B.Tech.

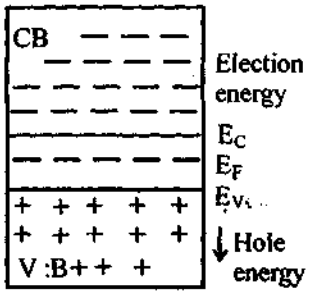
First Semester Fxamination, Dec.-2009

Basics of Electronics (ECE-101-F)

Note : Attempt any five questions. Q. No. 1 which is compulsory. All questions carry equal marks.

Q. 1. (a) What is fermi level?

Ans. Fermi Level : Fermi level is a characteristic energy of material. In an intrinsic semiconductor there is equal number of electrons and holes. The concentration of electrons decrease above the bottom of conduction band and similarly the concentration of holes decrease below the top of valence band as shown in fig.

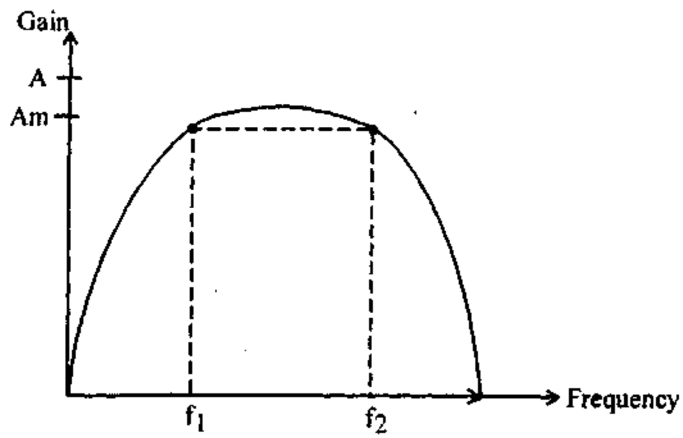


As fig. shows that the centre of gravity of electrons and holes-lies exactly at the middle of forbidden gap. The centre level is known as fermi level. Thus, the fermi level is the energy that corresponds to the centre of gravity of conduction electrons and holes weighted according to their energies. Fermi level is a concept like as a hollow body can have a centre of gravity where there is no matter.

When a donor impurity is added to an intensive semiconductor. It becomes N type. Now it has more conduction electrons than holes. This moves the centre of gravity up i.e., fermi level shift towards the conduction band. Similarly when an accepter impurity is added to an intrinsic semiconductor it becomes p type. Now it has more holes than electrons. This shift fermi level towards valence band.

Q. 1. (b) How band width of an amplifier will be calculated?

Ans. Bandwidth of Amplifier : The range of frequency over which the gain is equal to greater than 70.7% of the maximum gain is known as bandwidth.



The voltage gain of an amplifier changes with frequency. It is clear from the figure f_1 and f_2 the gain is equal to or greater than 70.7% of the maximum gain. Therefore $f_1 - f_2$ is the bandwidth, it may be seen that f_1 and f_2 are limiting frequencies f_1 is called lower cut-off frequency, f_2 upper cut-off frequency.

The bandwidth of an amplifier can also be defined in terms of dB suppose the maximum voltage gain of amplifier is 100. Then 7071 of it is 70.7.

Fall in voltage gain from maximum gain

$$= 20\log_{10}\frac{100}{70.7} = 20\log_{10} 1.4142$$

$$= 3\text{dB}$$

Bandwidth of an amplifier is the range of frequency at the limit of which its voltage gain falls by 3db from maximum gain f_1 and f_2 are also called 3dB frequency or half power frequency.

Q. 1. (c) What are Radio & Audio frequency oscillators?

Ans. Oscillator may be classified in several ways. Here they are on the basis of frequencies.

The classification based on frequency band is,

1. Audio frequencies oscillators (20Hz–20 kHz)
2. Radio frequencies oscillators (20 kHZ–30MHz)
3. Video frequencies oscillators (dC–5 MHz)
4. High frequencies oscillators (1.5 MHz–30 MHz)
5. Very high frequencies oscillators (30 MHz – 300 MHz)

Audio Frequencies Oscillators : Wein bridge and R_C phase shift oscillator are audio frequencies oscillators, they generate the frequencies 20 Hz to 20 kHz.

Radio Frequencies Oscillators : L-C oscillators are radio frequencies oscillators they are Hartley Osc., Colpitts osc, Clopp osc.

Q. 1. (d) What is slew rate? Explain.

Ans. Slew Rate : The slew rate is defined as the maximum rate of change of output voltage with respect to time. It is specified in V/μ s.

For example, 1 V/μ s slew rate means that the output rises or falls not faster than 1V every μs. For ideal op-Amp, slew rate is infinite.

$$\text{Slew rate (SR)} = \left.\frac{dV_o}{dt}\right|_{max} = V_p \cdot \omega$$

$$SR = \left.\frac{dV_o}{dt}\right|_{max} = 2\pi f V_p V/s = \frac{2\pi f V_p}{10^6} V/\mu s$$

$f \rightarrow$ input frequency

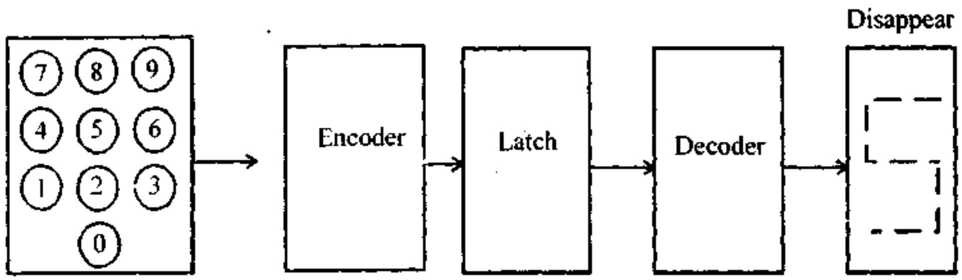
V_p = Peak value of output voltage.

Q. 1. (e) Differentiate between Latch and flip-flop.

Ans. Difference between Latch and Flip-Flop :

Lathes are level triggered device and flip-flop are edge trigger device.

A device that serves as a temporary buffer memory is called a Latch. The term latch, refers to a digital storage device as shown in fig.



When a decimal number 5 on the keyboard is pressed and released the 7 segment display continues to shows.

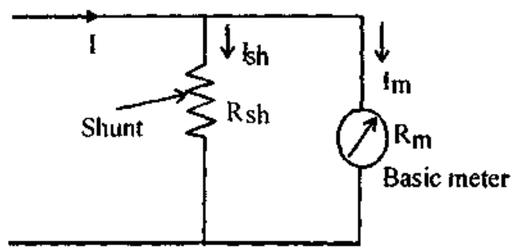
The flip-flop is an electronics circuit having two output stages Q & $\overline{Q}$ which are complementary to each other. The circuit consists two inverters the output of one is connected to input of other. If one of the output is high then other output is necessarily is low. It is also referred as Bi-stable multivibrators.

Q. 1. (f) Explain the working of Ammeter.

Ans. Working of Ammeter : The basic movement of a d.c. ammeter is a PMMC 'd' Arsonal galvanometer. The coil winding of a basic movement is small and light and can carry very small currents since the construction of an accurate instrument with a moving coil to carry current greater than 100 mA is impracticable owing to the bulk and weight of the coil that would be required.

When heavy current are to be measured. The major part of the current bypass through a low resistance called a shunt fig. shows the basic movement and its shunt to produce an ammeter.

The resistance of the shunt can be calculating using conventional circuit.



Basic Ammeter Circuit

R_m = Internal resistance of movement

R_{sh} = Resistance of shunt.

$I_m = I_{fs}$ = full scale deflection current of movement A

I_{sh} = Shunt current

I = Current to be measured

Since the shunt resistance is in parallel with the meter movement, the voltage drop across shunt and movement must be the same.

$$I_{sh} R_{sh} = I_m R_m \qquad R_{sh} = I_m R_m / I_{sh}$$

But
$$I_{sh} = I - I_m$$

$$R_{sh} = \frac{I_m R_m}{I - I_m}$$

$$I / I_m - 1 = R_m / R_{sh}$$

Or
$$\frac{I}{I_m} = 1 + R_m / R_{sh}$$

The ratio of total current to the current in the movement is called multiplying power of shunt.

Multiplying power

$$m = I / I_m$$

$\Rightarrow$
$$1 + R_m / R_{sh}$$

Resistance of shunt
$$= R_{sh} = \frac{R_m}{m-1}$$

The shunt resistance used with a d'Arsonal movement may consists of a coil of resistance wire within the case of the instrument or it may be external shunt having a very low resistance.

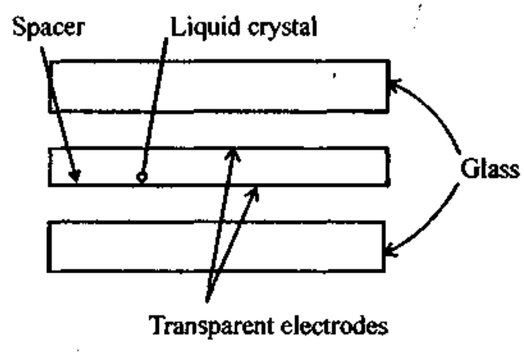
Q. 1. (g) LCD.

Ans. LCD (Liquid Crystal Display) : Liquid crystal are two types :

(i) Dynamic scattering type.

(ii) Field effect type.

Dynamic Scattering : The construction of dynamic scattering LCD shown in fig.



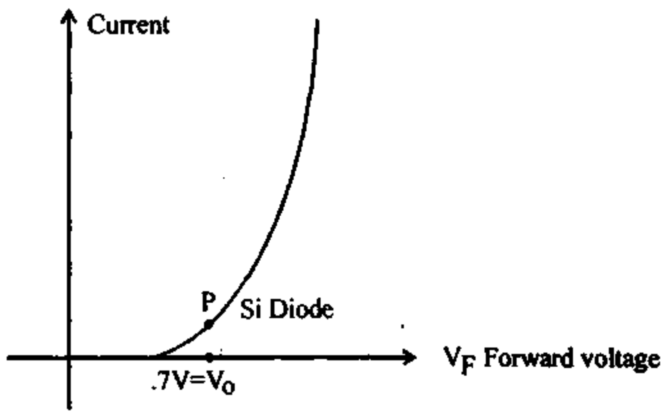
The liquid crystal material may be one of the several compounds which exhibit optical properties of crystal through the remain in liquid form. Liquid crystal is layered between glass sheets with transparent electrodes deposite on the inside faces.

When a potential is applied across the cell, charge carrier flowing through the disrupt the molecular alignment and produce turbulence. When the liquid is not activated it is transparent. When the liquid is activated the molecular turbulence causes light to be scattered in all directions and cell appear to be bright. This phenomenon is called dyr.amic scattering.

Field Effect LCD : It is smaller to the dynamic scattering LCD with the exception that two thin polarizing optical filters are placed at the inside of each glass sheet. The liquid crystal material is also different from dynamic scattering material. The material is used is twisted nematic type and actually twist the light passing through the cell when the latter is not energized. This allows the light to pass through the optical filters and the cell appears bright. When the cell is energised, no twisting of light takes place and the cell appear dull.

Q. 2. (a) What is knee voltage and what is its significance?

Ans. Knee Voltage : From the forward characteristics reveals the fact that upto point P, the diode current is very small. This is so because the applied voltage has to overcome the barrier potential and the diode conducts poorly. Once the applied voltage is slightly greater the barrier potential, the diode current increases rapidly and diode conduct heavily. This voltage at which current starts increasing is called knee voltage (V_0) its value 0.7V for Si diode and Ge = 3V..



Q. 2. (b) Differentiate between drift & diffusion current.

Ans. Valence electrons are always in motion and the motion of valence electrons are random. On an average, the number of electrons crossing unit area in any direction is equal to number of electrons crossing the same area in opposite direction. So net current is zero.

The steady state drift-velocity is super imposed on the random motion of electron caused by thermal agitation. This steady flow of electrons in one direction caused by an electric field constitutes an electric current. This current is called as drift current.

Drift current equation is,

$$J_n = e\mu_n n(x)\varepsilon(x) \quad ...(i)$$

$$J_p = e\mu_p p(x)\varepsilon(x) \quad ...(ii)$$

It is obvious from equation (i) and (ii) that the drift current is directly proportional to carrier concentration $\{n(x \text{ or } p(x)\}$. Therefore, minority carrier seldom provide much drift current.

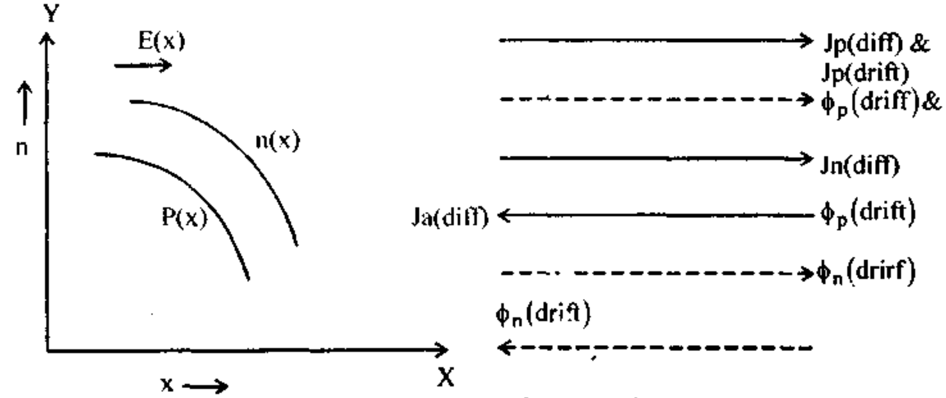
Diffusion Current Density : Diffusion means the random thermal motion of particles from a region of high concentration to a region of low concentration. In a semiconductor it is possible to vary the concentration of holes or free electrons or both during doping process. The holes and electrons then move from regions of high concentration to a region of low concentration. This type of motion is called diffusion.

$$J_n(\text{Diffusion}) = eD_n \frac{dn(x)}{dx} \quad ...(iii)$$

$$J_p(\text{Diffusion}) = -eD_p \frac{dp(x)}{dx} \quad ...(iv)$$

From equation (iii) & (iv) it is obvious that diffusion current is directly proportional to gradient of concentration $\left\{\frac{d}{dx}n(x) \text{ or } \frac{dp}{dx}p(a)\right\}$. Although the minority concentration may be smaller than the majority concentration yet the gradient may be significant. Therefore, minority carrier current through diffusion may be as large as majority carrier current.

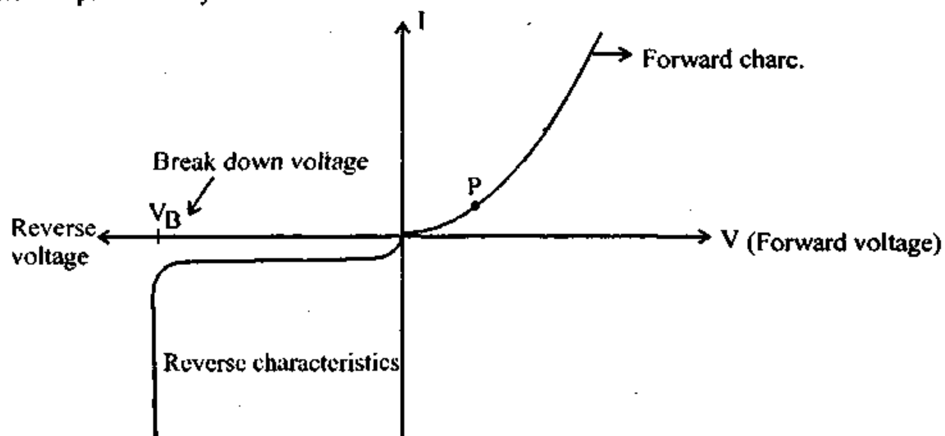
Let us consider the relation between particle flow and current in presence of electric field. Let the electric current the applied along the X-direction. The carrier distributions n(x) and p(x) are decreasing with x increasing as shown in fig.



Showing particle flow and current direction

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

Ans. The V-I characteristics of a diode is simply curve or graph between the voltage applied its terminals and current that flows through the diode due to this applied voltage. The entire V-I characteristics may be divided into two parts namely.



V-I Characteristics

(i) Forward characteristics

(ii) Reverse characteristics.

Forward characteristic reveals the fact upto point P, the diode current is very small. This is so because the applied voltage has to overcome the barrier potential and diode conducts poorly. Once the applied voltage is slightly greater than the barrier potential, the diode current increases rapidly and diode conducts heavily. This voltage at which the current starts increasing is called the knee voltage (V_o).

Diode current equation,

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

I = Diode current

I_0 = Reverse saturation current

V = Applied voltage

η = a constant

$$V_T = \frac{kT}{q} = \frac{T}{11,600}$$

k = Boltzmann constant

T = Temperature

If the value of applied voltage is greater than unity then the diode current equation for then current equation.

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

Current increases exponentially in forward bias.

Reverse Characteristics : Reverse characteristics ravels the fact that the below the breakdown voltage the diode current is very small and almost remains constant. This is also called reverse saturation current I_0 if a large reverse bias is applied, a process is known as junction breakdown due to this, the diode reverse current increase rapidly. The applied voltage reverse bias voltage at which this occur called as breakdown voltage V_B of the diode.

Diode current

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

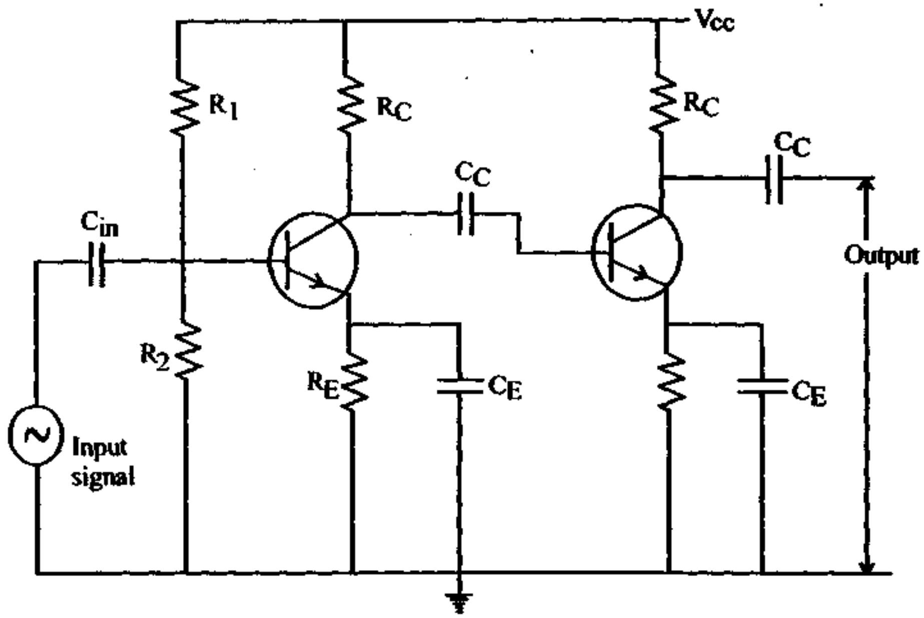
$$V >> V_T$$

$$e^{-V/\eta V_T} << 1$$

$I \approx I_0$ reverse saturation current.

Q. 3. (a) Draw and explain the frequency response curve and working of R-C coupled circuit.

Ans. Working of RC Coupled Amplifier : It is usually employed for voltage amplification below fig., shows the R-C coupled 2 stage amplifier.



A C_C coupling capacitor is used to connect the output of the first stage to the base of the second stage and so on. As the coupling from one stage to next is achieved by a coupling capacitor followed by a connection to a shunt resistor therefore, such amplifier are called resistance capacitance coupled amplifier.

The resistance R_1, R_2 & R_E from the biasing and stabilization network. The emitter bypass capacitor offers low reactance path to the signal, without it the voltage gain of each stage would be lost. The coupling capacitor C_C transmits a.c. signal but blacks dc. This prevents dc interference between various stages and shifting of operating point.

When ac signal is applied to the base of the first transistor, it appears in the amplified from across its load R_C. The amplified signal developed across R_C is given to base of next stage through the coupling capacitor C_C. The 2nd stage does further amplification of the signal. In this way, the cascaded stages amplify the signal and the overall gain is considerably increased.

It may be mentioned there the total gain is less then the product of the gains of individual stages it is because when a second stage is made to follow the Ist stage, the effective load resistance of the ist stage is reduced due to the shunting effect of the input resistance of IInd stage. This reduces the gain of the stage which is loaded by the next stage.

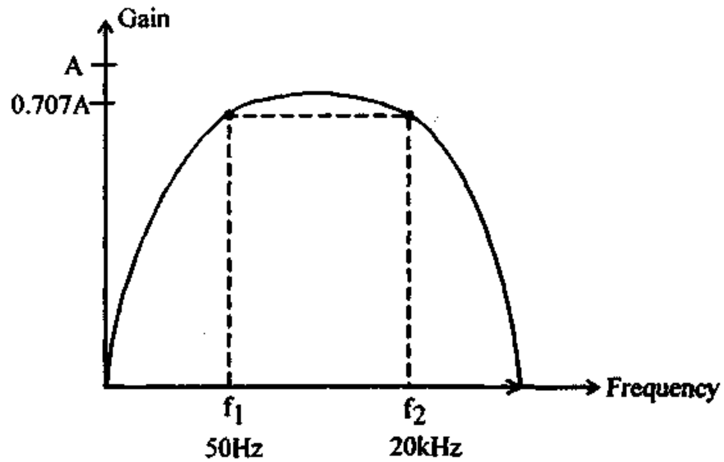
Frequency Response : Frequency response of typical R-C amplifier it is clear that voltage gain drops off at low (<50Hz) and high (> 20kHz) frequencies and it is uniform over mid frequency range. This behaviours of amplifier is briefly explained.

1. At low frequencies (<50Hz) the reactance of coupling capacitor C_C is quite high and hence very small part of signal will pass from one stage to the next stage. Moreover C_E cannot shunt the emitter

resistance R_E effectively because of its large reactance at low frequencies. These two factor cause a falling off voltage gain.

2. **At high frequencies** (> 20 kHz) the reactance of C_C is very small and it behave as a short circuit. This increase the loading effect of next stage and serves to reduce the voltage gain. Moreover at high frequency, capacitive, reactance of base emitter junction is low which increase the base current. This deduces amplification factor β, due to these two reason the voltage gain drops off at high frequencies.

3. **At mid frequencies** the voltage gain of the amplifier is constant. The effect of C_C in the frequency range is such so as to maintain a uniform voltage gain. Thus, as the frequency increase in this range, reactance of C_C decrease which tends to increase the gain. However, at the same time, lower reactance means higher loading of first stage and hence lower gain. These two factor must cancel each other, resulting in a uniform gain at mid frequency.



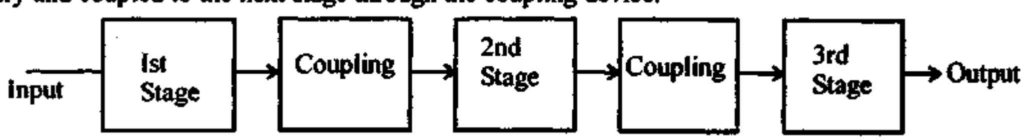
Frequency response curve

Q. 3. (b) Explain the concept of Cascaded Amplifier. Give suitable example. Derive a expression for the gain.

Ans. Multistage Amplifier or Cascaded Amplifier : A transistor circuit containing more than one stage of amplification is known as multistage transistor amplifier.

A number of single amplifier are connected in cascaded arrangement i.e., output of first stage is connected to the input of the second stage through a suitable coupling device and so on. The purpose of coupling device is to transfer the ac output of one stage to the input of the next stage and to isolate the dc conditions of one stage to the input of the next stage.

Block diagram of 3 stage amplifier cascaded type. Each stage consists of one transistor and associated circuitry and coupled to the next stage through the coupling device.



Voltage Gain for Cascaded Amplifier : Gain, the ratio of the output electrical quantity to the input one of amplifier is called gain.

The gain of multistage amplifier is equal to the product of gain of individual stages. For example, if G_1, G_2 and G_3 are individual voltage gain of a 3 stage amplifier then the total voltage gain G is given by

$$\boxed{G = G_1\, G_2 G_3}$$

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

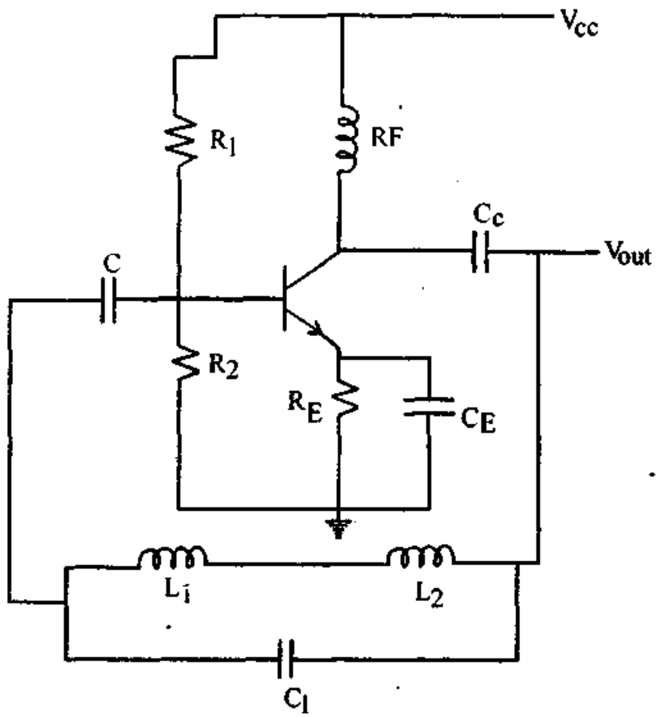
Ans. L-C Oscillators : There are two types of oscillators :

1. L-C oscillators
2. R-C oscillators.

L -C oscillators : L-C oscillators employs L-C elements as feedback network. There are basically 3 L-C oscillator :

1. Hartley oscillator
2. Clapp oscillator
3. Colpitt's oscillator.

Hartley Oscillators : It is most popular oscillator and is commonly used in radio receivers.



The circuit arrangement of Hartley oscillator shown in fig. It consists two coils L_1 and L_2. Thus, the mutual inductance exist between them and G is connected across the combination of L_1 & L_2 to from L-C circuit. R_1 & R_2 connected to base of transistor. R_F is connected to collector and R_E at emitter.

A capacitor C is connected at input side capacitor C blocks the dc components.

The frequency of oscillation is determined by L_1, L_2 & C_1.

When the circuit is turned on, the capacitor is charged, when this capacitor is fully charged. It discharge through the coil L_1 & L_2 setting up oscillation of frequency determined by,

$$f = \frac{1}{2\pi\sqrt{CL_T}}$$

$$L_T = L_1 + L_2 + 2M$$

M = Mutual Inductance between L_1 and L_2.

The output voltage of the amplifier appears across L_1 and feedback voltage across L_2. The voltage across L_2 is 180° out of phase with voltage developed across L_1. V_{out} shown in diagram, it is easy to see that voltage feedback to the transistor provide positive feedback. A phase shift of 180° is produced by the transistor and a further phase shift of 180° produced by $L_1 - L_2$ voltage diode. In this way, feedback is properly phased to produce continuous undamped oscillations.

Feedback fractions,

$$\beta = \frac{V_f}{V_{out}} = \frac{X_{L_2}}{X_{L_1}} = \frac{L_2}{L_1}$$

$$\boxed{\beta = L_2 / L_1}$$

Q. 4. (b) What is crystal oscillator? How it works? Draw its equivalent circuit and derive results for impedance, resonant frequency.

Ans. Crystal Oscillator : Quartz crystal usually employed in crystal oscillator because of their high mechanical strength and natural shape of quartz crystal is hexagonal but it is cut in different ways.

The natural frequency of a crystal is given as,

$$\boxed{f = k / t}$$

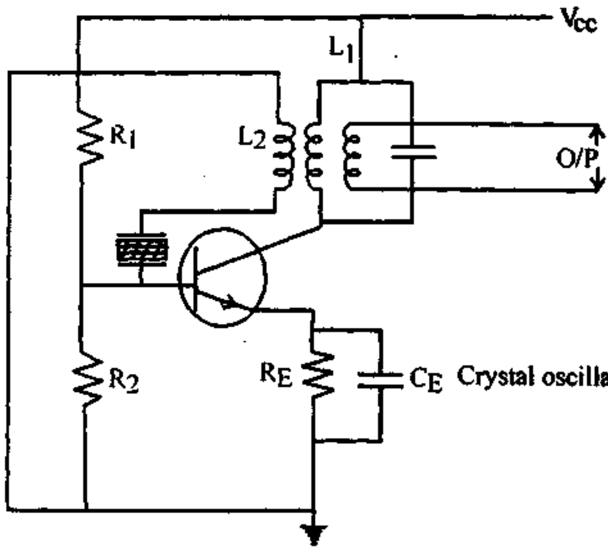
k is a constant which depend upon the dimensions of the crystal and natural frequency of crystal is inversely proportional to its thickness. In general practise, frequencies between 25 kHz to 5 MHz are obtain with crystals.

When a constant high frequency (25 kHz to 5 MHz for radio broadcasting transmitters) is required, a transistor crystal oscillator is always preferred.

The circuit arrangement of transistor crystal oscillator shown in fig. A tank circuit $L_1 - C_1$ is placed in the collector and the crystal connected in the base through a feedback coil L_2.

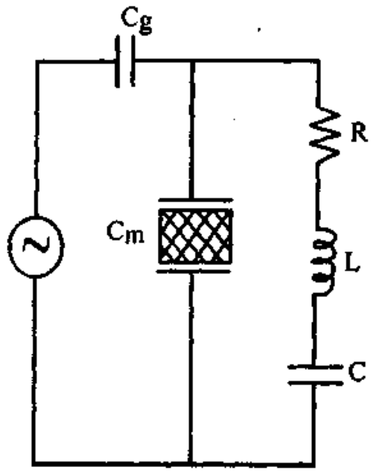
When power is turned on capacitor C_1 is charged when it discharge through L_1, it set up oscillations.

As coil L_2 is magnetically coupled to L_1 voltage is induced in this coil and power is feed back to the transistor in positive direction causing oscillator to produce oscillations. As crystal is connected in the base circuit therefore, its influence is much more than $L_1 - C_1$. Thus, the frequency of oscillations produced by oscillators are controlled by the crystal. Consequently, the entire circuit starts operating at the natural frequency of the crystal. Hence, the name crystal oscillator.

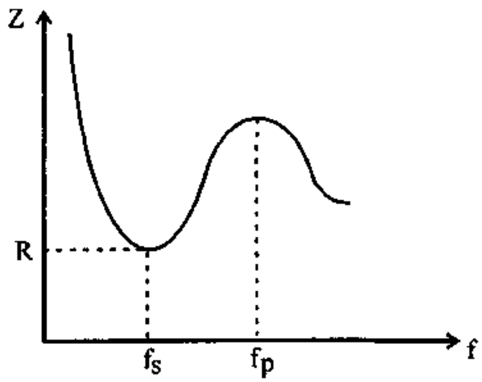


Crystal oscillator

Electrical equivalent circuit,



Impedance versus frequency graph of crystal.



Although the crystal has electromechanical resonance be we can represent its action by an equivalent electrical resonant circuit.

C_g = Series capacitance due to air gap.

C_m = Mounting capacitance.

Series Resonant Frequency (f_g) : It is due to RLC branch and is given as

$$\boxed{f_s = \frac{1}{2\pi\sqrt{LC}}} \text{ Hz}$$

Where L and C are in Henry and farads.

Parallel Resonance Frequency (f_p) : It is due to recombined circuit i.e., C_m in parallel with RLC circuit. The parallel resonant frequency is given as,

$$f_p = \frac{1}{2\pi\sqrt{LC_T}} \qquad = C_T = \frac{C \times C_m}{C + C_m}$$

The value of C_m is much larger $(\simeq 3.5\,P.F.)$ than C. Therefore, the frequencies f_p & f_s are very close to each other. Otherwise f_p is always.

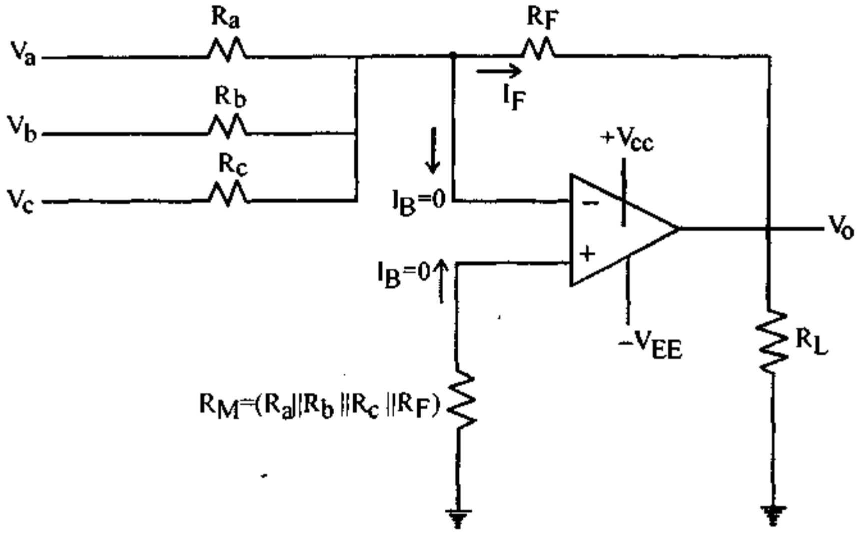
More always lie between f_s & f_p.

As frequency of crystal is independent of temperature, these oscillators have a high order of frequency stability. The quality factor Q of crystal is very high.

Q. 5. (a) Realize op-Amp as inverting adder, averages and scaling amplifier.

Ans. Summing (Inverting Adder) Average and Scaling :

Inverting Configuration : Below fig. shows three inputs V_a, V_b and V_c depending on the relationship between the feedback resistor R_F and the input resistor R_a, R_b & R_c the circuit can be used as either a summing scaling or averaging amplifier.



$$V_0 = -\left(\frac{R_F}{R_a}V_a + \frac{R_F}{R_b}V_b + \frac{R_F}{R_c}V_c\right)$$

Apply a KCL at V_2

$$I_a + I_b + I_c = I_B + I_F$$

Since R_i and A of op-amp are ideally & $I_B = 0$, $V_1 = V_2 = 0V$.

$$\frac{V_a}{R_a} + \frac{V_b}{R_b} + \frac{V_c}{R_c} = -\frac{V_o}{R_F}$$

$$V_o = -\left(\frac{R_F}{R_a}V_a + \frac{R_F}{R_b}V_o + \frac{R_F}{R_c}V_c\right)$$

Summing Amplifier :

If in fig. a $\quad R_a = R_b = R_c = R$

For example, $\quad V_o = -\frac{R_F}{R}(V_a + V_b + V_c)$

This means that the output voltage is equal to the negative sum of all the inputs times the gains of the circuit $\frac{R_F}{R}$. Hence the circuits is called summing amplifier, and if

$$R_a = R_b = R_c = R_F = R$$

$$V_o = -(V_a + V_b + V_c)$$

Scaling Amplifier : If each input voltage is amplified by a different factor, in other words weighted differently at the output. The circuit in fig. is then called a scaling or weighted amplifier. This condition accomplished. If R_a, R_b, R_e are different in value. Thus, the output voltage of the scaling amplifier is,

$$V_o = -\left(\frac{R_F}{R_a}V_a + \frac{R_F}{R_b}V_b + \frac{R_F}{R_c}V_c\right)$$

$$\frac{R_F}{R_a} \neq \frac{R_F}{R_a} = \frac{R_F}{R_c}$$

Average Circuit : Fig. circuit can be used as average circuit. In which the output voltage is equal to the average of all the $R_a = R_b = R_c = R$ then,

$$\frac{R_F}{R} = \frac{1}{n} \qquad n = \text{number of inputs}$$

In fig. $n = 3$

$$\frac{R_F}{R} = \frac{1}{3}$$

$$V_o = -\left(\frac{V_a + V_b + V_c}{3}\right)$$

Q. 5. (b) Realize op-Amp as integrator circuit.

Ans. Op-Amp as Integrator Circuit : An integrator is a circuit in which the output voltage waveform is the integral of the input voltage waveform.

We know that for an op-Amp.

$$A = \frac{V_o}{V_{id}}$$

Assuming op-Amp is ideal.

$A \approx \infty$ $\qquad V_{id} = \frac{V_o}{A} \approx \frac{V_o}{\infty} = 0$

$V_{id} = 0 \Rightarrow$ $\qquad V_1 - V_2 = 0,\ V_1 \Rightarrow V_2$

From diagram $\qquad V_1 = 0\ \&\ V_2 = 0$

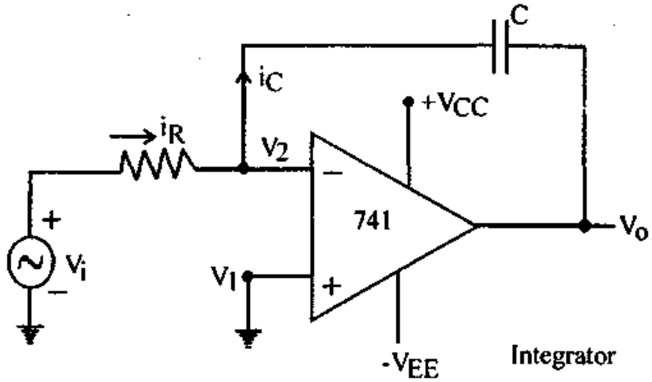
Since op-Amp is ideal, it will draw zero current.

$$i_R = i_C$$

We may write the value of i_R by KCL.

$$\frac{V_i - V_2}{R} = i_C$$

$$V_2 = 0$$



Integrator

Therefore, $$\frac{V_i - 0}{R} = i_C$$

i_C = Current through capacitor

$$i_C = C\frac{dV_c}{dt} = \frac{V_i}{R}$$

V_C = voltage across capacitor.

$$C\frac{dV_c}{dt} = \frac{V_i}{R} \quad \text{...(i)}$$

Given $$V_c = V_2 - V_0$$

Substituting this value in equation (i)

$$C\frac{d}{dt}[V_2 - V_o] = \frac{V_i}{R}$$

$$V_2 = 0$$

$$C\frac{d}{dt}(0 - V_o) = \frac{V_i}{R}$$

$$C\frac{d}{dt}(-V_o) = \frac{V_i}{R}$$

Integrate both side,

$$\int_0^t \frac{Vi}{R} dt = C(-V_o) + A$$

$$\boxed{V_o = -\frac{1}{R_C}\int_0^t Vidt + A}$$

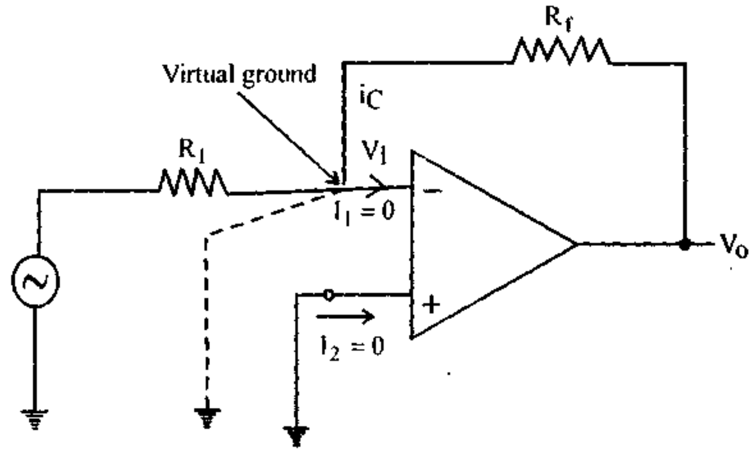
A is the integration constant and is proportional to the value of the output voltage, V_o at $t = 0$ sec.

Q. 5. (c) What is the concept of virtual ground?

Ans. Concept of Virtual Ground : A point in any circuit is said to be grounded if the potential at that point is equal to the ground potential. If that point is connected to the ground with the help of any conducting wire then all the current from that point will flow towards the ground, and the point is said to be physically grounded. In case of virtual grounded only the condition for potential is satisfied i.e., potential at that point becomes same as ground potential but physically no path for current from that point to ground exists.

For the op-amp we know that,

Gain $$A = \frac{V_o}{V_d}$$



$$V_d = V_2 - V_1 \qquad A = \frac{V_o}{V_2 - V_1}$$

$$V_2 - V_1 = \frac{V_o}{A} = \frac{V_o}{\infty} \text{ for ideal op-Amp } A = \infty$$

$$V_2 - V_1 = 0$$

$$V_2 = V_1 \qquad V_2 = 0 \quad \text{so} \quad V_1 = 0$$

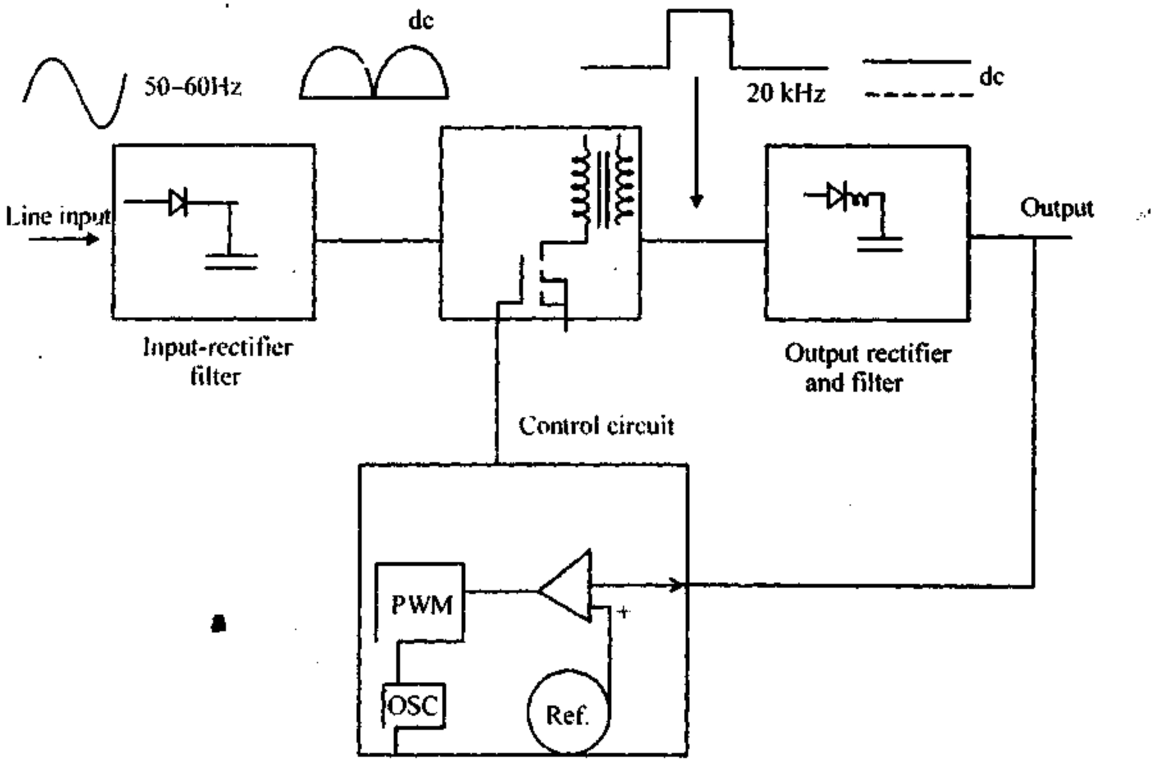
It is clear that the potential difference between two terminal is zero. In the inverting amplifier non-inverting amplifier is grounded so voltage at $V_2 = 0$.

Q. 6. Write short notes on :

(a) SMPS **(b) Inverter** **(c) Full adder**

Ans. (a) SMPS (Switched Mode Power Supply) : Modern electronics equipment, PC and instrumentation typically require dc voltage such as 5V, ±12V etc. in the power range of several watts to a few kW. However directly rectified ac voltage at the output result in fixed dc voltage depending on ac line input voltage. Therefore, the need for so called switched mode power supplies.

AC input voltage is rectified in to unregulated dc voltage by means of a diode rectifier. The unregulated rectified dc is capacitively smoothed and supplied to a high frequency power semiconductor devices based on dc to ac converter block which converts the input dc voltage from one level to another dc level. The chopped dc voltage is transformed, rectified and smoothed to give the required dc output voltage. This accomplished by high frequency switching which produce high frequency ac across isolation transformer. The secondary output of the isolation transformer is rectified and filtered to produce desired dc output voltage. The output of the dc supply is regulated by means of a feedback control that employ PWM controller where the control voltage is compared with a sawtooth waveform at switching frequency.



Block Diagram of SMPS

The electrical isolation in the feedback loop is provided either through an isolation transformer or through an optocoupler.

(b) Inverter : A circuit which converts dc power to ac power by sequentially switching devices with in the circuits.

They are 2 types :

(i) Voltage Source Inverters : A voltage fed inverter is one in which dc input voltage is essentially constant and independent of load current drawn. The significance of the term constant voltage fed (or voltage fed) is to emphasize that over the short time of one cycle of the output ac waveform any change in dc source voltage is negligible. A voltage source inverter is best suited to loads which have a high impedance to harmonic currents. Such as a series tuned circuit or an induction motor.

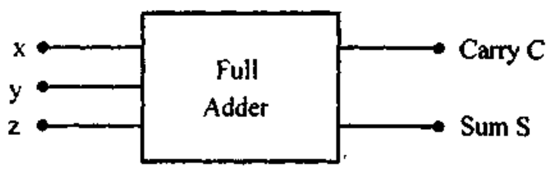
Current Source Inverters : A current fed inverter is one in which supply current cannot change quickly. A current fed inverter likes to see a stiff dc current source at input, which is in constant to the stiff voltage source desirable in a voltage fed inverter. A dc voltage source can be converted to a current source by connecting a large inductance in series and controlling the voltage within a current control loop with a stiff current source, the output current waves are not affected by the load. They are preferred for very high power ac motor drive application. The devices used in the circuit however have to withstand reverse voltage spikes and hence controllable switch devices may not be suitable.

(c) Full Adder : Full adder is a combinational circuit that performs the addition of 3 binary digits. The input variable are represented by x, y & z where x & y represent the 2 input variable to be added and z represents the carry from the previous lower significant positions.

Truth Table for Full Adder :

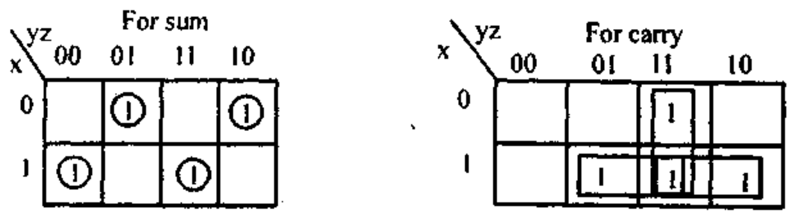
x	y	z	c	s
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

S represent the sum of three variables and C represent carry.



Logic symbol for full adder

It can be seen that S = 1, only when one input is 1 or when all the 3 input are equal to 1. The C output is 1, when 2 or 3 input are equal to 1. Two Boolean functions can be obtained, each to represent either source. We can simplify the functions by using k-map.

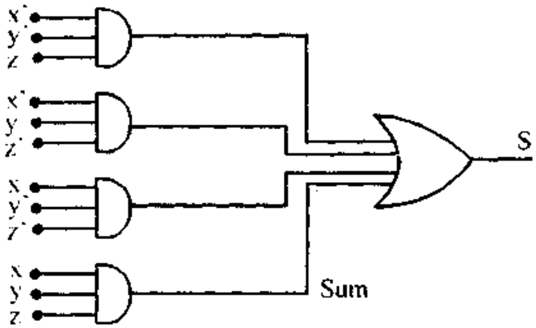


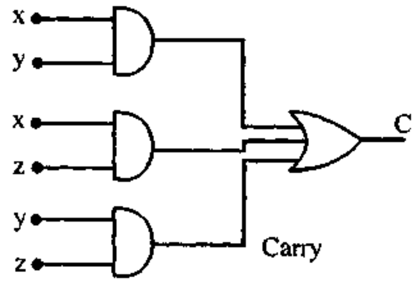
$$S = x'y'z + x'yz' + xy'z' + xyz$$

$$S = x \oplus y \oplus z$$

$$C = xy + xz + yz$$

Sum of products implementation of a full adder outputs, sum and carry as shown in fig.





Q. 7. Briefly describe :

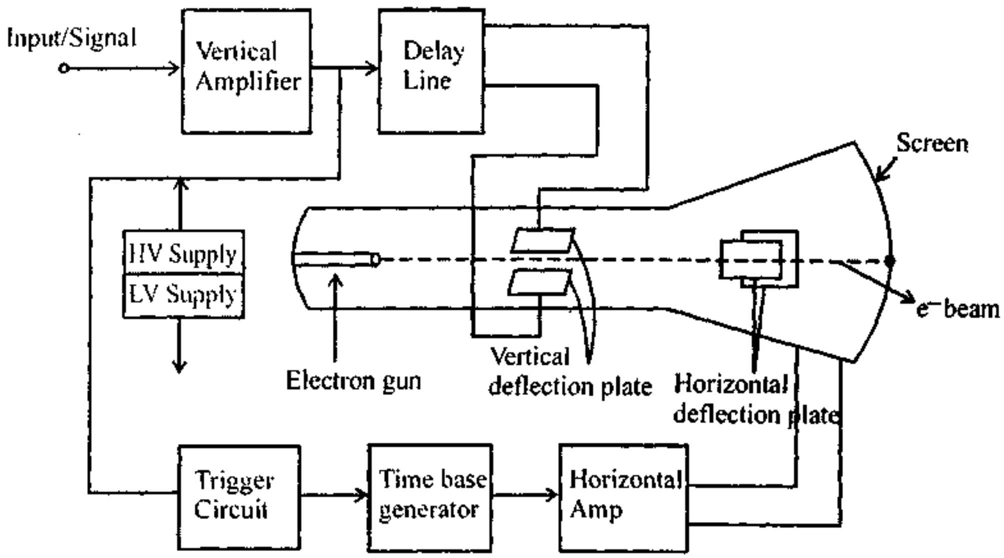
(a) CRO

(b) Signal Generator

Ans. (a) CRO (Cathode Ray Oscilloscope) : The cathode ray oscilloscope is an extremely useful and versatile laboratory instrument used for studying wave shape of alternating currents and voltage as well as for measurement of voltage current, power and frequency, almost any quantity that involves amplitude and waveform. It allows the user to see the amplitude of electrical signals as a function of time on the screen.

The CRO has been one of the most important tools in the design and development of modern electronic circuits.

The instrument employer cathode ray tube which is the heart of oscilloscope, it generate the electron beam by the help of electron gun. Electron gun consists a streams of electrons, focusing and accelerating anodes for producing a narrow and sharp focused electron be. .n. Accelerating the beam to a high velocity, deflect the beam to create the image and contains a phosphor screen where the electron beam eventually become visible. For accomplishing these tasks, a various electrical signals and voltage are required.



Block Diagram of CRO

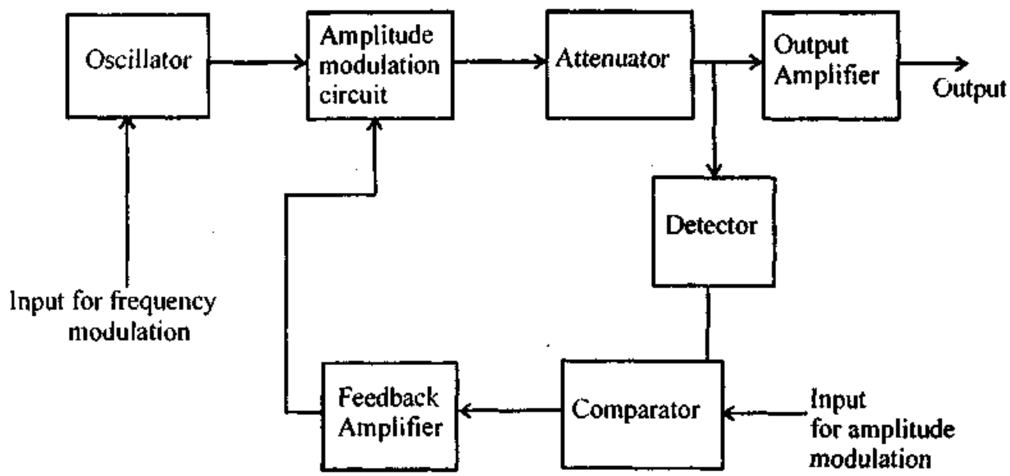
Which are provided by the power supply circuit of the oscilloscope. Low voltage supply is required for the heart of the electron gun for generation of electron beam and high voltage, of the order of few thousand volts, is required for cathode ray tube to accelerate the beam.

Horizontal and vertical deflection plates are fitted between electron gun and screen to deflect the beam according to input signal. Electron beam stricks the screen and creates a visible spot. This spot is deflected on the screen in horizontal direction (X axis) with constant time dependent rate. This is accomplished by a time base circuit provided in oscilloscope. The signal to be viewed is supplied to the vertical deflection plates through the vertical amplifier, which raises the potential of the input signal to a level that will provide usable deflection of the electron beam. Now electron beam deflects in two directions. Horizontal on x-axis and vertical on y-axis. A triggering circuit is provided for synchronizing two types of deflections starts at the same point of the input vertical signal each time it sweeps.

The screen of the CRO made by some crystalline materials, such as phosphor, have property of emitting light when exposed to radiation. This is called fluorescence characteristic of the materials.

The whole assembly is protected in a conical highly evacuated glass housing through suitable supports.

(b) Signal Generator : These instruments usually produces a fixed frequency sine wave whose output can be frequency or amplitude modulated by another signal. The instrument cover a frequency range of 0.01 Hz–50 GHz but not from the same device.



Block diagram of signal generator

Frequency modulation is achieved by varying the voltage across a variable capacitance diode in the turning circuit of the oscillator. This gives a system with low output distortion. For modulation depth 1% of the carrier frequency. Above this modulation level the waveform applied to the tunning diode needs to deliberately distorted, in order to compensate for its non linear characteristics. During frequency modulation manual or automatic method may be used to keep the amplitude of the output constant.

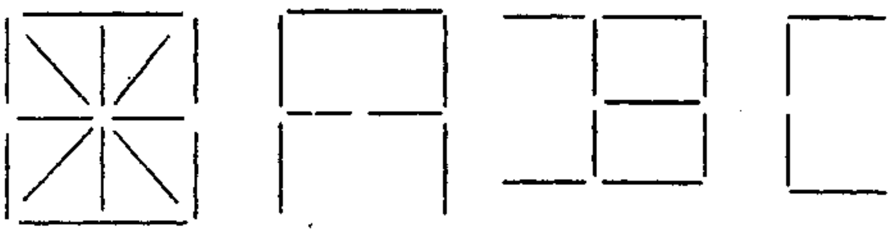
A M is most conveniently done by varying the supply voltage of oscillators. This method is, however only suitable for small modulation depth up to 50% it also gives phase modulation due to effect on the components used with in oscillator circuit feedback can be used to reduce output this with the amplitude modulation input and then amplifying and feedback the difference as the modulation signal. This technique is known as envelope feedback. The output amplifier shown in fig. provides the required signal level and buffers the oscillator from changes in the load impedance. The attenuator is needed to give the level output signals

Q. 8. (a) How fourteen segment display works? Design a circuit for it.

Ans. Segments Display : The segment displays may be either 7 or 14 segmental once depending upon whether numeric or alphanumeric display are require.

Fourteen Segmental Display : For display of alphanumeric characters both numerals as well as alphabets a 14 segments display unit is used.

14 segments display unit shown in diagram.



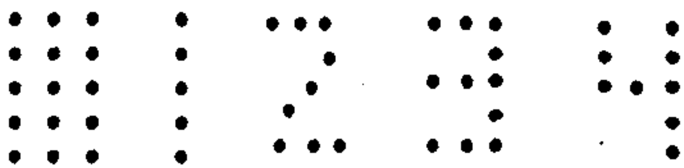
14 Segment display

Display of Alphabets

The diagram show how alphabets A, B, C are display by illumination of proper segments.

Dot matrix may be used for display of numeric and alpha numeric characters.

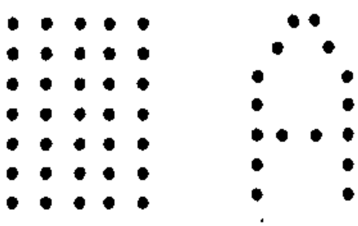
A 3 × 5 Dot Matrix : A 3 × 5 dot matrix shown in fig. may be used for display of numeric characters.



3 × 5 Matrix Numeric Characters 1,2,3,4

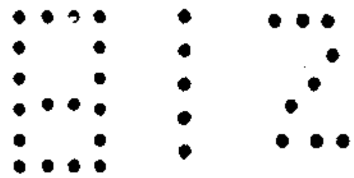
3 × 5 dot matrix and formation of numeric characters

A 5 × 7 Dot Matrix : For display of alphanumeric characters a 5 × 7 dot matrix is used as shown in fig.



5 × 7 Dot Matrix

Dot Matrix Utilizing 27 Dots : This system is used for numeric display. The dots may be square or round with 0.4mm side or diameter.



Digital display unit with grid illuminated dots

Q. 8. (b) Enumerate the advantages of LED over LCD.

Ans. Advantages of LED Over LCD :

1. LED are maniature in size and they can be stacked together to form numeric and alphanumeric display in high density matrix.
2. The light output from an LED is a function of the current flowing through it. Therefore intensity of light emitted from LED's can be smoothly controlled.
3. LEDs have a high efficiency as emitters of electromagnetic radiation. They require moderate power for then operation. A typical voltage drop of 1.2V and a current of 20mA is required for full brightness. Therefore, LED's are useful where miniaturization with low dc power are important.
4. LED are available which emit light in different colours like red, green, yellow and amber operation of large number of array is involved.
5. The switching time (both on and off) is than 1ns and therefore they very useful where dynamic operation of large number of array is involved.
6. LED are manufactured with the same type of technology as is used for transistors and IC and therefore are economical and have degree of reliability.
7. LED are rugged and can therefore withstand stocks and vibrations. They can be operated over a wide range of temperature say 0–70°C.

The disadvantages of LED's as compared with LCD is then high power requirement. Also LED are not suited for large are displays, primarily because of their high cost. For large displays, device using gas filled plasma are used.

Q. 8. (c) Explain the speciality of dot matrix display.

Ans. Speciality of Dot Matrix Display : A dot matrix is used to display of numeric and alphanumeric characters both so it is very useful for displays.

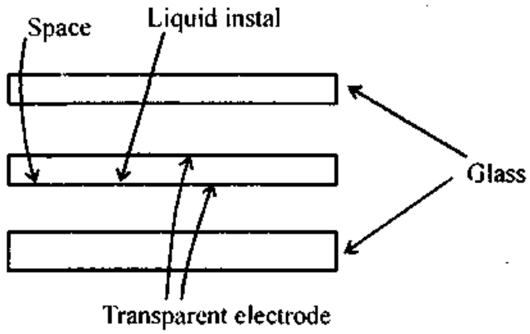
They are 3 types :

1. A 3 × 5 Dot matrix.
2. Dot matrix utilizing 27 dots.
4. A 5 × 7 dot matrix.

The dots may be square or round with 0.4mm side or diameter. LED and LCD are used for display of Dot.

Q. 9. (a) Enumerate the advantages of Dynamic & catering LCD display cells.

Ans. Dynamic Scattering : The construction of dynamic scattering LCD shown in fig.



The liquid crystal material may be one of the several compounds & which exhibit optical properties of crystal through the remain in liquid form liquid crystal is layered between glass sheets with transparents electrode deposite on the inside face.

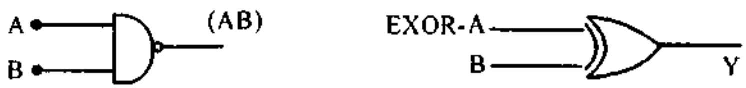
When a potential is applied across the cell, charge carrier flowing through the disrupt the molecule alignment and produce turbulence when the liquid is not activated it is transparent when the liquid is activated the molecular turbulence causes light to be scattered in all directions and cell appear to be bright. The phenomenon is called dynamic scattering.

Advantages:

1. They have low power consumption. A 7 segment displays require about $140\mu W$. This is great advantage over LED.
2. They have low cost.
3. LCD are used for 7 segments displays.

Q. 9. (b) Realize Ex-OR gate with four NAND gates only.

Ans. EX-OR using 4 NAND Gate:



EX-OR Gate expression:

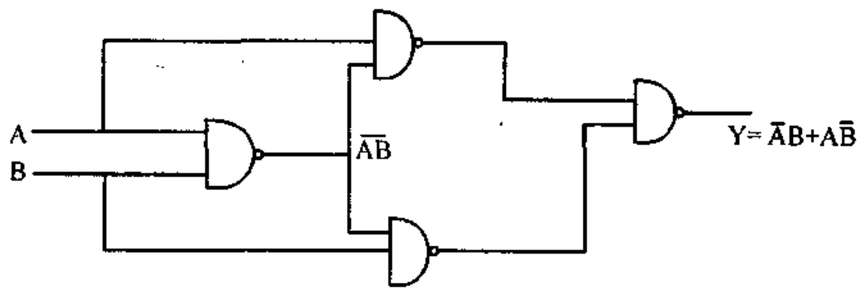
$$Y = A\overline{B} + \overline{A}B$$

$$Y = A\overline{B} + A\overline{A} + \overline{A}B + B\overline{B}$$

$$= A(\overline{A} + \overline{B}) + B(\overline{A} + \overline{B})$$

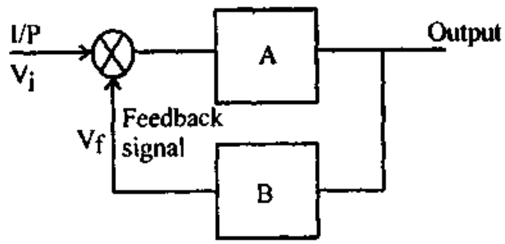
$$= A(\overline{AB}) + B(\overline{AB}) \text{ De- Morgan theorem}$$

$$Y = \overline{\overline{A.\overline{AB} + B\overline{AB}}}$$



Q. 9. (c) What is barkhausen criterion? Explain.

Ans. Barkhausen Criterion : Barkhausen criterion states that the total phase shift around loop, as the signal proceed from input through amplifier, feedback network back to input again, completely a loop is precisely 0° to 360°.

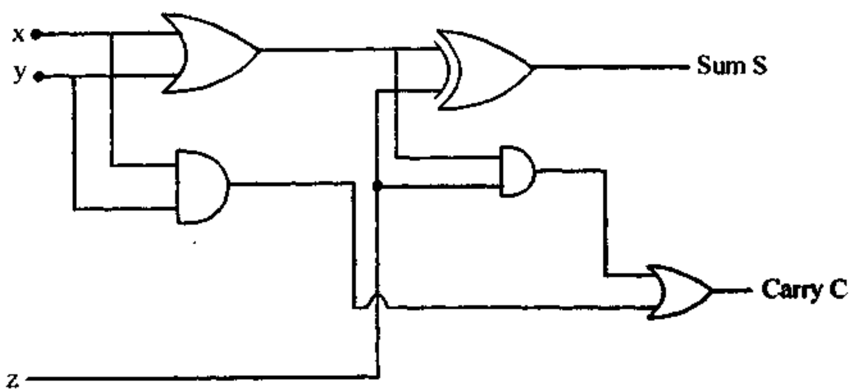


2. The magnitude of the product of the open loop gain of the amplifier A and feedback factor β is unity

$|A\beta| = 1$ or $-A\beta = 1$.

If a circuit satisfy the above circuit then the circuit works as an oscillator producing sustained oscillations of constant frequency and magnitude.

Full adder with the help of half adder :



Block diagram of full adder