

B.Tech.

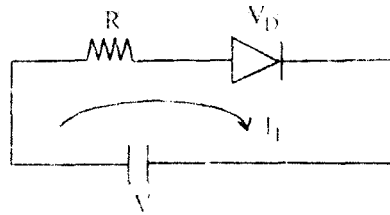
Second Semester Examination, 2009-2010

Basics of Electronics (ECE-101-F)

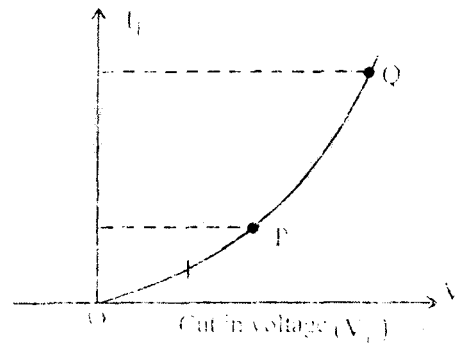
Note : Attempt any *five* questions.

Q. 1. (a) What is knee voltage?

Ans.



I_f (Forward Current):



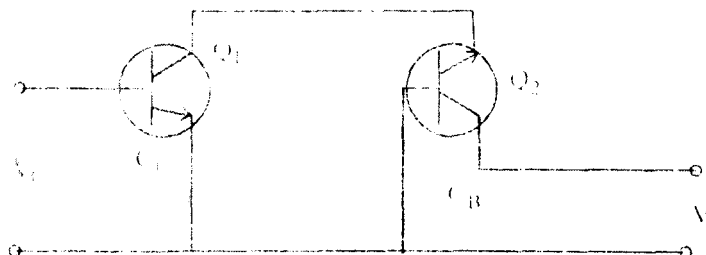
Region 'O to P' : As long as V_f is less than cut-in voltage. The current flowing is very small.

Region P to Q : As V_f increases towards V_f the width of the depletion region goes on reducing.

When V_f exceeds V_{f1} i.e., cut-in-voltage the depletion region becomes very thin and current I_f increases exponential as shown above, the point P after which the forward current start increasing exponentially is called "Knee" voltage.

Q. 1. (b) What is cas code amplifier?

Ans. Cascode Amplifier :



The cascode amplifier is a pair of two port network using two transistor one is common emitter and other is common base and the cascode amplified circuit is solved by using y-parameter.

$$Y_{11} = G_{11} + jB_{11} = \frac{I_1}{V_1} \bigg|_{V_2=0}$$

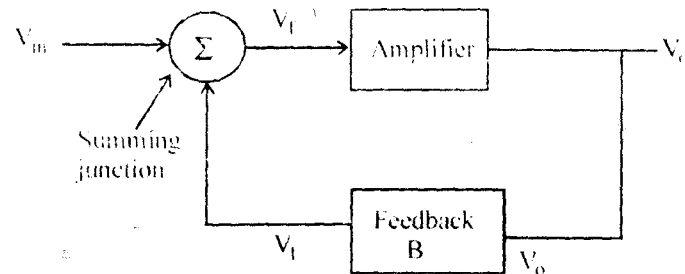
$$Y_{12} = G_{12} + jB_{12} = \frac{I_1}{V_2} \bigg|_{V_1=0}$$

$$Y_{21} = G_{21} + jB_{21} = \frac{I_2}{V_1} \bigg|_{V_2=0}$$

$$Y_{22} = G_{22} + jB_{22} = \frac{I_2}{V_2} \bigg|_{V_1=0}$$

Q. 1. (c) What is Barkausen criteria?

Ans. An oscillator is a type of feedback amplifier in which part of the output is feedback to the input via a feedback circuit. If the signal feedback is of proper magnitude and phase, the circuit produces alternating current or voltages.



$$V_d = V_f + V_m$$

$$V_o = A_v V_d$$

$$V_f = \beta V_o$$

$$V_o = A_v (V_f + V_m)$$

$$V_o = A_v (\beta V_o + V_m)$$

$$\frac{V_o}{V_m} = \frac{A_v}{1 - A_v \beta}$$

If $A_v \beta = 1$, Then $\frac{V_o}{V_m} = \infty$ called Barkausen criteria.

Requirement :

(i) The magnitude of the loop $A_v \beta$ must be at least 1.

(ii) The total phase shift of the loop $A_v\beta$ must be equals to 0° or 360° .

Q. 1. (d) What is CMRR?

Ans. Common Mode Rejection Ratio : CMRR is the ability of a differential amplifier to reject common mode signals. It is defined as the ratio of differential voltage gain A_d to the common mode voltage gain A_c of given differential amplifier.

$$\text{CMRR} = \left| \frac{A_d}{A_c} \right|$$

$$\text{CMRR} = 20 \log_{10} \left| \frac{A_d}{A_c} \right|$$

$$A_d = \frac{V_{od}}{V_{id}}, A_c = \frac{V_{oc}}{V_c}$$

$$V_o = A_d V_{id} + A_c V_c$$

$$= A_d \left[V_{id} + \frac{A_c}{A_d} V_c \right]$$

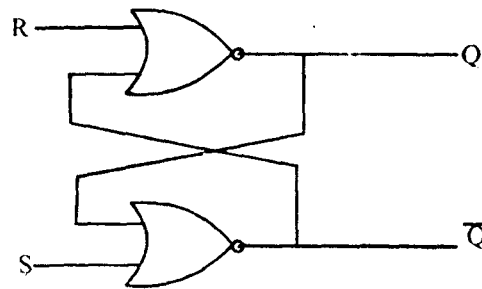
$$V_o = A_d \left[V_{id} + \frac{1}{\text{CMRR}} V_c \right]$$

Q. 1. (e) Define datch and flip-flop.

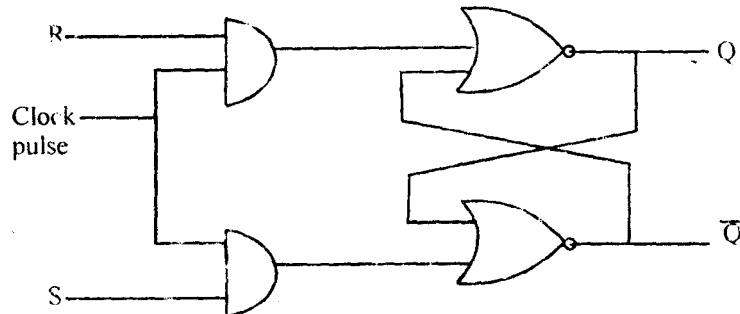
Ans. A flip-flop has only two stable state. A flip-flop is abbreviated to FF. The basic unit of memory is the latch.

The output of the flip-flop is either logic '0' and logic '1'. This means that it can store 1 bit information.

The basic latch (R, S) is an asynchronous transparent sequential circuit. This means that any change in the input of R and S is transmitted immediately to the output Q and \bar{Q} according to the truth table. But in FF can be modified by providing an additional control input that determines when the state of the circuit is to be changed. This additional control input called clockpulse.



Latch using NOR gate



Clocked RS flip-flop

Q. 1. (f) Advantages of LED over LCD.

Ans. LED have significant advantage over LCDs in backlighting application :

- (i) LED can provide higher brightness, when properly integrated into a system.
- (ii) LED backlighting have a longer life time.
- (iii) LED can be operated efficiently over a wider temperature range, particularly at the low end.
- (iv) LED operate at low level D.C. voltage.
- (v) The efficiency of LED is much higher than LCD.

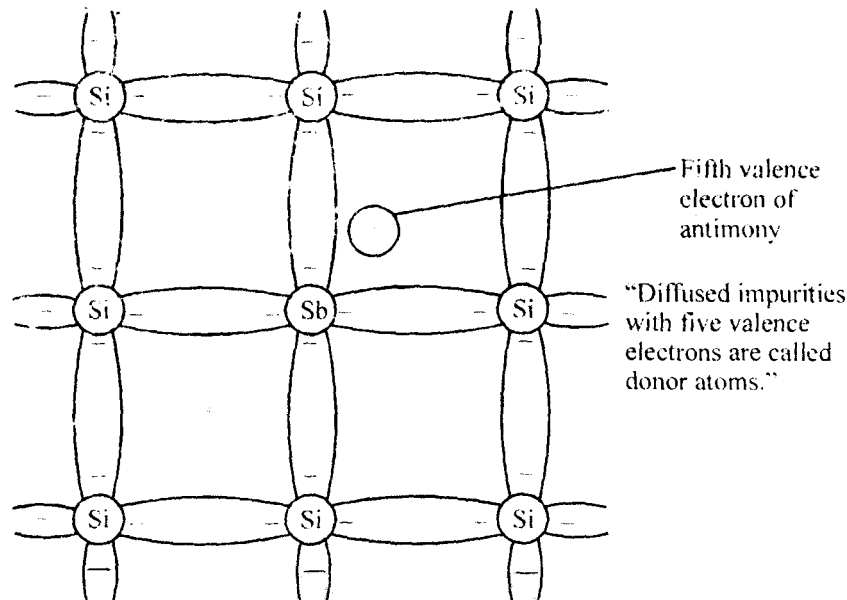
Q. 1. (g) What is gasticule?

Ans. A network of fine line, dots, cross hairs or wire in the focal plane of the eye-piece of an optical instruments.

Q. 2. (a) Differentiate between extrinsic and intrinsic semiconductors.

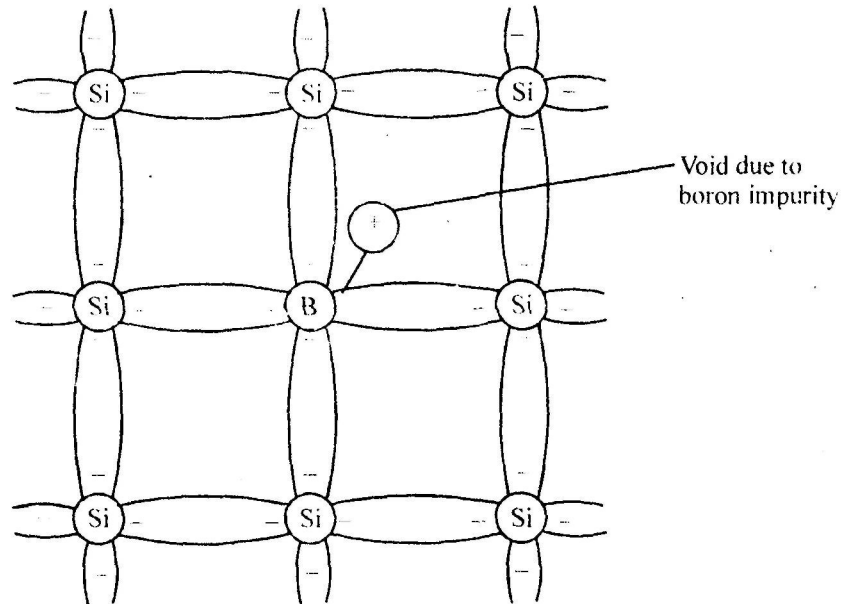
Ans. Extrinsic Semiconductor : A semiconductor material that has been subjected to the doping process is called an extrinsic material. There are two extrinsic material of immeasurable importance to semiconductor device fabrication n-type and p-type material. Each is described in some detail in the following subsections :

n-type Material :



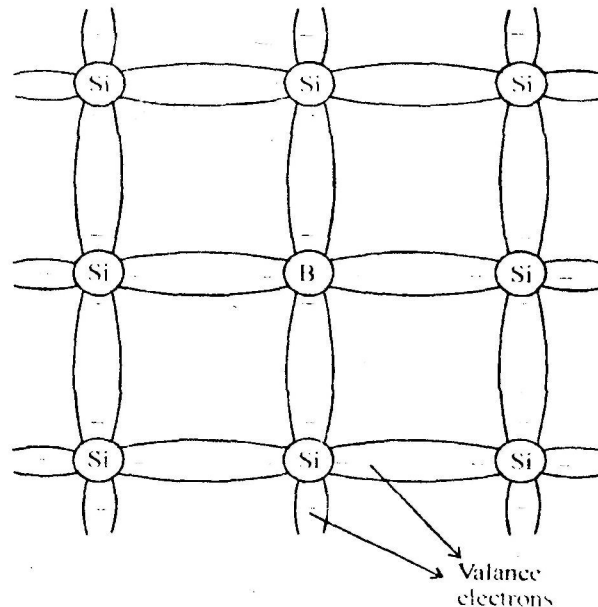
Both n-type and p-type material are formed by adding at predetermined number of impurity atoms of a silicon base. An n-type material is created by introducing impurity elements that have five valence electrons (pentavalent) such as antimony, arsenic and phosphorus.

p-type Material : The p-type material is formed by doping a pure Germanium or silicon crystal with impurity atoms having three valence electrons. The elements most frequently used for this purpose are boron, gallium and Indium.



The diffused impurities with three valence electrons are called acceptor atom.

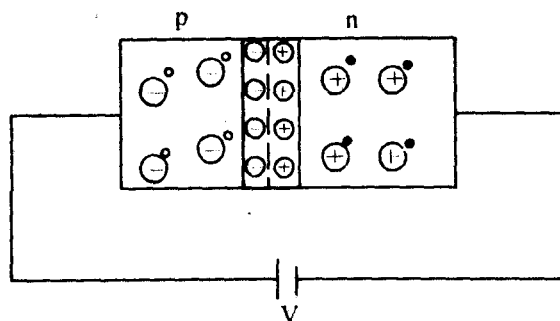
Intrinsic Semiconductor : Germanium and silicon there are four valence electrons called tetra valent.



The bonding of atoms, strengthened by the sharing of electrons is called covalent bonding.

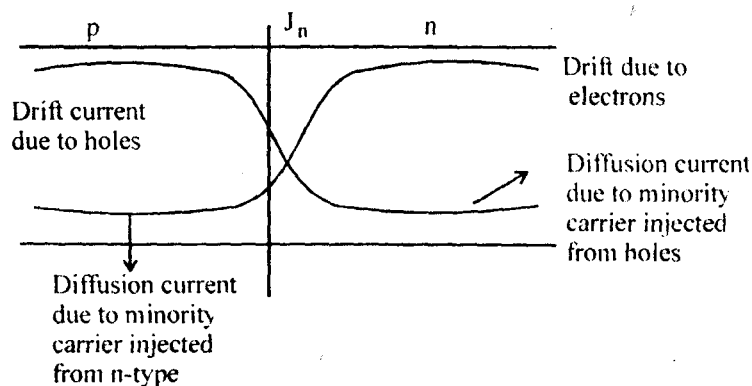
Q. 2. (b) Draw and explain the V-I characteristics of a diode with the help of current of diode.

Ans. p-n Junction :



Conditions for Forward Bias :

- (i) Higher voltage should be connected to p-type and lower voltage should be n-type.
- (ii) Applied voltage should be low (low level injection).
- (iii) Applied voltage $\gg V_T$.



$$n_i = \sqrt{A_0 T^3 e^{-\epsilon_0 / KT}} \quad n_i = 2.5 \times 10^{13} / \text{cm}^3 \text{ Ge}$$

$$A_0 = \text{Constant} \quad n_i = 1.5 \times 10^{13} / \text{cm}^3 \text{ Si}$$

$$T = \text{Temp. in K} \quad \text{at} \quad T = 300 \text{ K or } T = 27^\circ\text{C}$$

$$\epsilon_0 = \text{Forbidden energy gap as } T = 0^\circ\text{K}$$

$$K = \text{Boltzmann constant}$$

Diode Equation :

$$I = I_0 \left(e^{V/\eta V_T} - 1 \right)$$

I_0 = Reverse saturation current

I = Current through diode

V = Applied voltage

η = constant; $\eta = n$ for Ge; $\eta = 2$ for Si

(i) Forward Bias :

$$V \gg V_T$$

$$\frac{V}{V_T} \gg 1$$

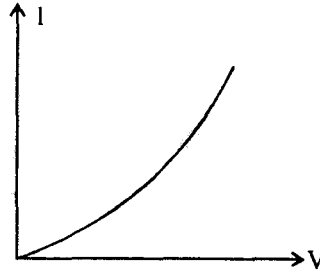
$$e^{V/V_T} \gg \gg 1$$

$$I = I_0 e^{V/\eta V_T}$$

Thus, in forward bias condition will follow exponential function.

$$I = I_0 e^{V/\eta V_T}$$

It means when a positive voltage is applied across diode. There will be a current from p to n type semiconductor and will follow exponential function and which can be represented in graphical manner.



(ii) Reverse Bias :

$$|V| \gg V_T$$

V should be less than breakdown voltage

$$|V| \gg V_T$$

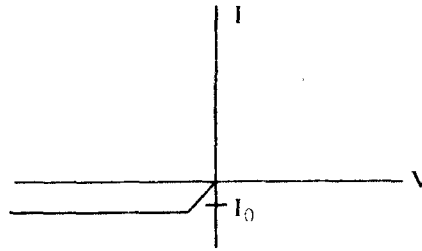
$$\frac{|V|}{V_T} \gg 1$$

$$-\frac{V}{V_T} \ll -1$$

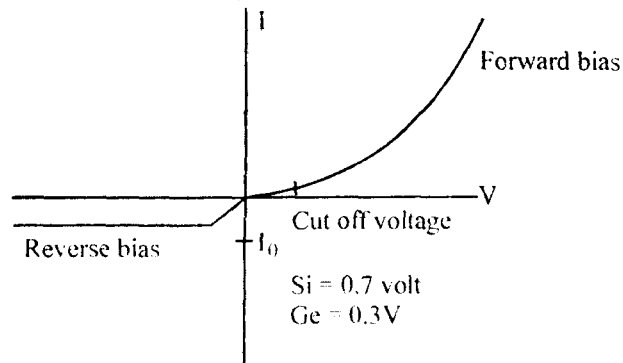
$$e^{-V/V_T} \ll \ll \ll 1$$

$$I = I_0 (e^{V/\eta V_T} - 1)$$

$$I = -I_0$$

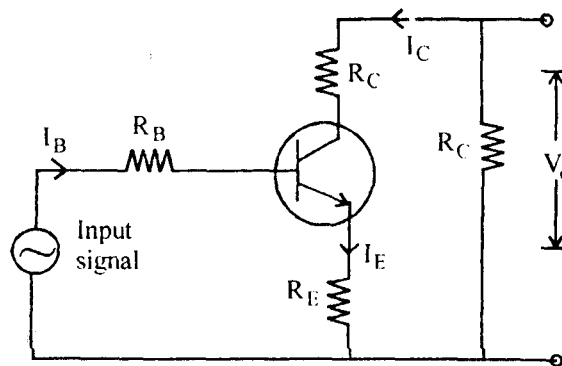


It means characteristic of diode can be represented by,

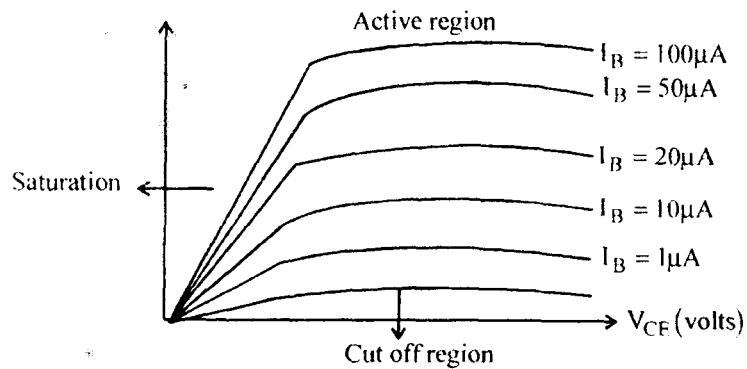


Q. 2. (c) Explain input/output (V-I) characteristics of CE amplifiers.

Ans.



Input Characteristics :

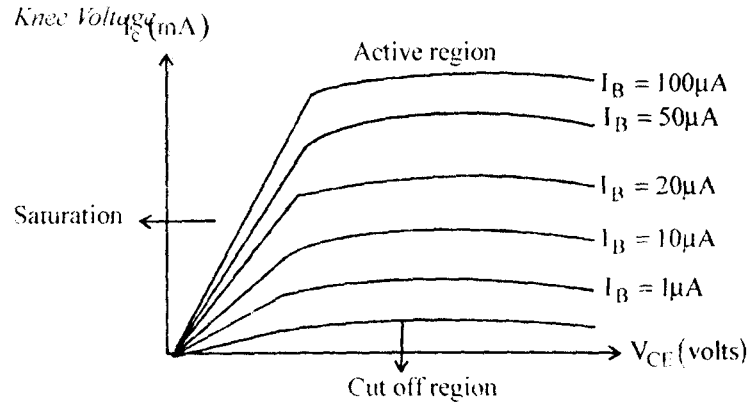


Input resistance $r_{in} = \frac{\Delta V_{BE}}{\Delta I_B}$

Observation : As compared to CB configuration I_B increases less rapidly with increase of V_{BE} .

∴ Input resistance of a CE configuration is higher than CB configuration.

Output Characteristics :



Output Resistance :

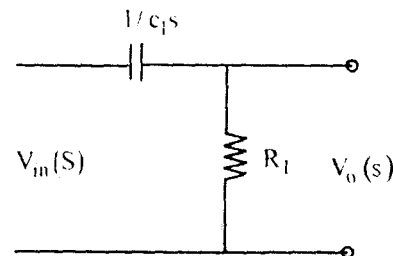
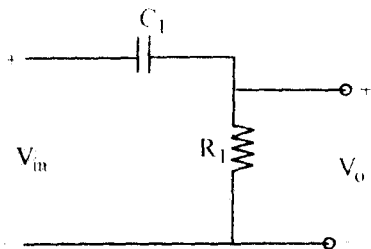
$$r_o = \frac{\Delta V_{CE}}{\Delta I_C} \text{ at constant } I_B$$

Observation :

- (i) The collector current I_C varies with V_{CE} between 0 and 1 volt. After this collector current is almost constant independent of V_{CE} .
- (ii) For any value of V_{CE} above knee voltage the collector voltage the collector current I_C approximately equals to βI_B .
- (iii) The transistors are operated in the region above knee voltage.

Q. 3. (a) Draw and explain the frequency response curve of RC coupled amplifier and derive expressions for upper and lower cut-off frequencies.

Ans. Low Frequency Response for RC Circuit :



$$V_0(s) = V_{in}(s) \frac{R_1}{\frac{1}{sC_1} + R_1} = V_{in}(s) \frac{R_1 s C_1}{1 + s R_1 C_1}$$

$$V_0(s) = \frac{s}{\frac{1}{R_1 C_1} + s} V_{in}(s)$$

The voltage transfer function at low frequency

$$T(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{s}{s + \frac{1}{R_1 C_1}}$$

The above transfer function has one zero at $S = 0$ and one pole at

$$s = -\frac{1}{R_1 C_1}$$

For physical frequencies $S = j\omega = j2\pi f$

$$T(j\omega) = \frac{j\omega}{j\omega + \frac{1}{R_1 C_1}} = A_c(j\omega)$$

$$A_c(j\omega) = \frac{1}{1 + \frac{1}{j\omega R_1 C_1}} = \frac{1}{1 + \frac{1}{j2\pi R_1 C_1 f}}$$

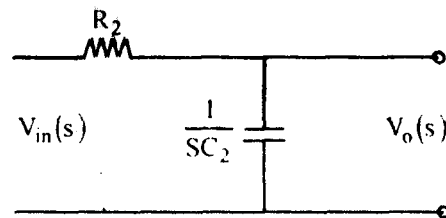
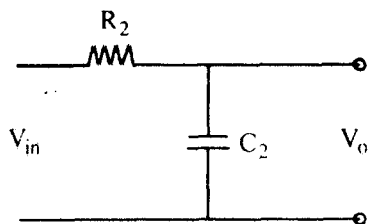
$$A_c(jf) = \frac{1}{1 - j\left(\frac{f_c}{f}\right)} \quad f_c = \frac{1}{2\pi R_1 C_1}$$

$$\tau_1 = R_1 C_1$$

$$f = \frac{1}{2\pi\tau_1}$$

$$|A_c(jf)| = \frac{1}{\sqrt{1 + \left(\frac{f_c}{f}\right)^2}}, \quad \theta = \tan^{-1}\left(\frac{f_c}{f}\right)$$

High Frequency Response :



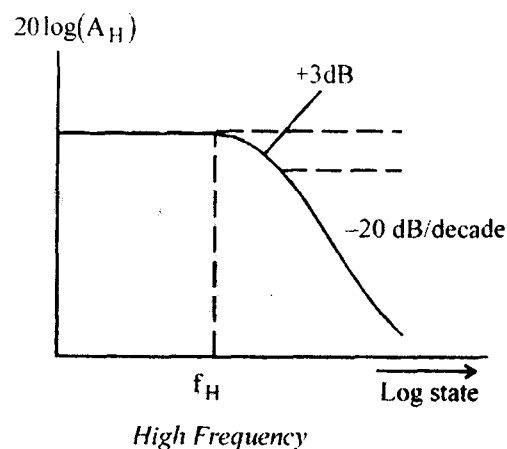
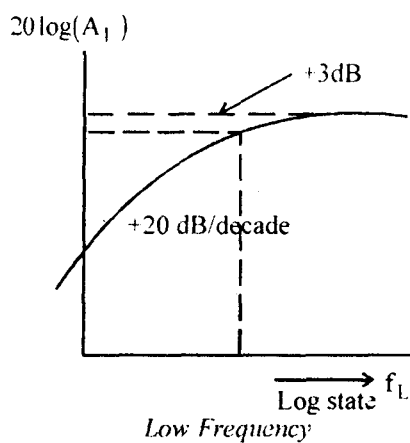
$$A_H(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{1}{1 + sR_2C_2}$$

$$A_H|j\omega| = \frac{1}{1 + j\omega R_2C_2} = \frac{1}{1 + j2\pi f R_2C_2}$$

$$A_H|j\omega| = \frac{1}{1 + jf/f_H}$$

$$f_H = \frac{1}{2\pi R_2C_2}, \quad f_H = \frac{1}{2\pi\tau_2}$$

$$\tau_2 = R_2C_2$$



Q. 3. (b) Explain the working of feed back networks. Why these are required? What are their advantages?

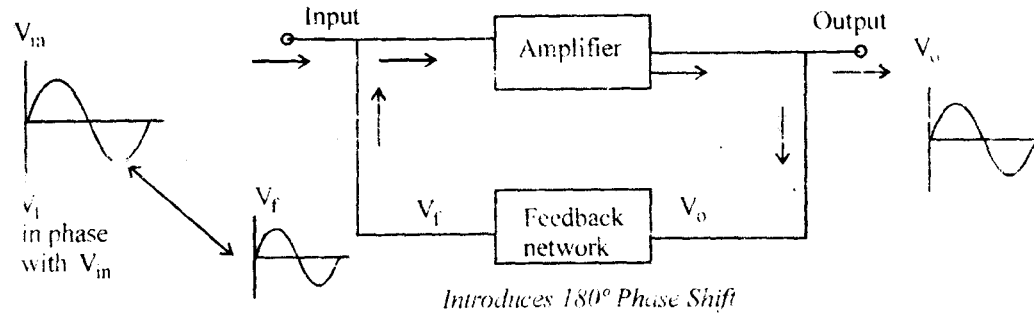
Ans. Feedback plays an important role in almost all electronic circuits. It is almost in variable used in the amplifiers to improve its performance and to make it more ideal. Feedback is the process of taking a part of output and feeding it back to input.

Therefore input gets constantly corrected by the output feedback helps as to get desirable effect of the output.

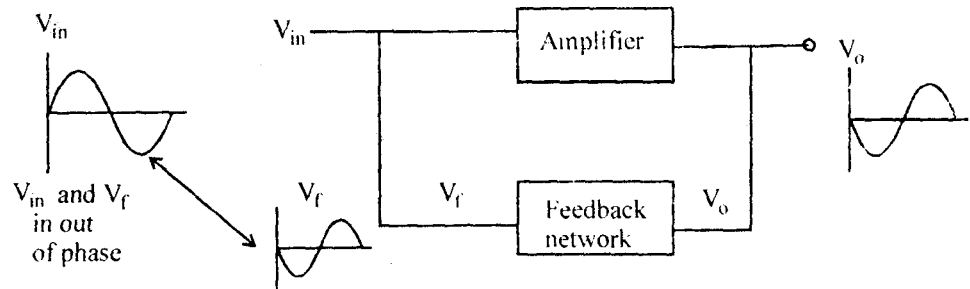
Classification of Feedback :

- (i) Positive feedback
- (ii) Negative feedback

(i) Positive Feedback :



(ii) Negative Feedback :



Advantages of Negative Feedback :

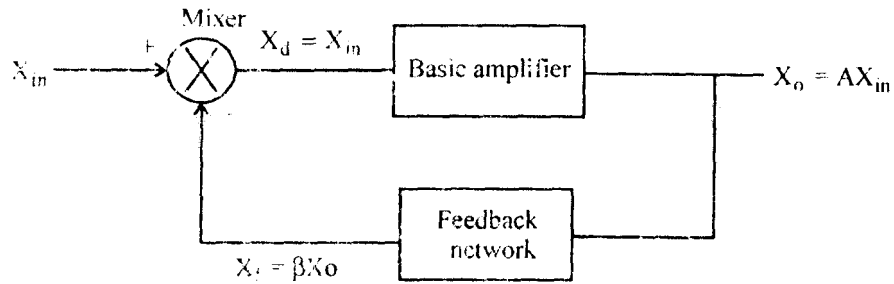
- (i) Reduction in distortion
- (ii) Stability in gain.
- (iii) Increased bandwidth
- (iv) Increased input impedance
- (v) More linear operation
- (vi) Lower output impedance.

Properties of Negative Feedback :

Transfer Gain : The symbol A is used to represent transfer gain of the basic amplifier without feedback and symbol A_f is used to represent transfer gain of the basic amplifier with feedback.

Gain without feedback $A = \frac{X_o}{X_{in}}$

Gain with feedback $A_f = \frac{X_o}{X_s}$



$$X_{in} = X_s - X_f$$

$$A_f = \frac{X_o}{X_s}, \quad A_f = \frac{X_o}{X_{in} + X_f}$$

$$A_f = \frac{\frac{X_o}{X_{in}}}{1 + \frac{X_f}{X_{in}}}$$

$$= \frac{A}{1 + \frac{X_f}{X_{in}} \cdot \frac{X_o}{X_o}}$$

$$= \frac{A}{1 + \frac{X_f}{X_o} + \frac{X_o}{X_{in}}}$$

$$A_f = \frac{A}{1 + A\beta}$$

Stability of Gain

$$A_f = \frac{A}{1 + \beta A}$$

$$\frac{dA_f}{dA} = \frac{1}{(1 + \beta A)^2}$$

$$\frac{dA_f}{A_f} = \frac{dA}{(\beta A + 1)^2} \times \frac{1}{A_f}$$

$$\frac{dA_f}{A_f} = \frac{dA}{(1 + \beta A)^2} \times \frac{1 + \beta A}{A}$$

$$S = \frac{\frac{dA_f}{A_f}}{\frac{dA}{A}} = \frac{1}{1 + A\beta}$$

$$S = \frac{1}{1 + A\beta}$$

Input Impedance :

$$R_{in} = 1 + A\beta$$

Output Impedance :

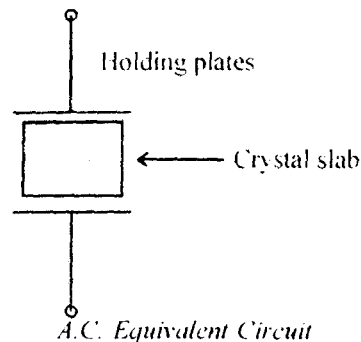
$$R_o = \frac{1}{1 + A\beta}$$

Q. 4. (a) Draw and explain the circuit and working of crystal oscillator.

Ans. When the frequency of oscillation needs to be accurate and stable the crystal oscillator is chosen. The frequency of a crystal oscillator changes by less than 0.1% due to temperature and other changes.

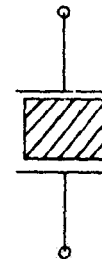
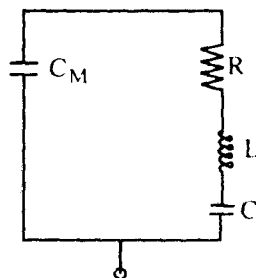
Therefore such oscillator offer the most satisfactory method of stabilising. The frequency and are used in majority of electronic application.

Constructional Details : The natural shape of a quartz crystal is a hexagonal prism. But for practical users, it is cut into a rectangular slabs. This slab is connected between the two metal plates.



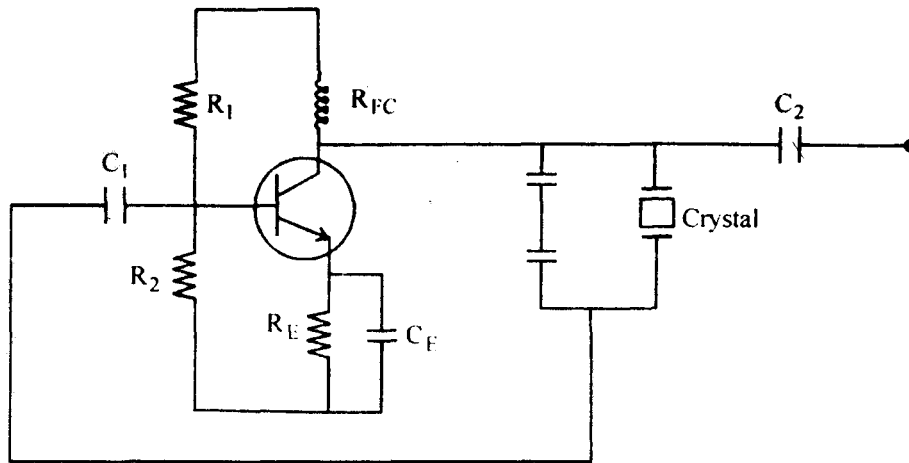
When the crystal is not vibrating, it is equivalent to capacitance C_m because it has two metal plates.

Separated by a dielectric, this capacitance C_m is known as mounting capacitance.



When it is vibrating there are internal frictional losses which are denoted by resistance R , while the mass of the crystal, which is indication of its.

Parallel Resonant Oscillator :



Advantages :

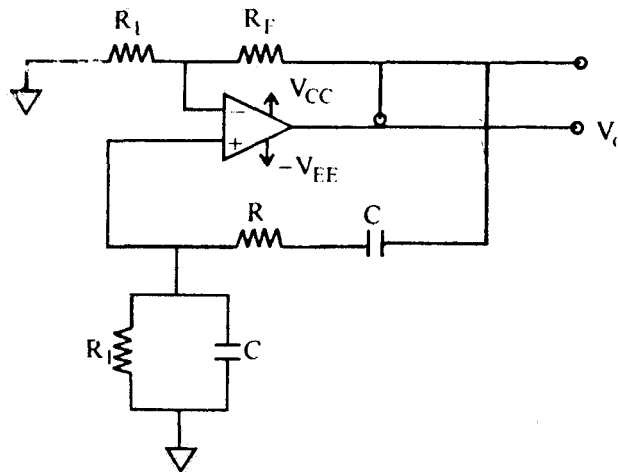
- (i) It has a high order of frequency stability.
- (ii) The quality factor Q of the crystal is very high as compare to LC tank circuit.

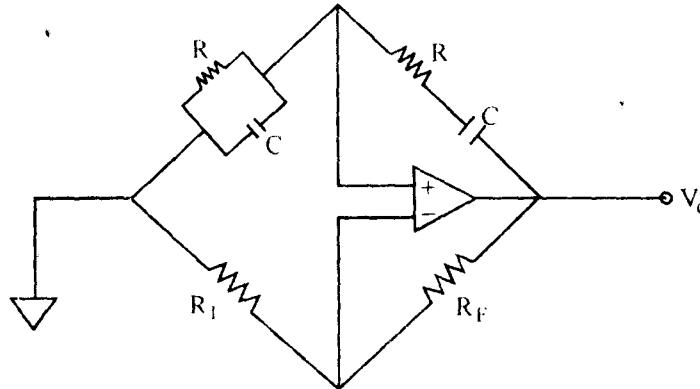
Disadvantages :

- (i) They are fragile and consequently can only be used in low power circuits.
- (ii) The frequency of oscillation cannot be change appreciably.

Q. 4. (b) Draw and explain the circuit and working of Wein bridge oscillator.

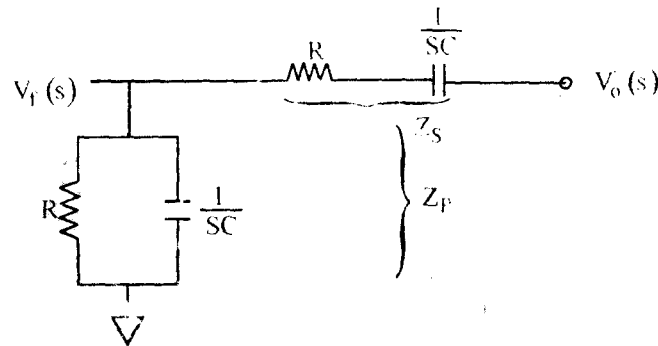
Ans.





Wien bridge circuit is connected between the amplifier input and output terminal. The bridge has a series RC network in one arm and a parallel RC network in the adjoining arm. In the remaining two arms, resistor R_1 and R_2 are connected.

Derivation :



$$V_f = \frac{(Z_p)(V_o)}{Z_p + Z_s} \quad (\text{using voltage divider rule})$$

$$Z_p = R \parallel \frac{1}{sC} = \frac{R}{1 + sRC}$$

$$Z_s = R + \frac{1}{sC} = \frac{R(s + 1)}{sC}$$

$$V_f(s) = \frac{\frac{RV_o(s)}{1 + sRC}}{\frac{R}{1 + sRC} + \frac{R(s + 1)}{sC}} = \frac{sRCV_o(s)}{(sRC + 1)^2 + sRC}$$

$$\beta = \frac{V_f(s)}{V_o(s)} = \frac{sRC}{R^2C^2s^2 + 3sRC + 1}$$

Now consider the op-amp parts,

$$A_v = \frac{V_o(s)}{V_f(s)} = 1 + \frac{R_f}{R_1}$$

$$A_v \beta = 1$$

$$\left(1 + \frac{R_f}{R_1}\right) \left(\frac{RCS}{R^2 C^2 S^2 + 3RCS + 1} \right) = 1$$

Put $S = j\omega$

$$\left(1 + \frac{R_f}{R_1}\right) (jRC\omega) = -R^2 C^2 \omega^2 + j3RC\omega + 1$$

Real part,

$$-R^2 C^2 \omega^2 + 1 = 0$$

$$R^2 C^2 \omega^2 = 1$$

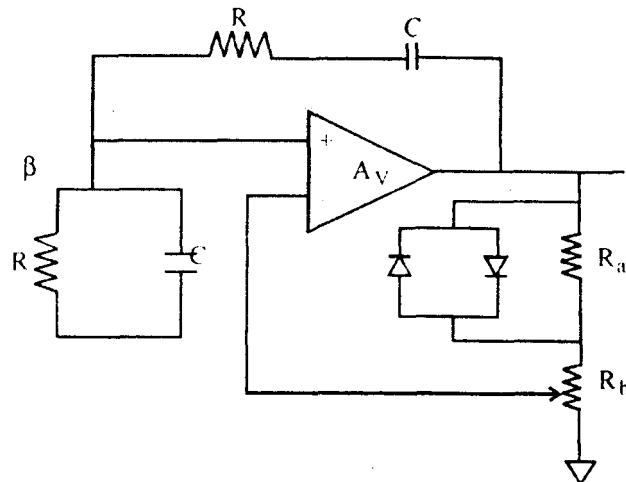
$$\omega = \frac{1}{RC}$$

$$f = \frac{1}{2\pi RC} \text{ Hz} \quad \text{oscillating frequency}$$

$$\text{Imaginary part } \left(1 + \frac{R_f}{R_1}\right) (jRC\omega) = j3RC\omega$$

$$1 + \frac{R_f}{R_1} = 3$$

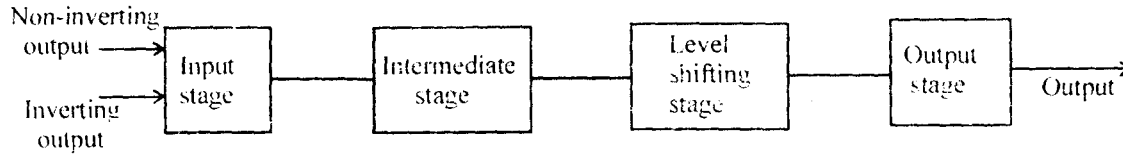
$$R_f = 2R_1$$



Wien-Bridge oscillator with adaptive negative feedback

Q. 5. (a) Draw the basic block diagram of op-amp.

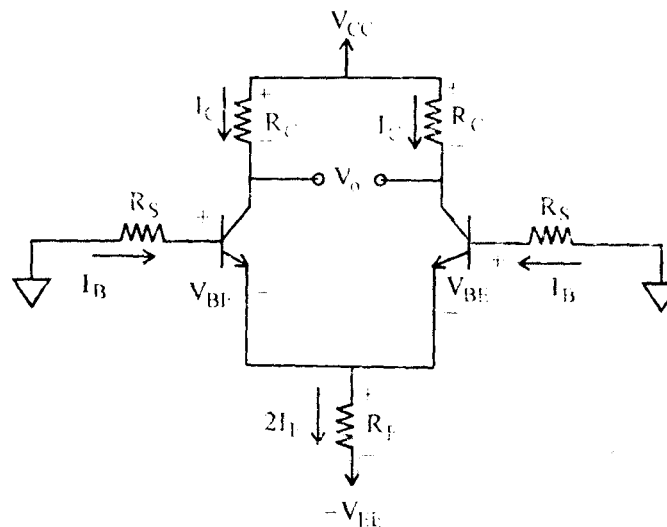
Ans. Block Diagram of a Typical Op-Amp :



The block diagram of a typical op-amp as shown above. The input stage is the dual input, balanced output differential amplifier. This stage provides most of the voltage gain and establishes the input resistance of the op-amp. The intermediate stage is usually another differential amplifier which is driven by the output of the first stage. It is dual input unbalanced output. Because direct coupling is used, the dc voltage at the output of the intermediate stage is well above ground potential. Therefore, a level translator circuit is used after the intermediate stage to shift the dc level at the output of the intermediate stage downward to zero volts with respect to ground. The final stage is complementary push pull amplifier which increases the output voltage swing and raise the current supply capability of the op-amp. A well-designed output stage also provides low output resistance.

Q. 5. (b) Explain op-amp as differential amplifier.

Ans.



D.C. equivalent circuit of differential amplifier

$$-R_S I_B - V_{BE} - R_E (2I_E) + V_{EE} = 0$$

$$I_B = \frac{I_C}{\beta}$$

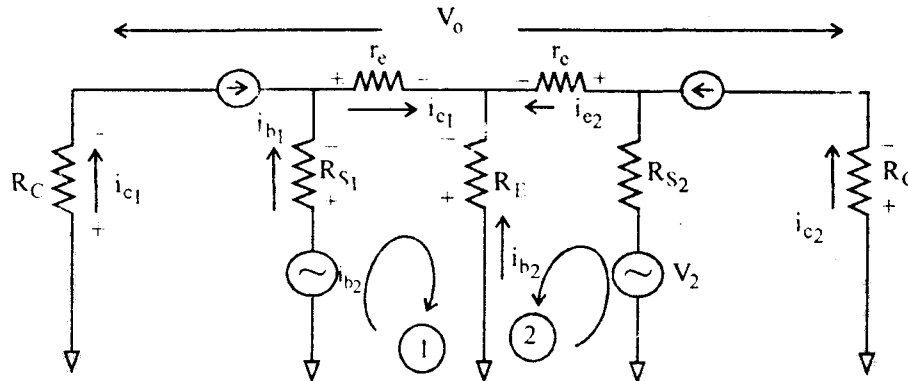
$$-R_S \frac{I_E}{\beta} - V_{BE} - 2R_E I_E + V_{EE} = 0$$

$$I_E = \frac{V_{EE} - V_{BE}}{2R_E + \frac{R_S}{\beta}}$$

If β is very high and R_S is very small,

$$I_E = \frac{V_{E_L} - V_{BE}}{2R_E}$$

AC Equivalent Circuit :



$$V_1 - i_{b1} R_{S1} - i_{e1} r_e - R_E (i_{e1} + i_{e2}) = 0$$

$$V_2 - i_{c2} r_c - R_L (i_{c1} + i_{c2}) = 0$$

$$i_{b1} \approx i_{b2} \approx \frac{i_{c1}}{\beta}$$

β is very high and i_{e1} in few mill amperes.

Neglecting $i_{b1} \approx i_{b2} \approx 0$

$$(r_e + R_E)i_{e1} + R_E i_{e2} = V_2$$

$$R_E i_{e1} + (r_e + R_E) i_{e2} = V_2$$

On solving

$$i_{e1} = \frac{(r_e + R_E)V_1 - R_E V_2}{(r_e + R_E)^2 - R_E^2}$$

$$i_{c2} = \frac{(r_c + R_E)V_2 - R_E V_1}{(r_c + R_E)^2 - R_E^2}$$

&

$$\begin{aligned}
 V_o &= V_{C2} - V_{C1} \\
 &= R_1 (i_{e1} - i_{e2}) \\
 &= R_c \left[\frac{(r_e + R_E)(V_1 - V_2) + R_E(V_1 - V_2)}{(r_e + R_E)^2 - R_E^2} \right] \\
 &= R_c \left[\frac{(r_e + 2R_E)(V_1 - V_2)}{(r_e + 2R_E)(r_e)} \right] \\
 V_o &= \frac{R_c}{r_e} (V_1 - V_2) \\
 \frac{V_o}{V_d} &= \frac{R_c}{r_e} \quad (V_d = V_1 - V_2) \\
 \boxed{A_d = \frac{R_c}{r_e} = \frac{V_o}{V_d}}
 \end{aligned}$$

Q. 5. (c) Explain : (i) slew rate (ii) output offset voltage (iii) PSRR.

Ans. (i) Slew Rate : The gain bandwidth and rise time are characteristics defined for small signals, where the peak output voltage is less than one volt. For a large signal output ($V_{peak} C/V$) as required for the power or driver stage, the op-amp speed is limited by the slew rate. Slew rate is defined as the maximum rate of change of output voltage per unit of time and is expressed in volt per microseconds.

$$S.R. = \left. \frac{dV_o}{dt} \right|_{\text{maximum}}$$

Slew rate indicates how rapidly the output of an op-amp can change in response to change in the input frequency. The slew rate of an op-amp is fixed. \therefore if the slope requirements of the output signal are greater than slew rate then distortion occurs.

(ii) Output Offset Voltage : The op-amp output of a differential amplifier and hence for zero input output should be zero and vice-versa.

But practically it is not so. due to mismatch in the differential pair transistor. As the two collector junctions will not have same or identical characteristics, results in different B are to emitter voltage $V_{BE1} \neq V_{BE2}$. So, the inverting output doesn't equal to non-inverting output. The voltage difference between these two inputs is termed as output offset voltage.

PSRR (Power Supply Rejection Ratio) : It is defined as the change in op-amp input offset voltage (V_{io}) caused by the variation in supply voltage S , is known as PSRR.

$$PSRR = \frac{\Delta V_{io}}{\Delta V}$$

Typical value of PSRR of 741 IC is $150 \mu\text{V} / \text{V}$.

Note : The lower value of PSRR is desirable for ideal case PSRR is zero.

Q. 6. Write short notes on :

(a) SMPS

(b) Master slave flip-flop

(c) Johnson counter

Ans. (a) SMPS (Switching Mode Power Supply) : In switching mode power supply, the regulated elements consists of series connected transistor that act as rapidly opening and closing switches. The dc input is first converted to unregulated dc using input rectifiers and filters which in turn is chopped by the switching element operating at a rapid rate typically of 20 kHz. The resultant 20 kHz pulse train is transformer coupled to an output rectifier and filter network which provide final rectification and smoothing of the d.c. output. Regulation is accomplished by duty cycle control circuit which vary the duty cycle (ON-OFF periods) of the switching elements if the output voltage tends to vary.

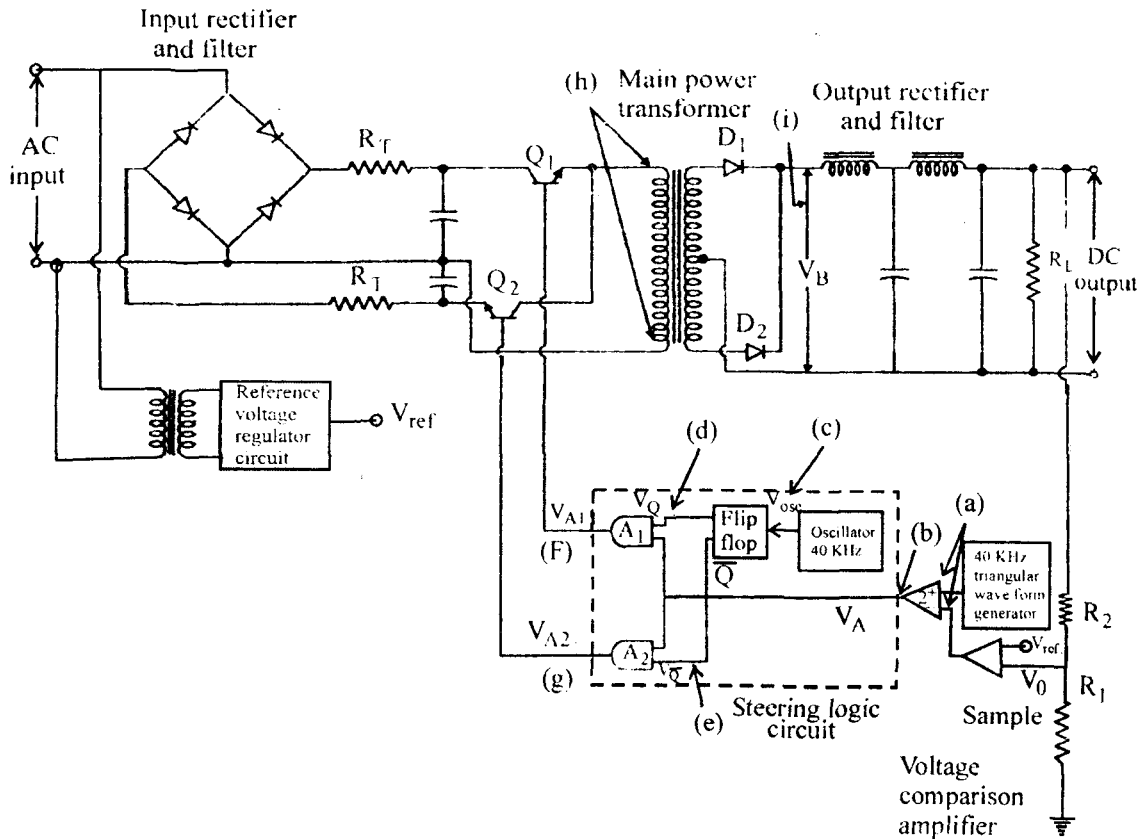
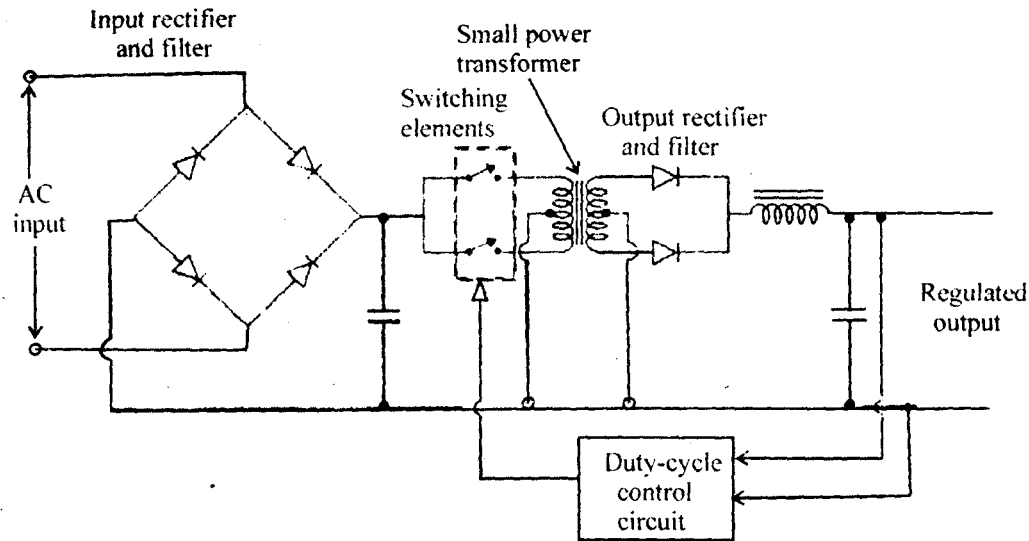
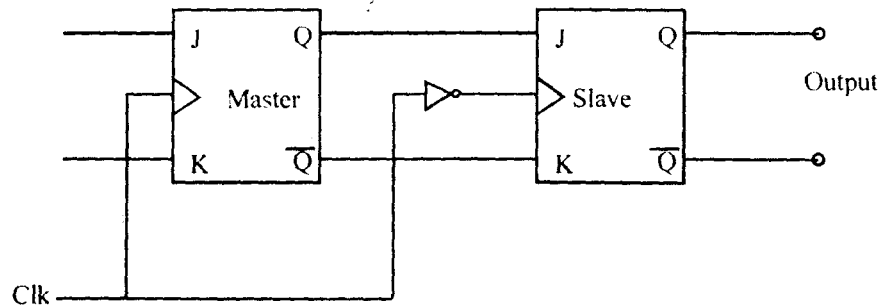


Fig. Basic Block Diagram of SMPS



Basic principle of operation of an SMPS

(b) Master Slave Flip-Flop :



Case (i) : When clock (CLK) = 1, the master acts according to its JK inputs but the slave does not respond since it requires a negative edge at the clock input.

Case (ii) : When clock (CLK = 0) i.e., the slave flip-flop copies the master output but the master does not respond since it requires a positive edge at its clock input. Thus, master slave flip-flop does not have race around problem.

(c) Johnson Counter : The Johnson counter is a variation of a shift register counter. Johnson counters have basic counting cycle of length $2N$. Where N is the number of flip-flop.

In Johnson counter the complements of the output of the last flip-flop is connected back to the D input of the first flip-flop. This feedback arrangement produced a unique sequence of states.

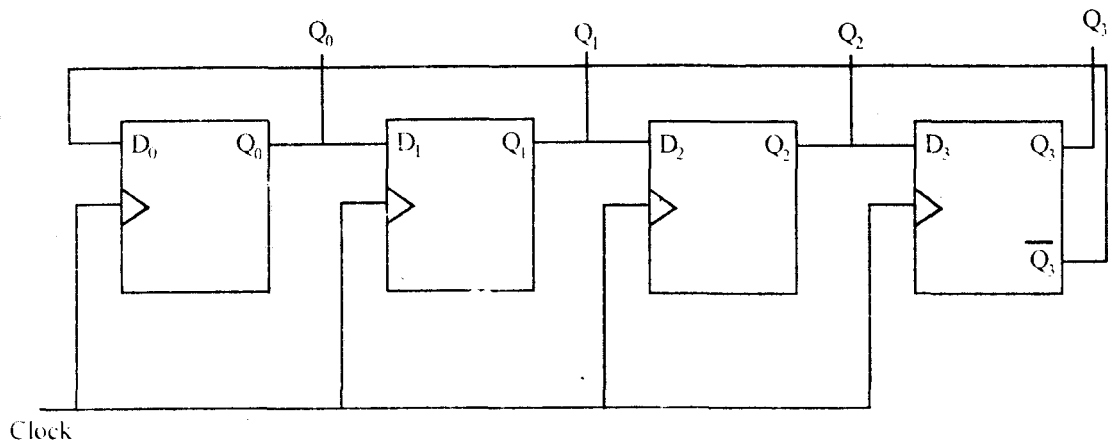


Fig. 4-bit Johnson Counter

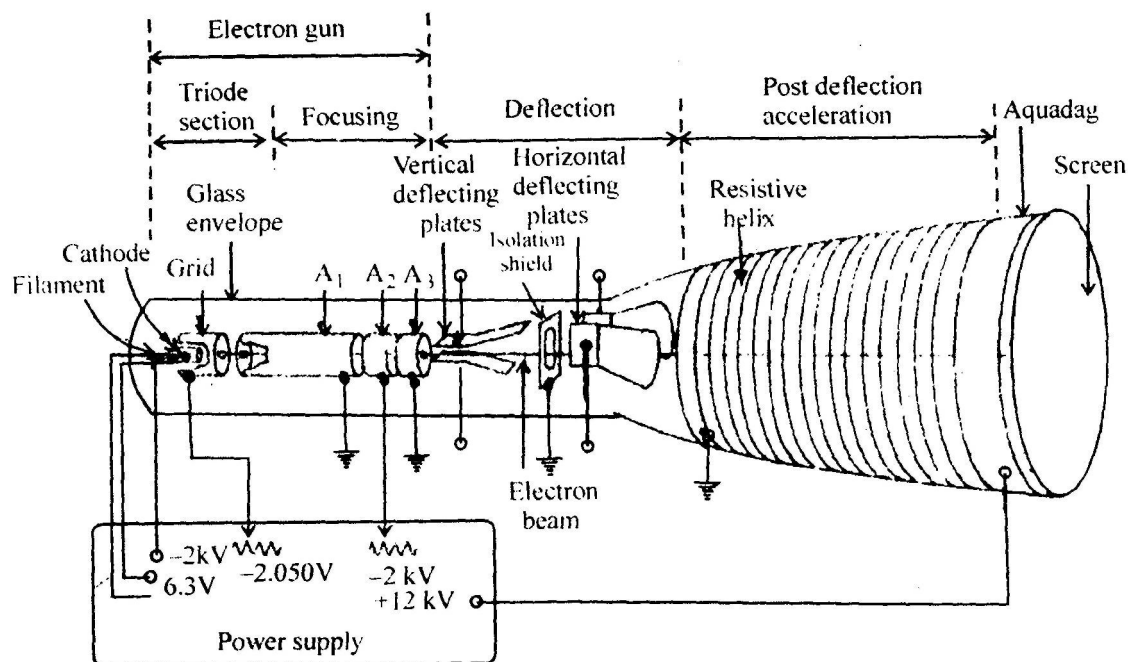
Clock	Q_0	Q_1	Q_2	Q_3	$\overline{Q_3}$
0	0	0	0	0	1
1	1	0	0	0	1
2	1	1	0	0	1
3	1	1	1	0	1
4	1	1	1	1	0
5	0	1	1	1	0
6	0	0	1	1	0
7	0	0	0	1	0
8	0	0	0	0	1

Truth table of 4-bit Johnson Counter

Working of 4-bit Johnson Counter : The last flip-flop of $\overline{Q_3}$ is connected to the input of first flip-flop D_0 . Since $\overline{Q_3}$ is 1 so at the rising pulse of the first clock cycle Q_0 will change to 1. The output state will change to $Q_3 Q_2 Q_1 Q_0 = 0001$ after first clock pulse, then at the rising pulse of the second clock cycle the output state will change $Q_3 Q_2 Q_1 Q_0 = 0011$ and so on till at the rising pulse of the truth clock pulse the output state changes to 1111. At the fifth rising pulse the state then becomes 1110 at the sixth pulse the state becomes 1100 and so on at the eighth pulse it becomes 0000.

Q. 7. (a) Draw the basic block diagram of CRT and explain its working.

Ans. Operation : The basic construction and biasing of a cathode ray tube as shown below. The system of electrode is contained in an evacuated glass tube with a viewing screen at one end. A beam of electron is generated by the cathode and direct to the screen, causing the phosphor coating on the screen to glow where the electrons strike. The electron beam is deflected vertically and horizontally by externally applied voltages.

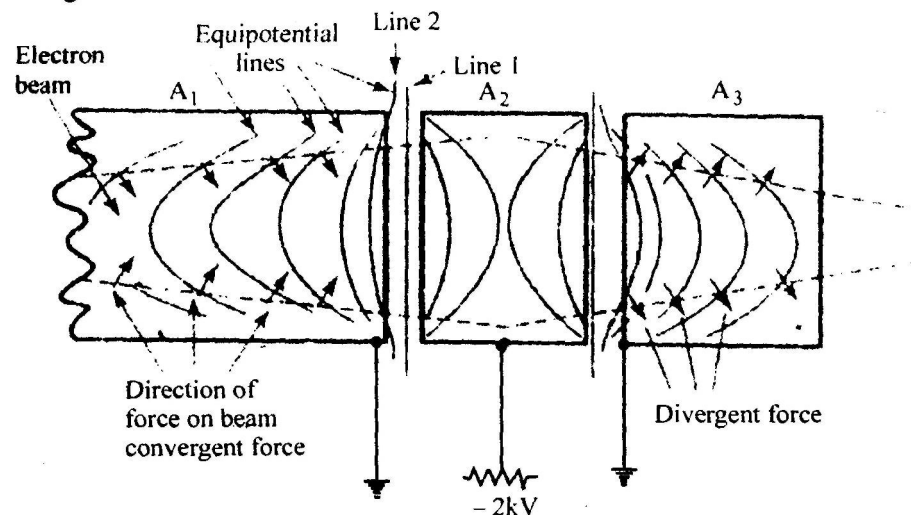


Parts Used in CRT :

- (i) Triode section (ii) Focusing section (iii) Deflection section.

(i) Triode Section : The triode section of the tube consists of a cathode, a grid and an anode. The grid which is a nickel cup with a hole in it, almost complementary encloses the cathode emitting surface directed towards the hole in the grid.

(ii) Focusing Section :

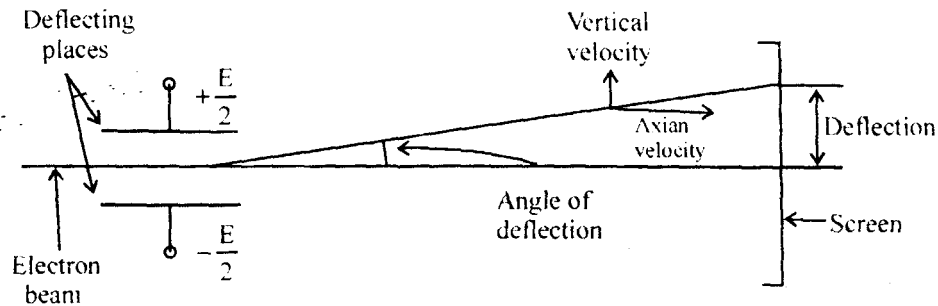


The focusing electrodes A_1 , A_2 , A_3 are sometime referred to as an electron lens. The function of electron lens is to focus the electrons to a fine point on the screen of the tube.

A_1 provides the accelerating field to draw the electrons from the cathode and the hole in A_1 limits the initial cross-section of the electron beam. A_3 and A_1 are held ground potential while the A_2 potential is adjustable around 2KV. The result of the potential difference between anode is equipotential line are set up shown in figure.

(iii) Deflection Section : If the horizontal and vertical deflecting plates were grounded or left unconnected, the beam of electrons would pass between each pair of plates and strike the centre of the oscilloscope screen. They would produced a bright growing point. When one plate of a pair of deflecting plates has a positive voltage applied to it, and the other one has a negative potential. The electrons in the beam are attracted towards the positive plate and repelled from the negative plates. The electron are actually accelerated in the direction of the positive plate.

Since they are travelling axially between the plates no electrons strikes the screen at a new position.



Q. 7. (b) Explain the working of function generator.

Ans. The circuit were used to produce either triangular wave square wave or sine wave. A function generator produces all these waveforms simultaneously. It also provides the facility to change the frequency (from 0.01 Hz to 100 kHz) along with the amplitude control of the waveforms.

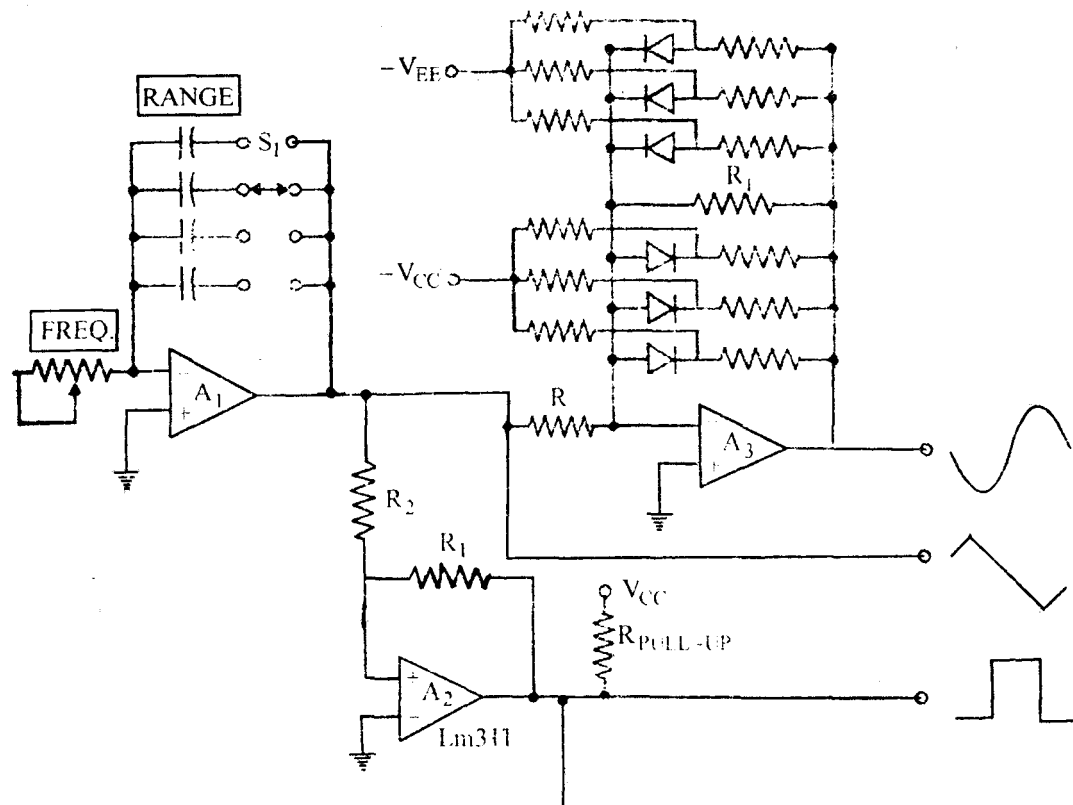
Multi Op-amp Function Generators : The multi op-amp function generator used a sine shapper in addition to the basic triangular wave generator. The sine shapper circuit rounds OFF the tips of the triangular wave, producing a fairly low distortion ($< 1\%$) sine waveform the triangular wave. The sine shapper circuit is consists of an array of resistor and diodes, where diodes are used as switching elements.

The circuit diagram of multi op-amp function generator is shown below :

Working : To understand the working principle of the sine shapper, it is used to shape the triangular wave into sine wave.

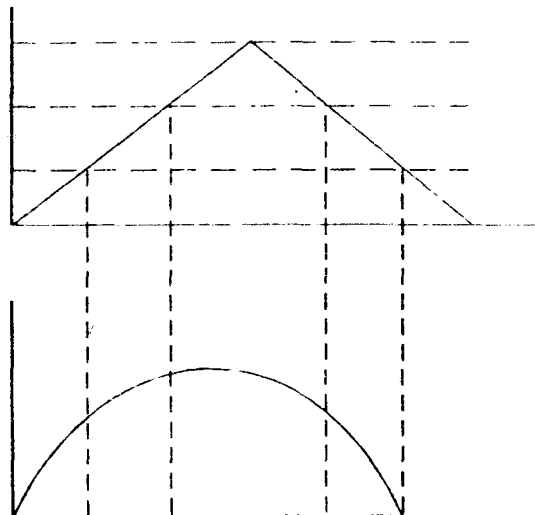
When the amplitude of triangular wave is low, all the diodes in the feedback path of op-amp 3 are OFF making amplifiers gain equals to $-\frac{R_F}{R}$. This is known as line segment.

When the output reaches to an amplitude of A at time $t = 1$ a diode in the feedback path becomes forward bias and places a resistor in parallel with resistor R_F , lowering the total feedback resistance, which also lowers the gain of the amplifier. Consequently after time $t = 1$ the output rises at a slower rate.

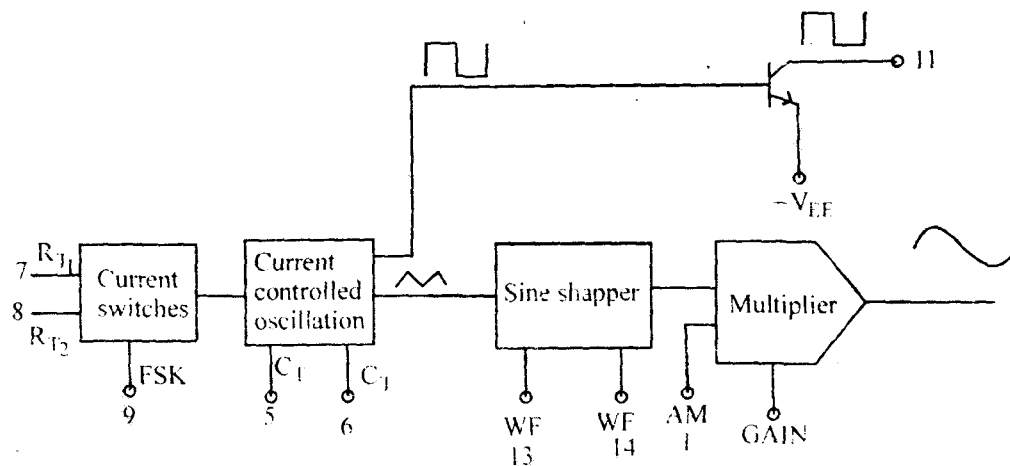


Basic block diagram of function generator

Thus, the sine shapper produces a sine wave by sounding off the tips of the triangular wave. The disadvantage of this circuit is introduction of distortion in the sine wave outputs. The amount of distortion is higher than that in the sine wave produced by the RC oscillation.



IC Function Generator :

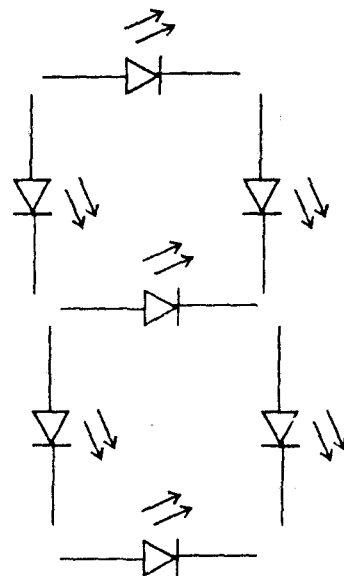


"Function generator block diagram for XR2206"

Q. 8. Write short notes on :

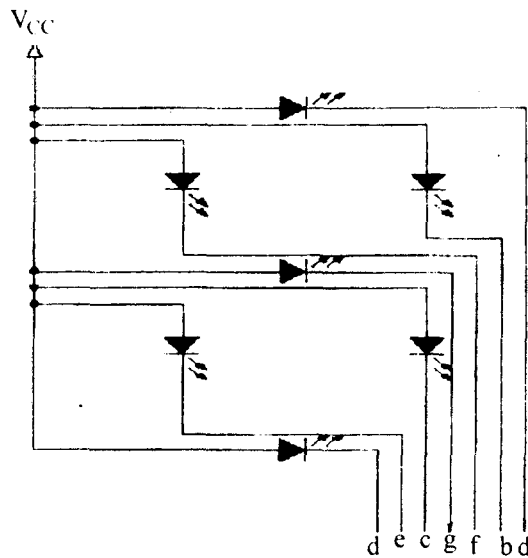
- (a) Seven segment display
- (b) Electronic displays.

Ans. (a) Seven Segment Display :

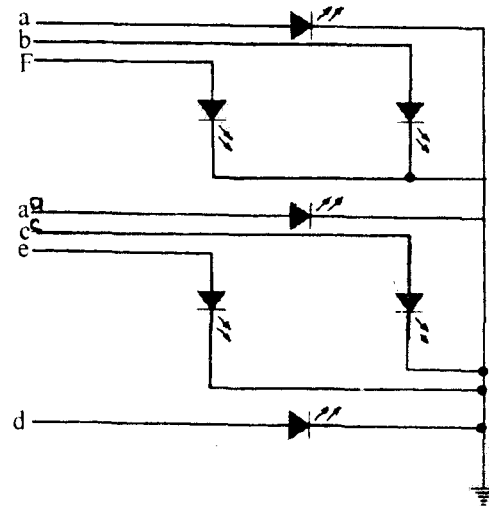


Diode placement in a seven segment display

There are two types of display available, common anode and common cathode the wiring for a common anode is shown below :

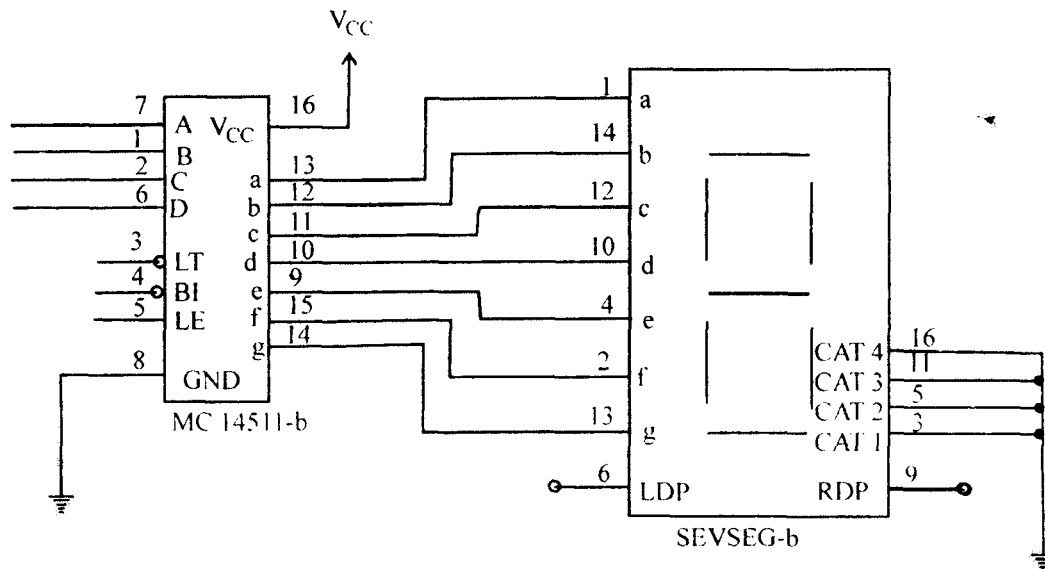


Common anode internal wiring



Common Cathode Internal Wiring

The truth table shown is used to conform that the digital signal sent to the display light up the correct segment.



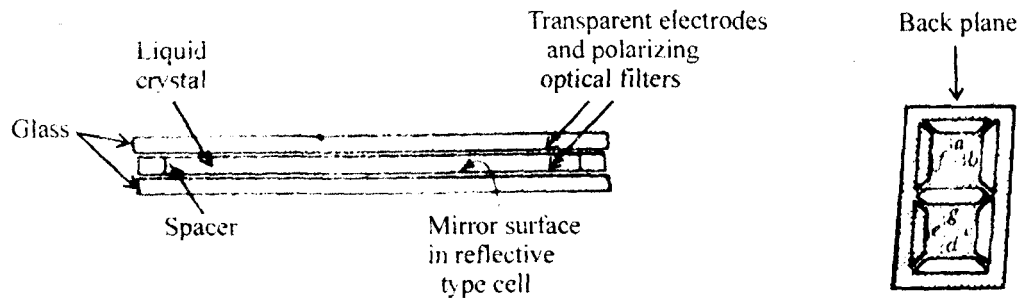
Seven Segment Display with Display Driver

(b) Electronic Displays : Electronic display are divided in two parts :

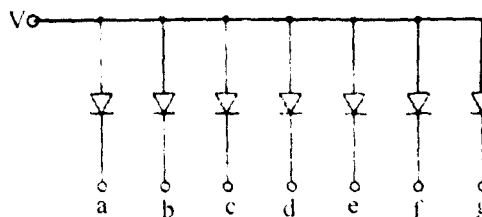
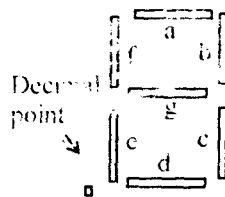
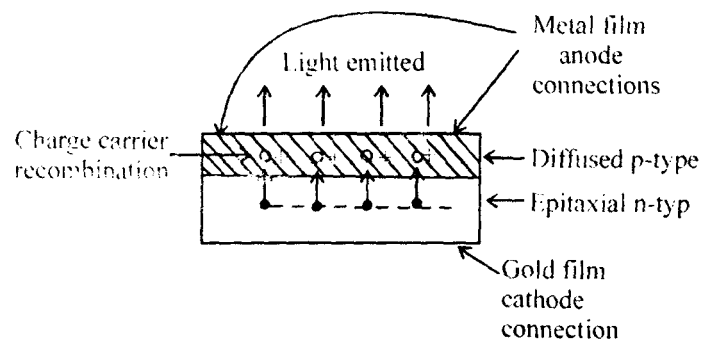
(LED) Liquid Crystal Cell Display : LCD are usually arrange in the seven-segment numerical format as LED display. The cross-section of a field-effect of liquid crystal cell show in figure.

The liquid crystal material may be one of several organ compounds that exhibits the optical properties of

crystal. Liquid crystal material is layered between glass sheet with transparent electrodes deposited on the inside face. Two thin polarizing optical fibres are placed at the surface of each glass sheet.



Light Emitting Diode Display : Charge carrier recombination occurs at a forward bias p-n junction as electron cross from the n-side and recombine with holes on the p-side. When recombination takes place the charge carrier gives up energy in the form of heat and light. If the semiconductor material charge carrier gives up energy in the form of heat and light source, that is a light emitting diode (LED). When forward biased the device is on and glowing when reverse biased it is off.



Q. 9. Briefly describes :

(a) Types of liquid crystal cells

(b) Multimeter.

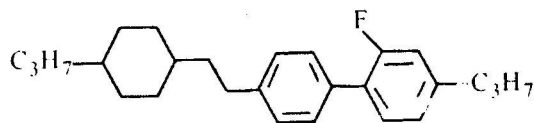
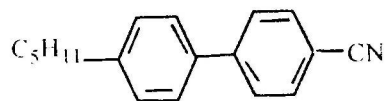
Ans. (a) Types of Liquid Crystal Cells :

Liquid Crystal : A stable phase of matter characterized by an isotropic property without the existence of

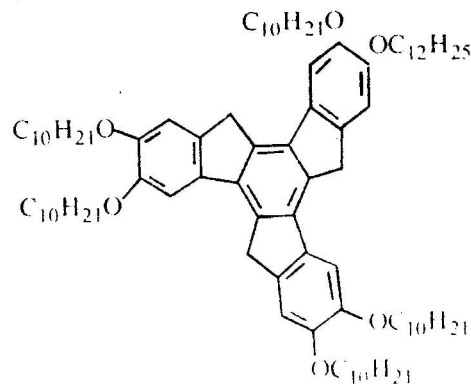
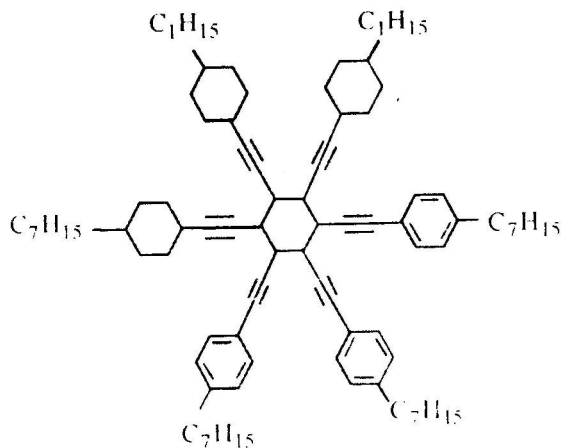
a three-dimensional crystal lattice generally lying between the solid and isotropic (liquid) phase.

Shape of liquid crystal.

(i) Rod Shaped Molecules :



(ii) Disc Like Molecules :



Types of Liquid Crystal Cells :

- (i) Nematics cell
- (ii) Smectic cell
- (iii) Cholesterics cell

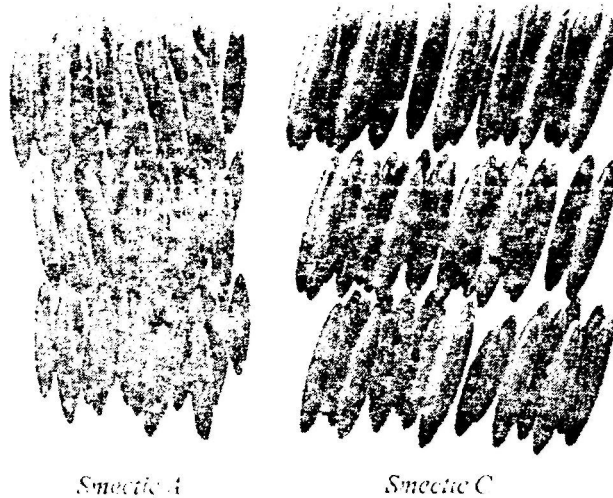
(i) Nematic Cell :

- (i) Has orientation order (point in the same direction).
- (ii) No positional order.
- (iii) Molecules can flow as liquid.



(ii) Smectic Cell :

- (i) Has orientational order which means they order in layer (different from nematic)
- (ii) Has positional order.
- (iii) Also can flow like liquid.
- (iv) The most common and simplest cells are smectic A and C as shown below :



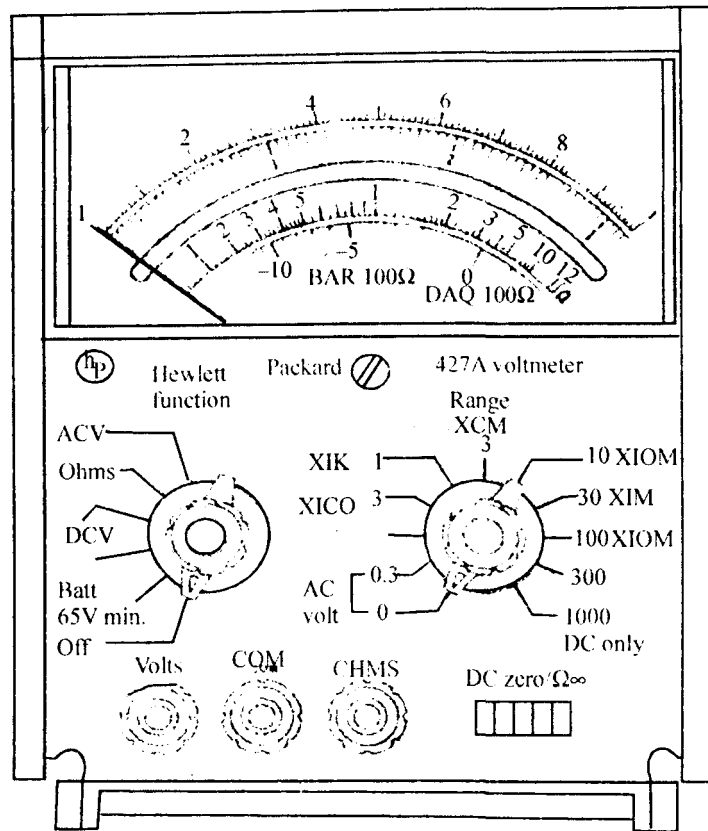
(b) Multimeter :

Procedure for DC Multimeter :

- (i) With the instrument switched off, check the pointer zero position. Adjust the mechanical zero as required
- (ii) If the instrument is battery operated set the function switch to BATT and check that the battery voltage is minimum 1.5 volt. For instruments with an internal power supply and line cord. This step is- not necessary.
- (iii) Set the function switch to DCV or + DCV as required.
- (iv) Set the range with 0.1 and short circuit the VOLTS and COM terminal.
- (v) Select a voltage range greater than the voltage to be measured. Where the approximate value of the voltage is not known, rotate the RANGE switch to the highest range.
- (vi) Connect the input voltage to the VOLTS and COM Terminals, and adjust range switch to give the greatest on scale pointer deflection.

Resistance Measured Procedure :

- (i) With the instrument switched OFF, check the pointer zero and adjust the mechanical zero control as necessary.
- (ii) Check the battery voltage as explained for dc voltage measurement.
- (iii) Select a resistance range to suit the approximate value of the resistance to be measured.
- (iv) Connect the resistance to COM and OHMS terminals, and adjust the RANGE control to give a resistance reading as close as possible to center scale.



Multimeter Probes : There are many probes and adapters available for use with multimeter that can extend the ranges of measurement or adapt the instrument for measuring of temperature or other quantities.

