(Electrons)
- Base: The middle section which forms two pn junctions between emitter & collector is called the Base.
- Collector: The section on one side that collects carriers(Electrons/Holes) is called Collector . The collector is always forward reverse bised w.r.t. base. Its function is to removes charges from its junction with the base.





- Conventional Current Flow in npn: The base emitter junction is forward biased . allowing low resistance in emitter (input) side & base-collector junction is reverse biased & provides high resistance in collector(Output) side .
- Accordingly the current flows from emitter towards base & collector

Therefore , Using Kirchhoff's Current Law:

$\mathbf{I_E = I_B + I_C}$

Emitter Current = Base Current + Collector Current

PNP transistor: Similarly the in pnp , the current conduction is due to majority carriers i.e. Holes as shown below.

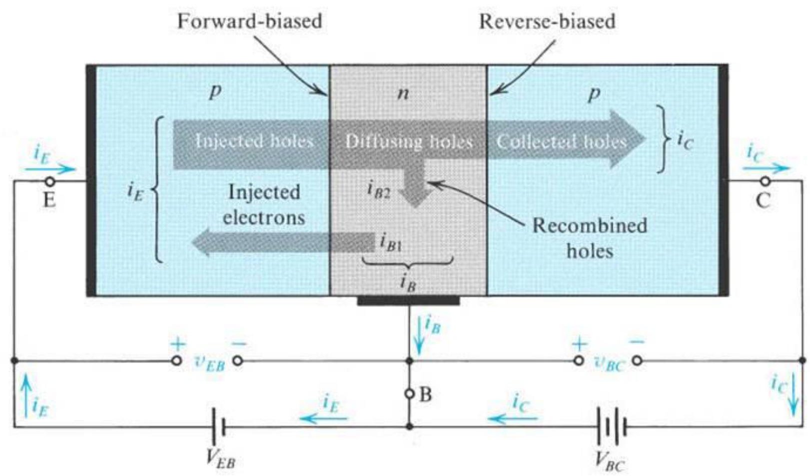


Fig 16 :Relation between different currents in transistor (I_E , I_B, I_C)

Using Kirchhoff's Current Law:

$\mathbf{I_E = I_B + I_C}$

Emitter Current = Base Current + Collector Current

4.1.2 Transistor Configurations:CB ,CE& CC

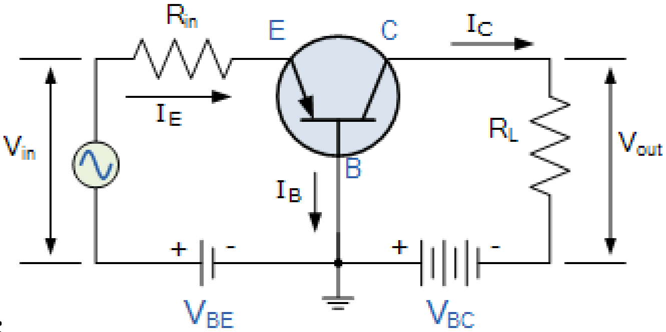
As the **Bipolar Transistor** is a three terminal device, there are basically three possible ways to connect it within an electronic circuit with one terminal being common to both the input and output. Each method of connection responding differently to its input signal within a circuit as the static characteristics of the transistor vary with each circuit arrangement.

- Common Base Configuration - has Voltage Gain but no Current Gain.
- Common Emitter Configuration - has both Current and Voltage Gain.

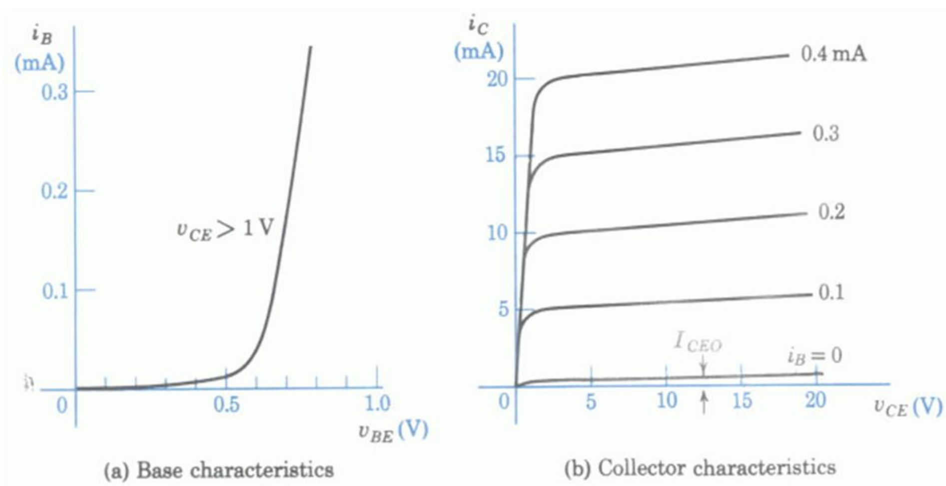
- Common Collector Configuration - has Current Gain but no Voltage Gain.

The Common Base (CB) Configuration:

As its name suggests, in the Common Base or grounded base configuration, the BASE connection is common to both the input signal AND the output signal with the input signal being applied between the base and the emitter terminals. The corresponding output signal is taken from between the base and the collector terminals as shown with the base terminal grounded or connected to a fixed reference voltage point.



Input Output Characteristics :

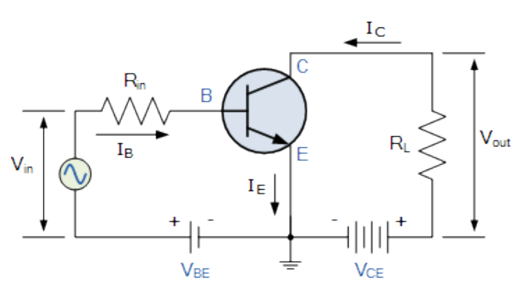


(a) Base characteristics (b) Collector characteristics

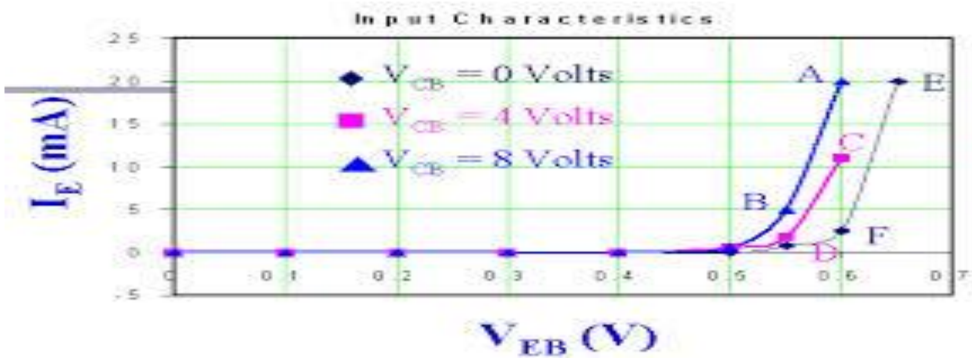
The Common Emitter (CE) Configuration:

In the Common Emitter or grounded emitter configuration, the input signal is applied between the base, while the output is taken from between the collector and the emitter as shown. This type of configuration is the most commonly used circuit for transistor based amplifiers and which represents the "normal" method of bipolar transistor connection.

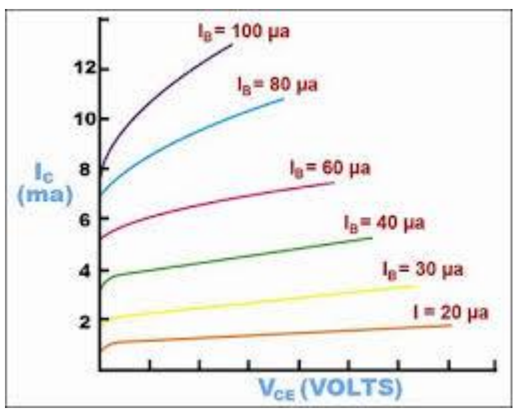
Circuit diagram to find the characteristics :



Input Characteristics:



Output Characteristics:



The Common Collector (CC) Configuration:

In the Common Collector or grounded collector configuration, the collector is now common through the supply. The input signal is connected directly to the base, while the output is taken from the emitter load as shown. This type of configuration is commonly known as a

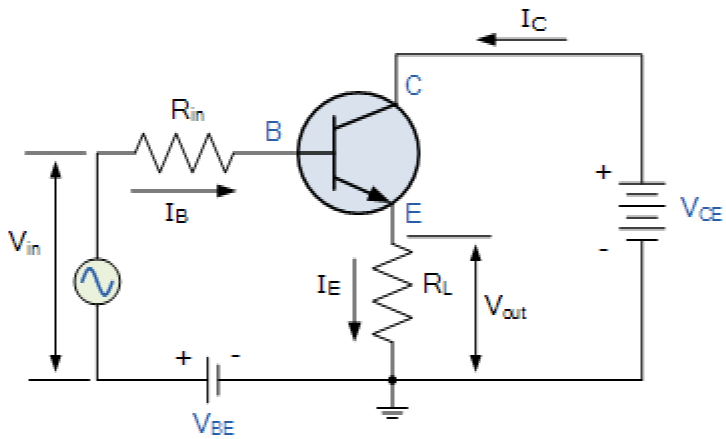
Voltage Follower or Emitter Follower circuit: The emitter follower is a current amplifier that has no voltage gain.

Its important characteristics are:

i. No voltage gain.
ii. It has high input impedance & low out put impedance.
iii. Relatively high current & power gain.
iv. Input & output ac voltages are in phase.

Thus it is an ideal circuit for impedance matching & DC load line analysis.

Circuit diagram of Emitter Follower :

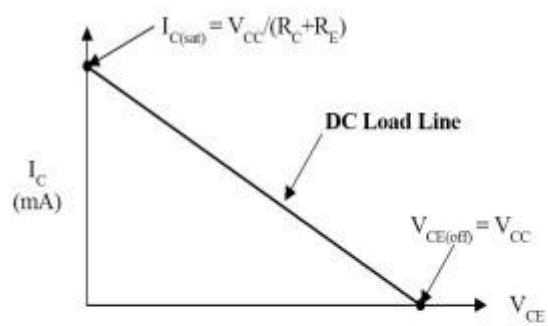


Working Principle: As the collector is at ac ground , the circuit is known as CC amplifier.

i) There is no collector load(R_C) and emitter bypass capacitor (C_E)
ii) The emitter resistor (R_E=R_L) itself acts as the load.
iii) The biasing is provided by input resistor (R_{in})

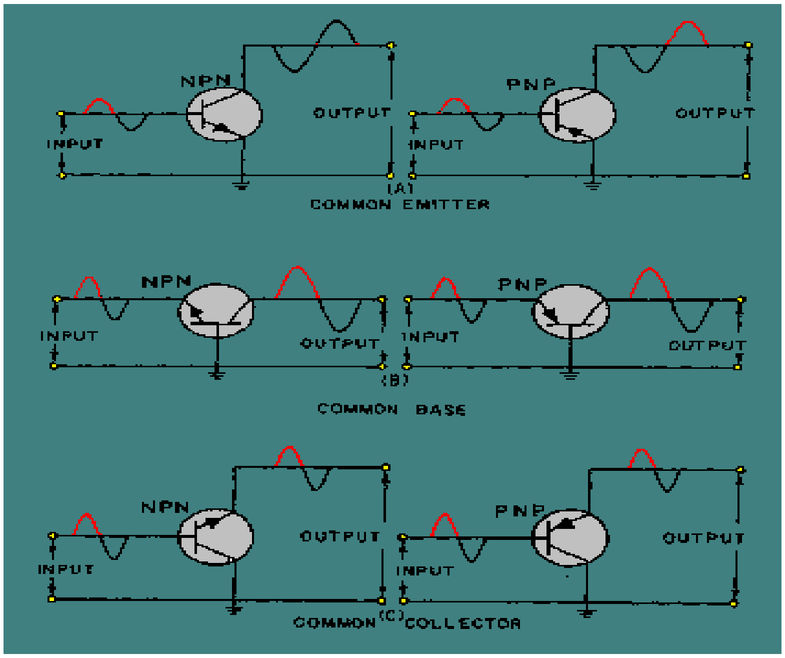
Characteristics:

i) When transistor is saturated ,V_{CE}=0



ii) When transistor is off $I_{c(Sat)=}V_{CC}$/

Input Output Characteristics: Same as that of Common Base configuration.



4.1.3 Transistor Parameters:

Input Resistance :It is the ratio of change input voltage to the change in input current.

Output Resistance : It is the ratio of change output voltage to the change in output current.

Transistor Parameters	CB	CE	CC
I/P Resistance	Low	Low	Very High
O/P Resistance	Very High	High	Low
Application	High frequency	Audio frequency	Impedance Matching

<u>Relation between α , β & γ :</u>

<u>Current Amplification Factor in common Base(β):</u>

Defined as the ratio of change in collector current to the change in base current is known as current amplification facto in CB configuration.

Mathematically, $\beta = \frac{\Delta I_C}{\Delta I_B}$

<u>Current Amplification Factor in common Emitter(α):</u>

Defined as the ratio of change in collector current to the change in base current is known as current amplification factor in CE configuration.

Mathematically , $\alpha = \frac{\Delta I_C}{\Delta I_E}$

<u>Current Amplification Factor in common Collector (γ):</u>

Defined as the ratio of change in emitter current to the change in base current is known as current amplification factor in CC configuration.

Mathematically , $\gamma = \dfrac{\Delta I_E}{\Delta I_B}$

Relation between α , β & γ : $\alpha = \dfrac{\beta}{\beta + 1} \quad \beta = \dfrac{\alpha}{1 - \alpha} \quad \gamma = \beta + 1$

$\beta = \dfrac{\Delta I_C}{\Delta I_B}$, $\alpha = \dfrac{\Delta I_C}{\Delta I_E}$, $\gamma = \dfrac{\Delta I_E}{\Delta I_B}$

$\gamma = \dfrac{\Delta I_E}{\Delta I_B}$, $\alpha = \dfrac{\Delta I_C}{\Delta I_E} \quad \alpha = \dfrac{\beta}{\beta + 1}$

$$\alpha = \frac{\beta}{\beta + 1} \quad \beta = \frac{\alpha}{1 - \alpha} \quad \gamma = \beta + 1$$

For Example:We know IE = IB + IC

If IB =5% &IC = 95% , Then IE =100%

Transistor Specification :

V_{CEsat}: Collector emitter saturation voltage

I_{CMax}: Maximum Collector Current.

V_{CEO} : Collector emitter voltage with base open circuit

I_{CEO} : Collector emitter cut-off current .

α= Current Amplification Factor in common Emitter_.

β=Current Amplification Factor in common Base_.

V_{CE} breakdown: Collector to emitter breakdown voltage .

Power Dissipation: It is due to large currents for which the transistor heats up (thermal effect) during its operation.

Remedy: By using Heat Sink (made up of metal case) the heat can be dissipated &the device can be expected to operate without self-damage.

4.1.5 Construction , Working Principle , Characteristics of Photo Transistor:

Photo Transistor :

If the operating point is selected in the middle of active region, then there is no clipping and the output follows input faithfully as shown in fig. C. If input is large then clipping at both sides will take place. The first circuit for biasing the transistor is CE configuration is fixed bias.

Need of Stabilisation :
The process of making operating point independent of temperature changes or variations in transistor parameters is known as **stabilisation.**
Once stabilisation is done, the zero signal *IC* and *VCE* become independent of temperature variations or replacement of transistor *i.e.* the operating point is fixed.
A good biasing circuit always ensures the better stabilization of operating point.

Need for stabilisation. Stabilisation of the operating point is necessary due to the following reasons :

(*i*) Temperature dependence of *IC*
(*ii*) Individual variations
(*iii*) Thermal runaway

Chapter Review Questions:

1. What is a transistor ?
2. Define ɑ .
3. State relation between I_E , I_B& I_C .
4. Draw the transistor symbols.
5. State different types of transistor configurations.
6. Draw the input output characteristics of common emitter configuration.
7. Define input & output resistance of transistor in common mode.
8. State relation between ɑ & β and β & γ.
9. State working principle of phototransistor.
10. Draw the symbol of n-channel & p-channel JFET . State the working principle & application of JFET.
11. State the need of biasing & name different types of biasing.
12. Draw the circuit of base bias methofbising.
13. State saturation & cut-off of transistor.
14. What is Q –point ? State need of stabilization of Q-piont .
15. State power dissipation of transistor.

Chapter-5 Regulated Power Supply.

5.1 Regulator: A device which maintains the output voltage of an ordinary power supply constant.

Example: Zener diode is used as basic voltage regulator.

5.1.1Need of Regulator:To ensure constant output voltage

i) In spite of load variations.(changes in load Current)
ii) Changes in input a.c voltage .

Voltage Regulation :The variation of output voltage w.r.t the amount of load current drawn from the power supply is known as voltage regulation.

Voltage Regulation Factor: (Expressed as the % ge of voltage regulation)

% Voltage Regulation = $(V_{NL}-V_{FL})/V_{FL} \times 100$

V_{NL} =DC output voltage at no load.

V_{FL} = DC output voltage at full load.

5.1.2 Concept of Load Regulation & Line Regulation:

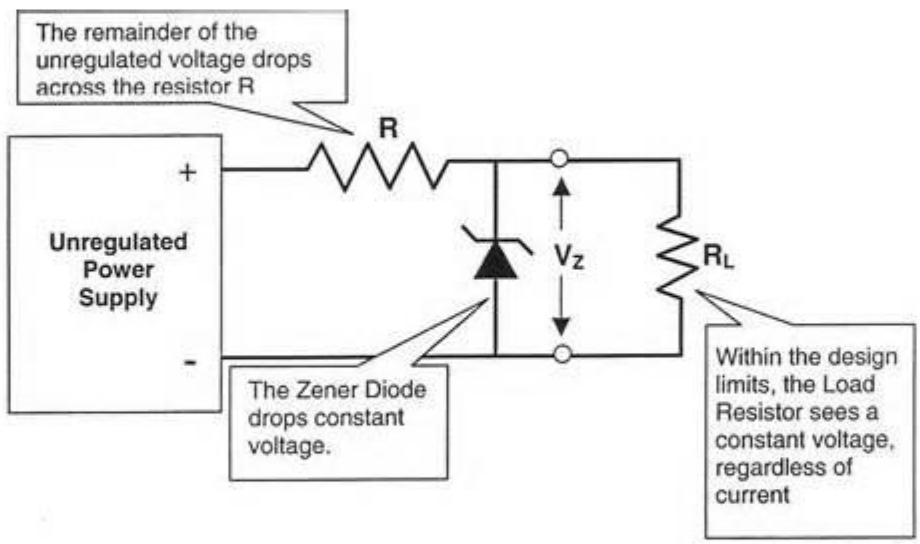
Load Regulation: (Also called Voltage regulation) The load regulation indicates the change in output voltage due to change in load current .

Line Regulation : The line regulation of a voltage regulator indicates the change in output voltage that will occur per unit change in the input voltage.

5.1.3 Basic Zener Diode as a Voltage Regulator.

A zener diode can be used as a voltage regulator to provide a constant voltage from a source whose voltage may vary over sufficient range.

The zener diode of zener voltage V_Z is reversly connected across the load R_L across which constant output is desired . The series resistance R absorbs the output voltage fluctuations so as to maintain constant voltage across the load.

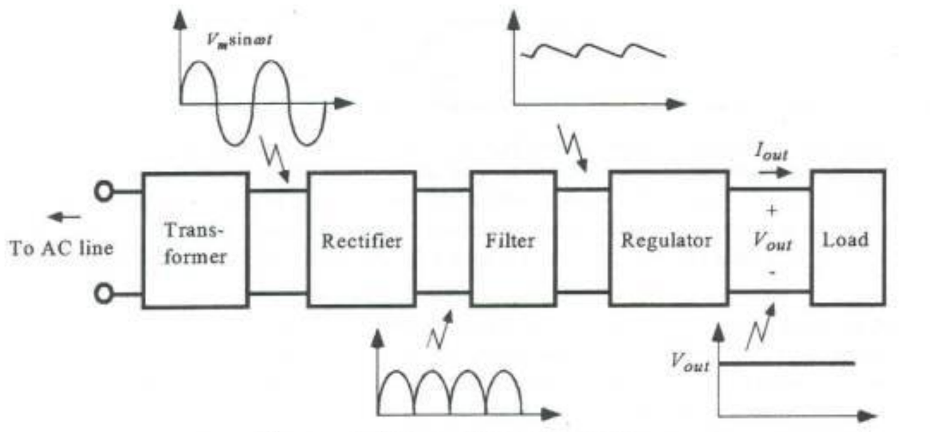


5.2 Line Regulators: As discussed above.

5.2.1 Basic Block Diagram of DC Regulated Power Supply.

DC Regulated Power Supply: A DC power supply which maintains the output voltage constant irrespective of a.c mains fluctuations Or load variations is known as regulated DC Power Supply.

Basic Block Diagram :

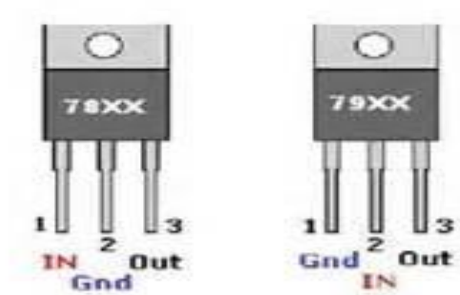


Components of a typical linear power supply

Working Principle: The output of power supply (V_{in})is fed to the voltage regulator which produces the final output(V_{laod}). The output voltage (V_{laod})remains constant whether the load current changes or there are fluctuations in the AC input.

5.3 IC s Voltage Regulator : 78XX , 79XXv(Fixed) & LM- 317(As Variable)

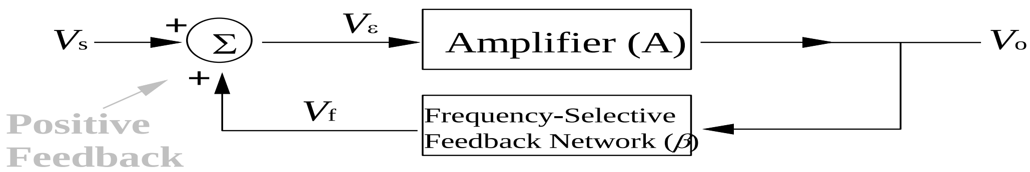
78XX Series of IC Regulators:This series of IC regulator provides fixed positive voltage.



Pin Description:

Pin No	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	

Essentials of Oscillators

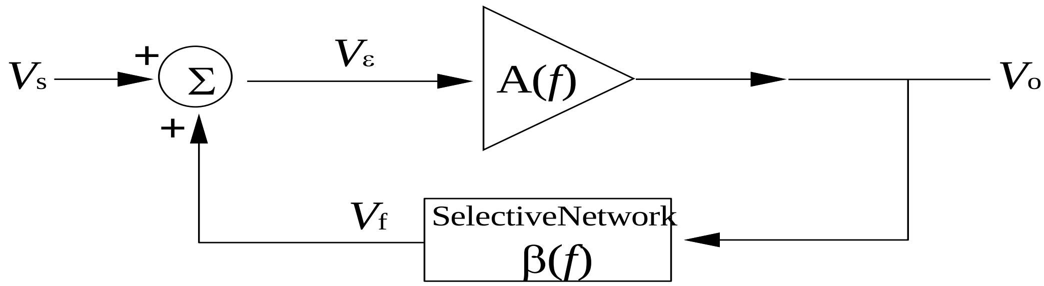


For sinusoidal input is connected "Linear" because the output is approximately sinusoidal

<u>A linear oscillator contains:</u>

- a frequency selection feedback network

- an amplifier to maintain the loop gain at **unity**



$$V_0 = AV_\varepsilon = A(V_s + V_f) \qquad V_f = \beta V_o$$

$$\Rightarrow \frac{V_o}{V_s} = \frac{A}{1 - A\beta}$$

APPLICATION OF OSCILLATORS

- Oscillators are used to generate signals, e.g.
- Used as a local oscillator to transform the RF signals to IF signals in a receiver;
- Used to generate RF carrier in a transmitter
- Used to generate clocks in digital systems;
- Used as sweep circuits in TV sets and CRO.

TYPES OF OSCILLATORS

1. Wien Bridge Oscillators
2. RC Phase-Shift Oscillators
3. LC Oscillators
4. Crystal Oscillator
5. Colpitt's Oscillator

6. Tuned collector Oscillators
7. Hartley Oscillators

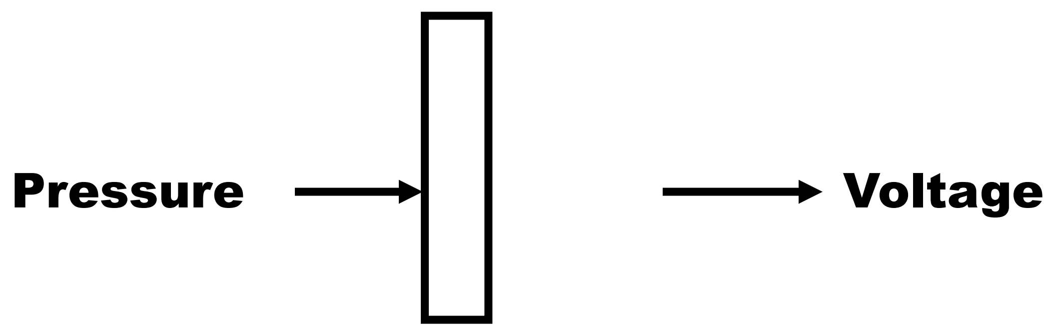
Chapter Review Questions

1. Define Concept of amplification
2. Define Small signal amplifier using BJT power gain voltage gain.
3. Define AC Load Line.
4. What is Function of Input & Output coupling capacitors & criteria for the value selection.
5. What is Function of emitter bypass capacitor & its value selection.
6. Explain AC equivalent circuit of transistor CE amplifier.
7. Explain Single stage CE amplifier with voltage divider biases its explanation.
8. Explain Frequency response of single stage CE Amplifier,
9. Define Bel, Decibel unit, Bandwith & its significance.
10. What are Effect of coupling & emitter bypass capacitor on bandwidth.
11. What is Cascade Amplifiers (Multistage Amplifier)
12. Explain Need of Multistage Amplifiers, Gain of amplifier.

Chapter-8 Transducers and Measuring Instruments

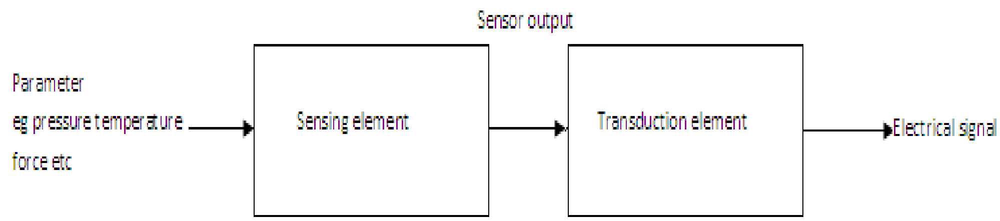
8.1 TRANSDUCERS

- A transducer is a device that converts one form of energy to other form. It converts the measurand to a usable electrical signal.
- In other word it is a device that is capable of converting the physical quantity into a proportional electrical quantity such as voltage or current.



BLOCK DIAGRAM OF TRANSDUCERS

- Transducer contains two parts that are closely related to each other i.e. the sensing element and transduction element.
- The sensing element is called as the sensor. It is device producing measurable response to change in physical conditions.
- The transduction element converts the sensor output to suitable electrical form.



CHARACTERISTICS OF TRANSDUCERS

1. Ruggedness
2. Linearity
3. Repeatability
4. Accuracy
5. High stability and reliability
6. Speed of response
7. Sensitivity
8. Small size

8.2 CLASSIFICATION OF TRANSDUCERS

The transducers can be classified as:

I. Active and passive transducers.

II. Analog and digital transducers.

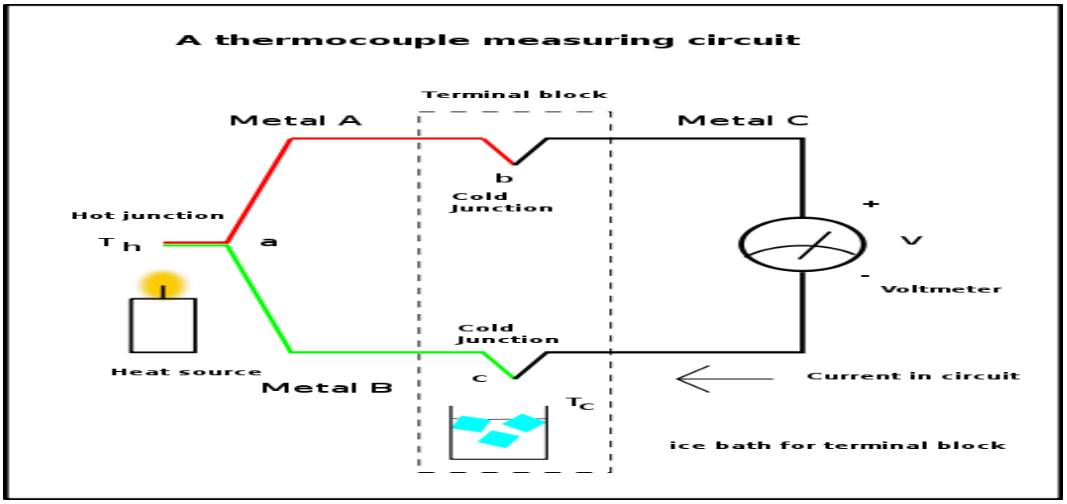
III. On the basis of transduction principle used.

IV. Primary and secondary transducer

V. Transducers and inverse transducers.

8.3 Discuss working of thermocouple & its application

A thermocouple is a temperature-measuring device consisting of two dissimilar conductors that contact each other at one or more spots. It produces a voltage when the temperature of one of the spots differs from the reference temperature at other parts of the circuit. Thermocouples are a widely used type of temperature sensor for measurement and control, and can also convert a temperature gradient into electricity.



The voltage is not generated at the junction of the two metals of the thermocouple but rather along that portion of the length of the two dissimilar metals that is subjected to a temperature gradient. Because both lengths of dissimilar metals experience the same temperature gradient, the end result is a measurement of the difference in temperature between the thermocouple junction and the reference junction. As long as the junction is at a uniform temperature, it does not matter how the junction is made (it may be brazed, spot welded, crimped, etc.), however it is crucial for accuracy that the *leads* of the thermocouple maintain a well-defined composition. If there are variations in the composition of the wires in the thermal gradient region (due to contamination, oxidation, etc.), outside the junction, this can lead to changes in the measured voltage.

8.4 Explain working of multimeter and comparison between Analog and Digital multimeter

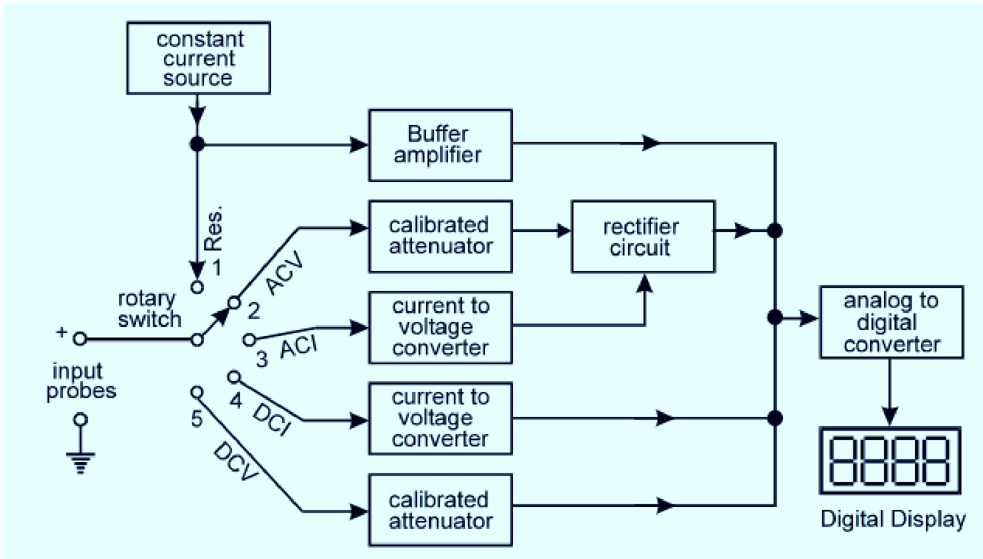
WORKING OF MULTIMETER

To measure voltage (a.c., d.c.), current (ac, dc) and resistance, two types of instruments, analog and digital meters, are utilized. The measurements of these fundamental electrical quantities are based on either one of the following:

i) Current sensing. The instruments are mostly of the electromagnetic meter movement type, such as an analog multimeter.

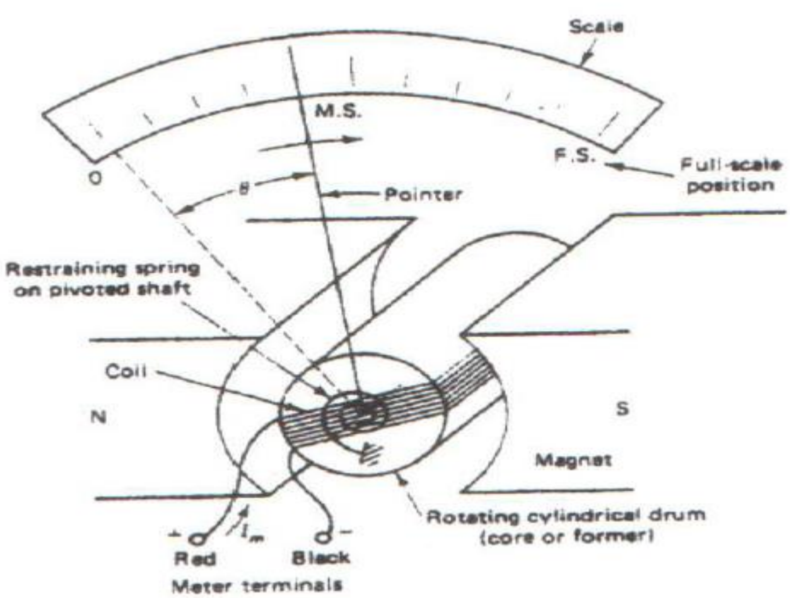
ii) Voltage sensing. The instruments are mostly electronic in nature, using amplifiers and semiconductor devices, such as a digital multimeter.

Block Diagram



ANALOG MULTIMETER

The main part of an analog multimeter is the D'Arsonval meter movement also known as the permanent-magnet moving-coil (PMMC) movement. This common type of movement is used for dc measurements.



When the meter current I_m flows in the wire coil in the direction indicated in Figure, a magnetic field is produced in the coil. This electrically induced magnetic field interacts with the magnetic field of the horseshoe-type permanent magnet. The result of such an interaction is a force causing a mechanical torque to be exerted on the coil. Since the coil is wound and permanently fixed on a rotating cylindrical drum as shown, the torque produced will cause the rotation of the drum around its pivoted shaft. When the drum rotates, two restraining springs, one mounted in the front onto the shaft and the other mounted onto the back part of the shaft, will exhibit a counter torque opposing the rotation and restraining the motion of the drum. This spring-produced counter torque depends on the angle of deflection of the drum, θ, or the pointer. At a certain position (or deflection angle), the two torques are in equilibrium. Each meter movement is characterized by two electrical quantities:

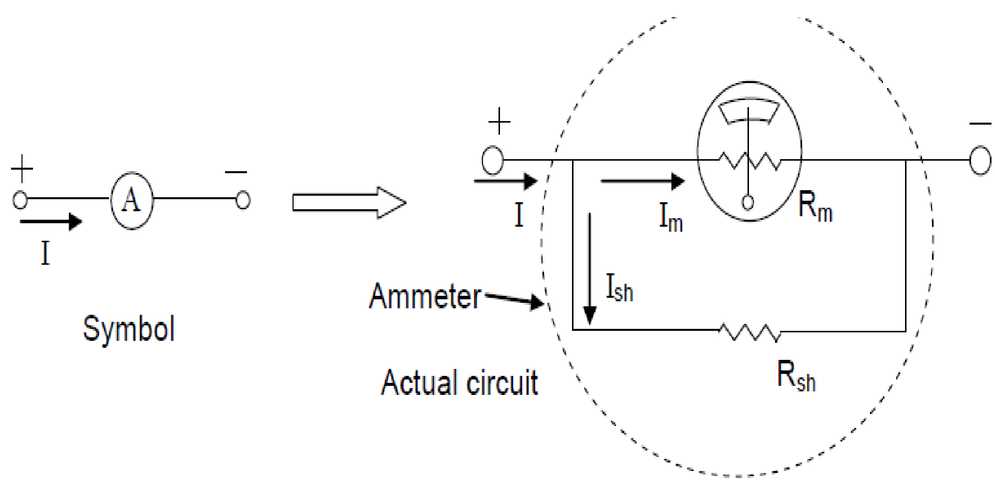
1. R_m: the meter resistance which is due to the wire used to construct the coil.

2. IFS: the meter current, this causes the pointer to deflect all the way up to the full-scale position on the fixed scale. This value of the meter current is always referred to as the full-scale current of the meter movement.

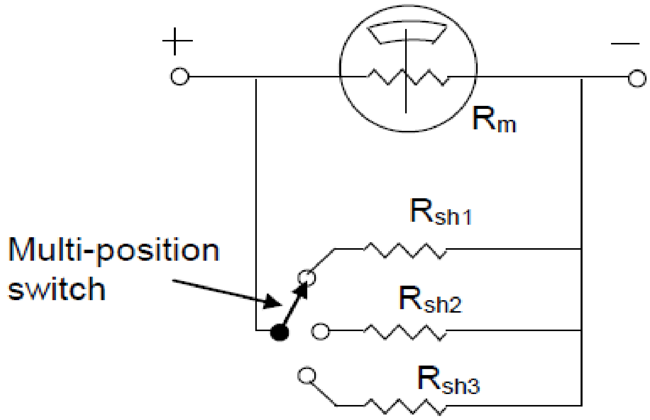
Pre Knowledge:

AMMETER

The deflection of the pointer in the D'Arsonval meter movement is proportional to the meter current I. Therefore, this instrument can be used to measure current. However, the meter movement by itself is of limited use and capability, since its full-scale current value IFS is practically too small (at most in the order of milliamperes). If the current allowed to flow in the movement, Im, exceeds IFS, permanent damage can result, in particular to the restraining springs.
To be able to measure currents higher in value than IFS of a given meter movement, the division principle is applied. Figure 4 shows the construction of an ammeter.

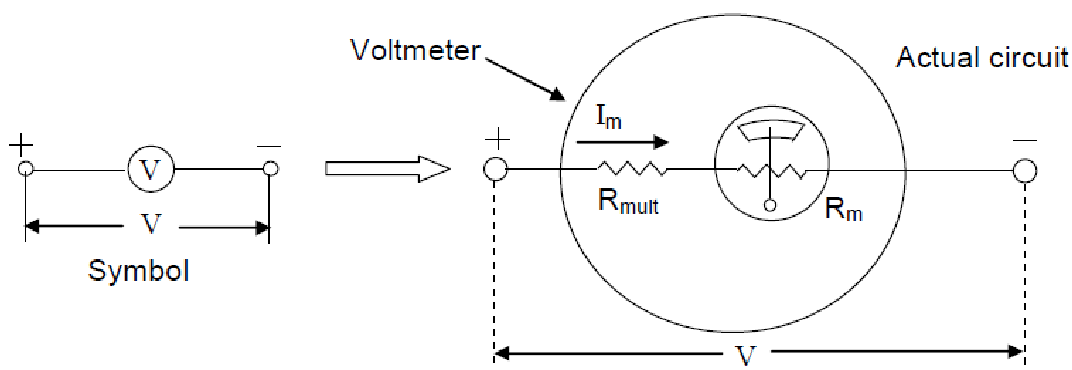


A given meter movement can be used to build a multirange ammeter. Each range requires a different value of the shunt resistance. So a three-range ammeter requires three different shunt resistors.

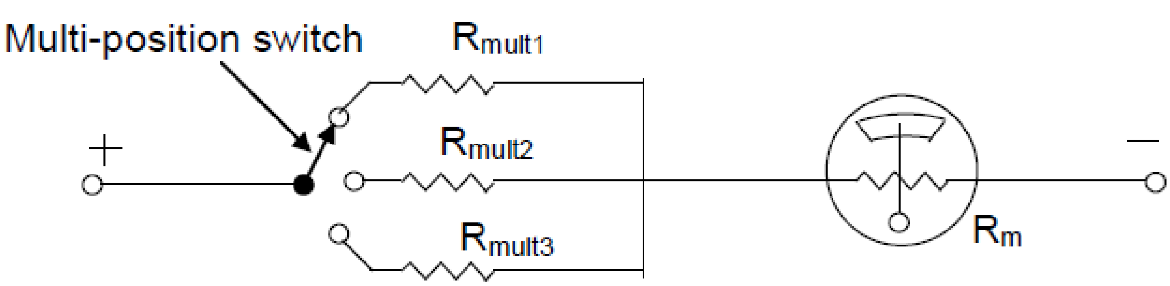


VOLTMETER

To increase the full-scale voltage range of the movement when functioning as a voltmeter, the meter movement current I_m has to be lowered. This can easily be achieved by inserting a large resistance, called the multiplier resistance, R_{mult}, in series with the meter movement

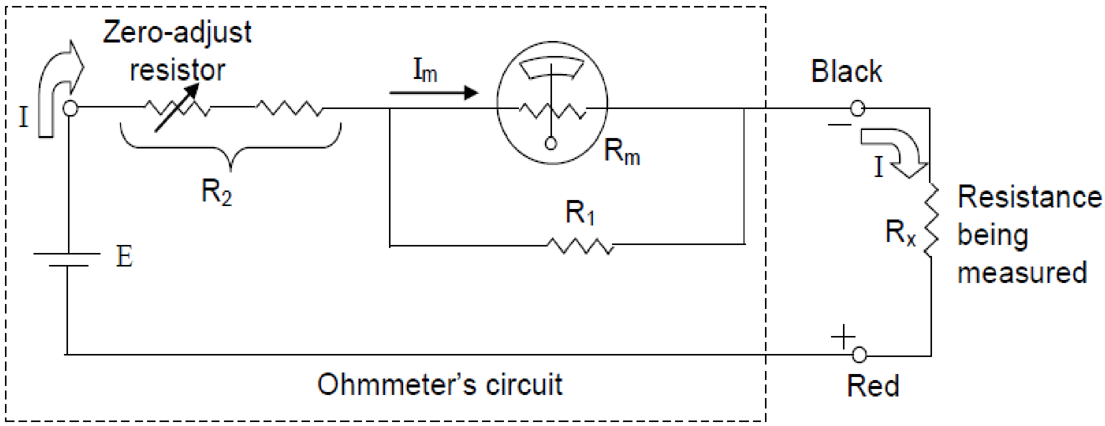


Using the same meter movement, a multirange voltmeter can be designed. A three-range Voltmeter



OHMMETER

If the meter movement current Im is somehow made to be proportional to the value of an unknown resistance to be measured, the meter's scale can be calibrated to read resistance directly. Here, however, a voltage source (e.g., a battery) must be added to the meter's circuit to drive the current necessary for the deflection of the pointer.

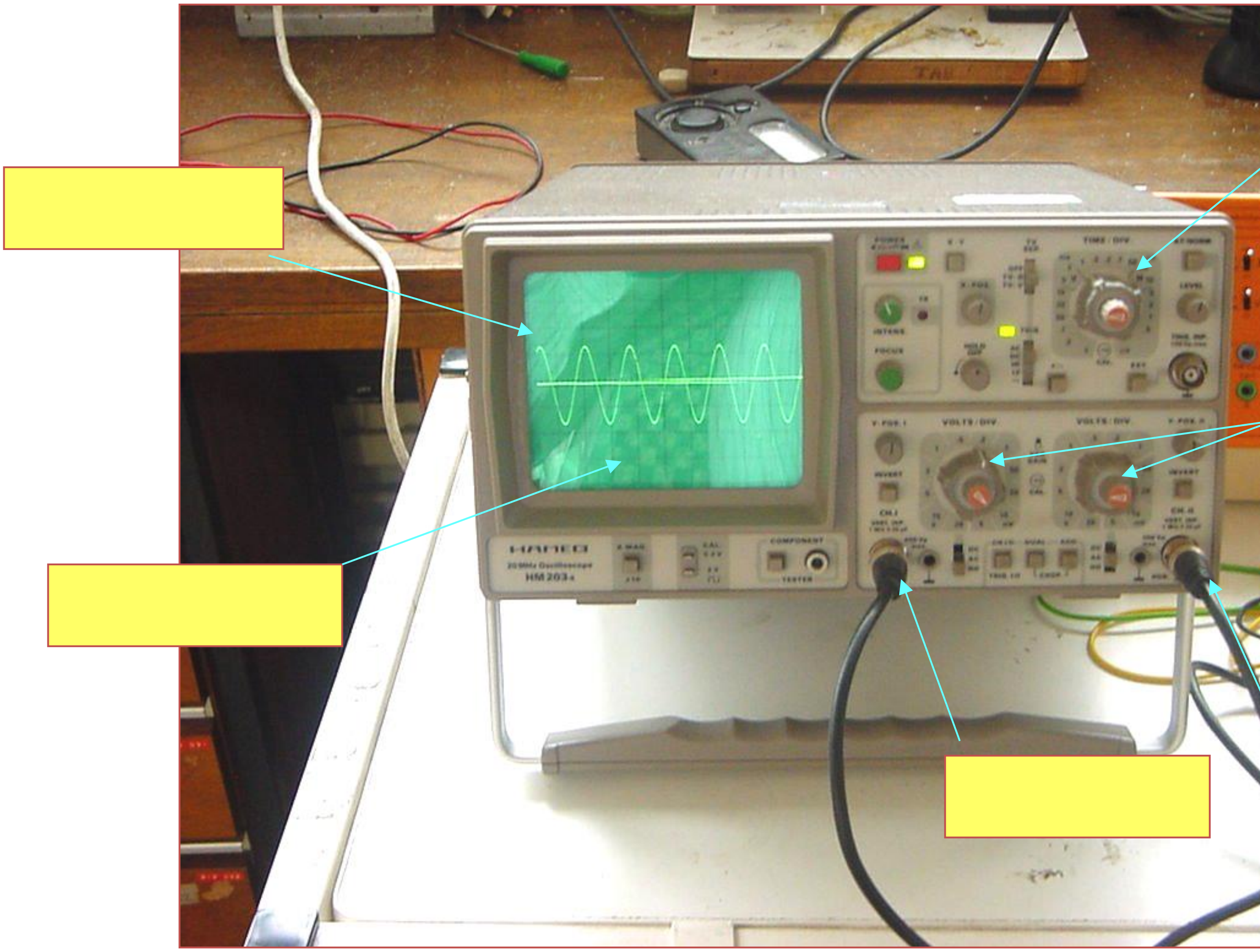


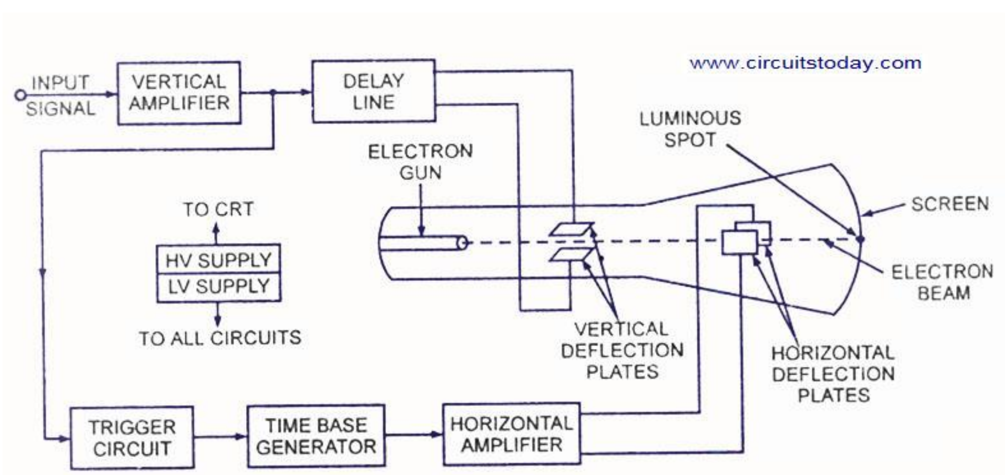
COMPARISON BETWEEN ANALOG AND DIGITAL MULTIMETER

1. Analog multimeter use a needle and calibrated scale to indicate values where as digital multimetres display those values in a digital display.
2. Digital meters are easier to read and adjust to a proper range required for the circuit or device.
3. Digital voltmeters have 50 times more impedance than analog voltmeter. So digital meters are more accurate when measuring voltage in high resistance circuit.
4. Digital meters are often capable of measuring smaller current in microamperes and easier than analog ammeters.
5. Many analog ohmmeter will, when switched to the ohm function, reverse the polarity of the tested leads where as this problem is not happened in digital ohmmeter.

8.5 Explain Block diagram of CRO, Measurement (Frequency & amplitude)& its use.

CATHODE RAY OSCILLOSCOPE (CRO)





Block Diagram of a General Purpose CRO

- Popular instrument to show time, voltage both in D.C. and A.C. Shows Volts / Time.
- Display waveforms. Spectrum scope shows volts to Frequency

- Cathode (-ve) is heated, emits electrons, accelerated toward a (+ve) fluorescent screen. Intensity grid, Focus grid, accelerating anode. (Electron gun)
- Horizontal deflection plates.
- Vertical deflection plates

Cathode ray tube (CRT) is the heart of the CRO. Electron beam generated by the electron gun first deflected by the deflection plates, and then directed onto the fluorescent coating of the CRO screen, which produces a visible light spot on the face plane of the oscilloscope screen.

It consist of two main parts:-

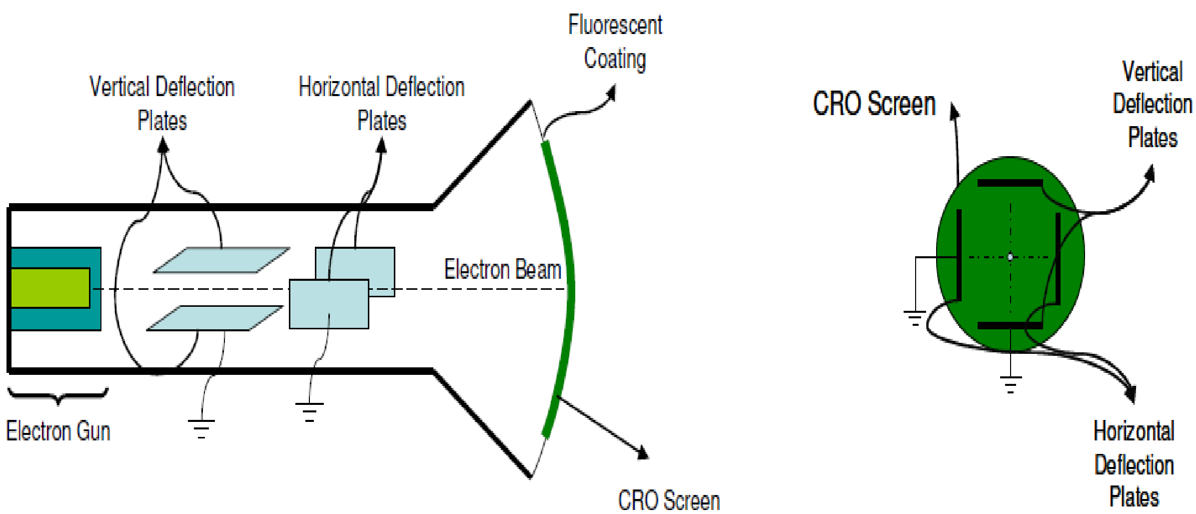
- Electron Gun
- Deflection System

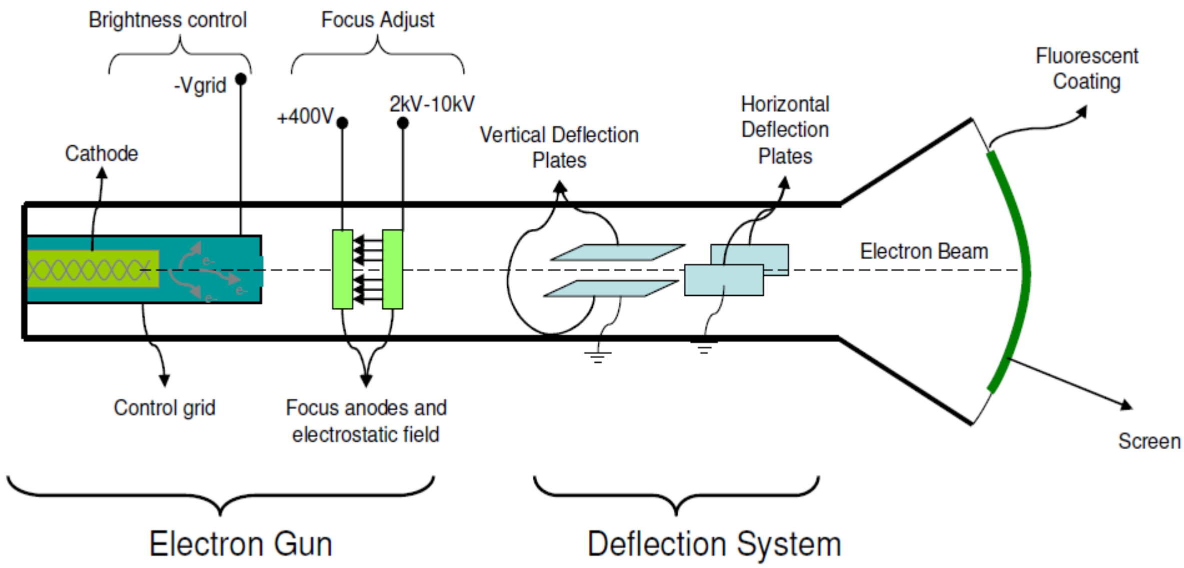
ELECTRON GUN

Electron gun provides a sharply focused electron beam directed toward the fluorescent-coated screen. The thermally heated cathode emits electrons in many directions. The control grid provides an axial direction for the electron beam and controls the number and speed of electrons in the beam.

THE DEFLECTION SYSTEM

The deflection system consists of two pairs of parallel plates, referred to as the vertical and horizontal deflection plates. One of the plates in each set is permanently connected to the ground (zero volt), whereas the other plate of each set is connected to input signals or triggering signal of the CRO.





Y-input: It is the main input of CRO, to which the input signal is connected. The waveform of this input signal is displayed on the screen of CRT.

Vertical attenuator[1]: It consists of RC voltage divider, which is marked on the CRO front panel as Volt/div control knob. Thus the 'gain' of CRO can be controlled with Volt/div knob.

Vertical amplifier: It is a set of preamplifier and main vertical amplifier. The input attenuator sets up the gain of vertical amplifier.

Delay line: The delay line delays the striking of electron beam on the screen. It synchronizes the arrival of the beam on screen when time base generator signal starts sweeping the beam horizontally. The **propagation delay[2]** produced is about 0.25msec.

Trigger circuit: It takes the sample of input voltage connected at y-input of CRO and feeds it to the input of time base generator. So the TBG starts only when input signal is present at y-input.

Time base generator: It produces a saw tooth wave. The waveform is used to sweep (move) the electron beam horizontally on the screen. The rate of rise of positive going edge of saw tooth waveform is controlled by Time/div control knob. Thus, the saw tooth wave controls the horizontal deflection of electron beam along x-axis.

A switch known as INT/EXT is also connected after the output of TBG. When the switch is in INT position, the output of TBG is connected to H-plates through horizontal amplifier. When it is in EXT position, internal saw tooth is cut-off and some external signal can be connected to horizontal plates.

Horizontal amplifier: It amplifies the saw tooth waveform coming from TBG. It contains phase inverter circuit also. Due to this circuit, two outputs are produced. One output produces positive going saw tooth and other output produces negative going saw tooth. The first output is connected to right side H-plate and the second output is connected to left side H-plate. So the electron beam moves properly from left to right of the screen.

Blanking circuit: It is necessary to eliminate the retrace, which would produce when the spot on screen moves from *right to left*. This retrace can produce confusion with the original wave.

So when the electron beam reaches right end of screen, the negative blanking voltage is produced by TBG. It is fed to control grid of CRT, to stop the electron beam completely.

HV/LV power supply: The high voltage section is used to power the electrodes of CRT and the low voltage section is used to power the electronic circuits of the CRO.

Applications of CRO

Some important applications of *CRO* are :

1. Observation of waveforms
2. Voltage measurement
3. Frequency measurement
4. Measurements using Lisajous pattern
5. Identification of Components(New type CRO)

Chapter review questions

1. Define transducer.
2. Classify different type of transducers.
3. Discuss working of thermocouple & its application
4. Explain working ofmultimeter with neat block diagram
5. comparison between Analog and Digital multimeter
6. Explain Block diagram of CRO,Measurement(Frequency & amplitude)& its use.
7. What is CRO
8. What are different sections of CRO

Chapter-9 Communication System

Basics of Communication Systems

Communication is the transfer of information from one point in space and time to another point. The block diagram of a communication system is shown in Figure 19.

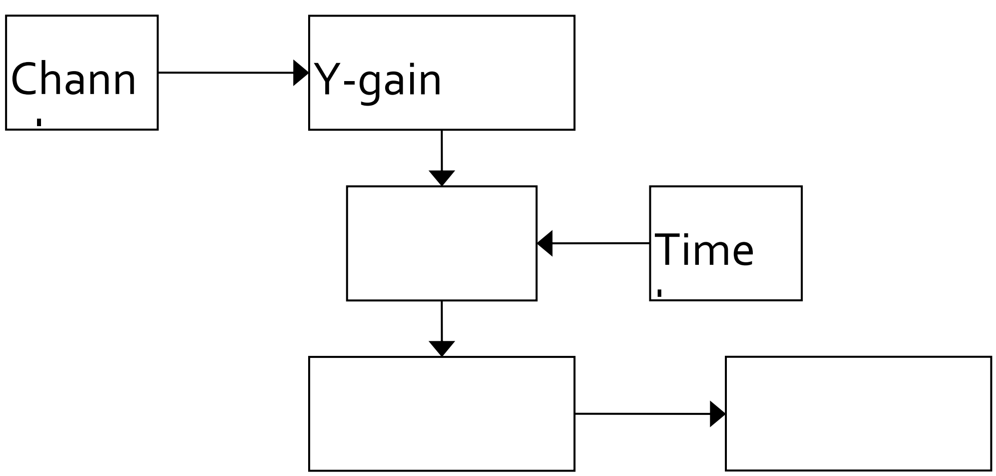


Figure 19 A block diagram of a communication systems

Transmitter - couples the message onto the channel using high frequency signals

Receiver - restores the signal to its original form

Channel - the medium used for transmission of signals and Channels can be of two types: i) wired channels or ii) wireless channels.

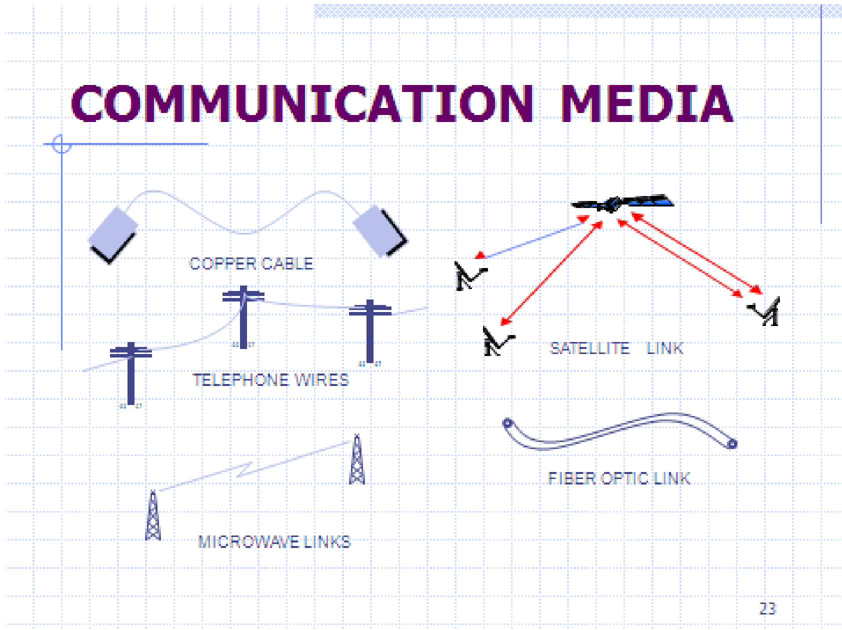
Modulation - the process of shifting the frequency spectrum of a message signal to a frequency range in which more efficient transmission can be achieved

Demodulation - the process of shifting the frequency spectrum back to the original baseband frequency range and reconstructing the original form, if necessary

Baseband - refers to the lower portion of the over-all electromagnetic spectrum

Spectrum of Communication Systems

Frequency Designation	Transmission Media	Propagation Modes	Applications
Infrared 1 THz – 430 THz	Optical fibers	Laser beam	Wideband Data Multimedia ATM
Super High Frequency (SHF) 3 GHz – 30 GHz	Waveguides	Line-of-Sight (LOS) Radio	Satellite Microwave Radar Navigational
Ultra High F'cy (UHF) 300 MHz – 3000 MHz	Waveguides/ Co-axial cable	LOS Radio	UHF ,TV ,Mobile
Very High F'cy (VHF) 30 MHz – 300 MHz	Co-axial cable	LOS Radio	Mobile ,VHF ,TV, FM
High F'cy (HF) 3 MHz – 30 MHz	Co-axial cable	Sky wave Radio	CB Amateur Radio Civil Defense
Medium F'cy (MF) 300 kHz – 3000 kHz	Co-axial cable	Ground wave Radio	AM
Low F'cy (LF) 30 kHz – 300 kHz	Wire pairs	Ground wave Radio	Aeronautical , ransoceanic Radio
Very Low F'cy (VLF) 3 kHz – 30 kHz	Wire pairs	Ground wave Radio	Telephone Telegraph
Audio F'cy (AF) 20 Hz – 20 kHz	Wire pairs		



9.1 Define Modulation & its need.

The process of changing some characteristic (e.g. amplitude, frequency or phase) of a carrier Wave in accordance with the intensity of the signal is known as modulation. The resultant wave is called modulated wave or radio wave and contains the audio signal. Therefore, modulation permits the transmission to occur at high frequency while it simultaneously allows the carrying of the audio signal. It is also the process of manipulating the frequency or the amplitude of a carrier wave in response to an incoming voice, video or data signal

Why Modulation needed?

Modulation is required to match the signal to the transmission medium. Some of the major reasons why modulation is required are:

- ***Practical antenna length.***

Ex- Audio frequencies range from 20 Hz to 20 kHz, therefore, if they are transmitted directly into space, the length of the transmitting antenna required would be extremely large. For instance, to radiate a frequency of 20 kHz directly into space, we would need an antenna length of 3 ×10 power 8/20 × 10 power 3 = 15,000 metres. This is too long antenna to be constructed practically. If a carrier wave say of 1000 kHz is used to carry the signal, we need an antenna length of 300 metres only and this size can be easily constructed.

- ***Operating range.*** The energy of a wave depends upon its frequency. The greater the frequency of the wave, the greater the energy possessed by it. As the audio signal frequencies are small, therefore, these cannot be transmitted over large distances if radiated directly into space. Thus modulate a high frequency carrier wave with audio signal and permit the transmission to occur at this high frequency (*i.e.* carrier frequency).
- ***Wireless communication.*** One desirable feature of radio transmission is that it should be carried without wires *i.e.* radiated into space. At audio frequencies, radiation is not practicable because the efficiency of radiation is poor. However, efficient radiation of electrical energy is possible at high frequencies > 20 kHz.
- Modulation for ease of radiation
- Modulation for frequency assignment and multiplexing
- Modulation to reduce noise and interference

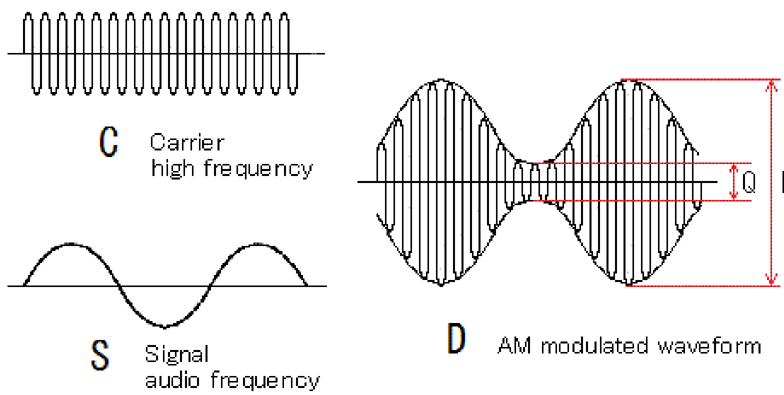
9.2 Types of Modulation

There are three basic types of modulation, namely ;

(i) Amplitude modulation ***(ii)*** Frequency modulation ***(iii)*** Phase modulation

(i)Amplitude Modulation

When the amplitude of high frequency carrier wave is changed in accordance with the intensity of the signal, it is called amplitude modulation*.* In amplitude modulation, only the amplitude of the carrier wave is changed in accordance with the intensity of the signal and the frequency of the modulated wave remains the same *i.e*. carrier frequency. Amplitude modulation (AM) is a **modulation** technique used in electronic communication, most commonly for transmitting information via a **radio carrier wave** and in portable **two way radios**, **VHF aircraft radio** and in computer **modems** ."AM" is often used to refer to **medium wave AM radio broadcasting**.



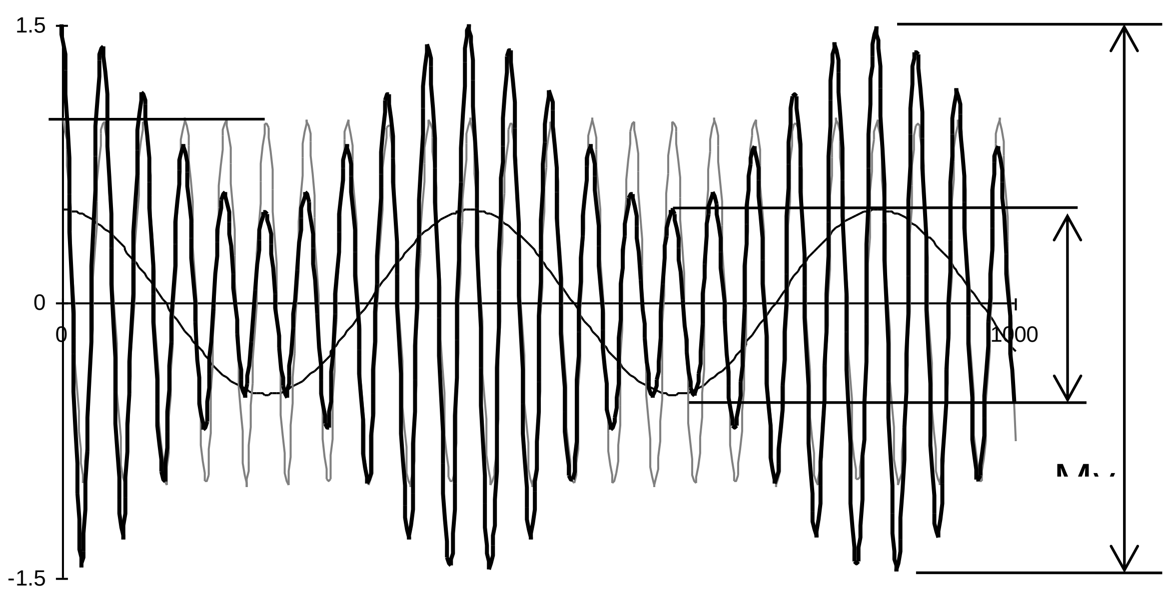
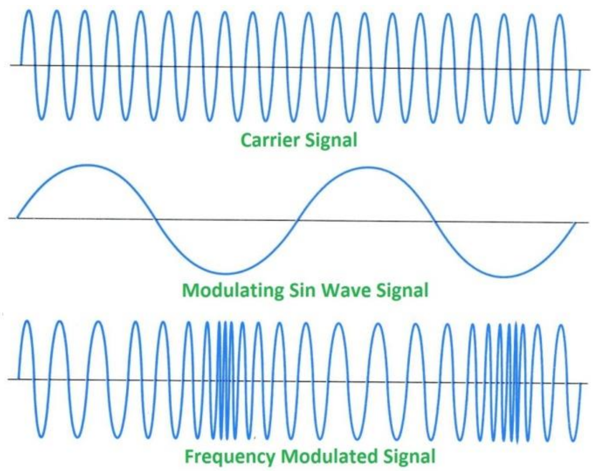


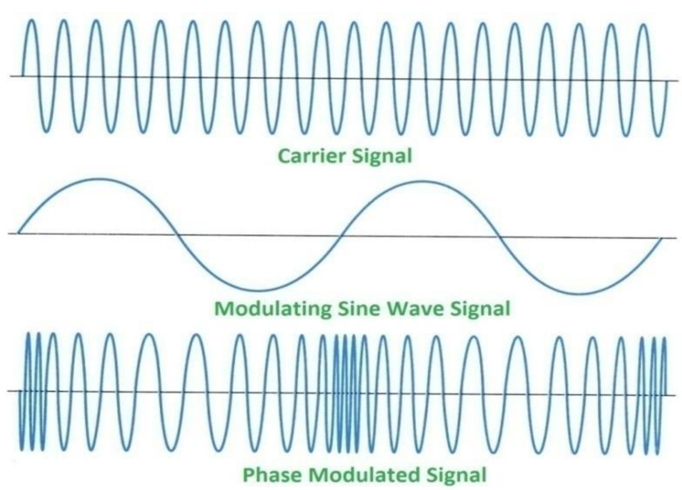
Figure1.2 An AM signal with modulating and carrier signals shown

(ii)Frequency Modulation (FM)

When the frequency of carrier wave is changed in accordance with the intensity of the signal, it is called frequency modulation (FM). In frequency modulation, only the frequency of the carrier wave is changed in accordance with the signal and the amplitude of the modulated wave remains the same *i.e*. carrier wave amplitude. The frequency variations of carrier wave depend upon the instantaneous amplitude of the signal(Compare with **amplitude modulation**, in which the **amplitude** of the carrier wave varies, while the frequency remains constant.) It is used in **radio**, **telemetry**, **radar**, seismic prospecting, and monitoring **newborns** for seizures via **EEG**. FM is widely used for **broadcasting** music and speech, **two-way radio** systems, magnetic tape-recording systems and some video-transmission systems. Frequency modulation is known as **phase modulation** when the carrier phase modulation is the time **integral** of the FM signal



(iii) Phase modulation (PM) is a **modulation** pattern that encodes **information** as variations in the **instantaneous phase** of a **carrier wave**. Phase modulation is a form of modulation that can be used for radio signals used for a variety of radio communications applications. As will be seen later, phase modulation, and frequency modulation are closely linked together and it is often used in many transmitters and receivers used for a variety of radio communications applications from two way radio communications links, mobile radio communications and even maritime mobile radio communications. Unlike **frequency modulation** (FM), phase modulation is not widely used for transmitting **radio** waves. It is used for signal and waveform generation in **digital synthesizers**.



9.4 Demodulation

The process of recovering the audio signal from the modulated wave is known as modulation *or* detection. At the broadcasting station, modulation is done to transmit the audio signal over larger distances to a receiver. When the modulated wave is picked up by the radio receiver, it is necessary to recover the audio signal from it. This process is accomplished in the radio receiver and is called demodulation. A demodulator is an electronic circuit (or computer program in a software defined radio) that is used to recover the information content from the modulated carrier wave. Demodulation is the act of extracting the original information-bearing signal from a modulated carrier wave**.** A demodulator is an **electronic circuit** (or **computer program** in a **software-defined radio**) that is used to recover the information content from the modulated **carrier wave**.

The comparison of FM and AM is given in the table below

FM	AM
The amplitude of carrier remains constant with modulation	The amplitude of carrier changes with Modulation
The carrier frequency changes according to the strength of the modulating signal.	The carrier frequency remains constant with modulation.
The carrier frequency changes with modulation.	The carrier amplitude changes according to the strength of the modulating signal
The value of modulation index (mf) can be more than 1.	The value of modulation factor (m) cannot be more than 1 for distortionless AM signal.

Chapter Review Questions

1. Define communication system
2. Define Transmission & Reception.
3. Define Modulation & its need.
4. Define Signal, Carrier Wave & Modulated Wave
5. Name different types of Modulation.(AM,FM & PM)
6. Discuss Amplitude Modulation & draw its wave form
7. Discuss Frequency Modulation & draw its wave form.

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