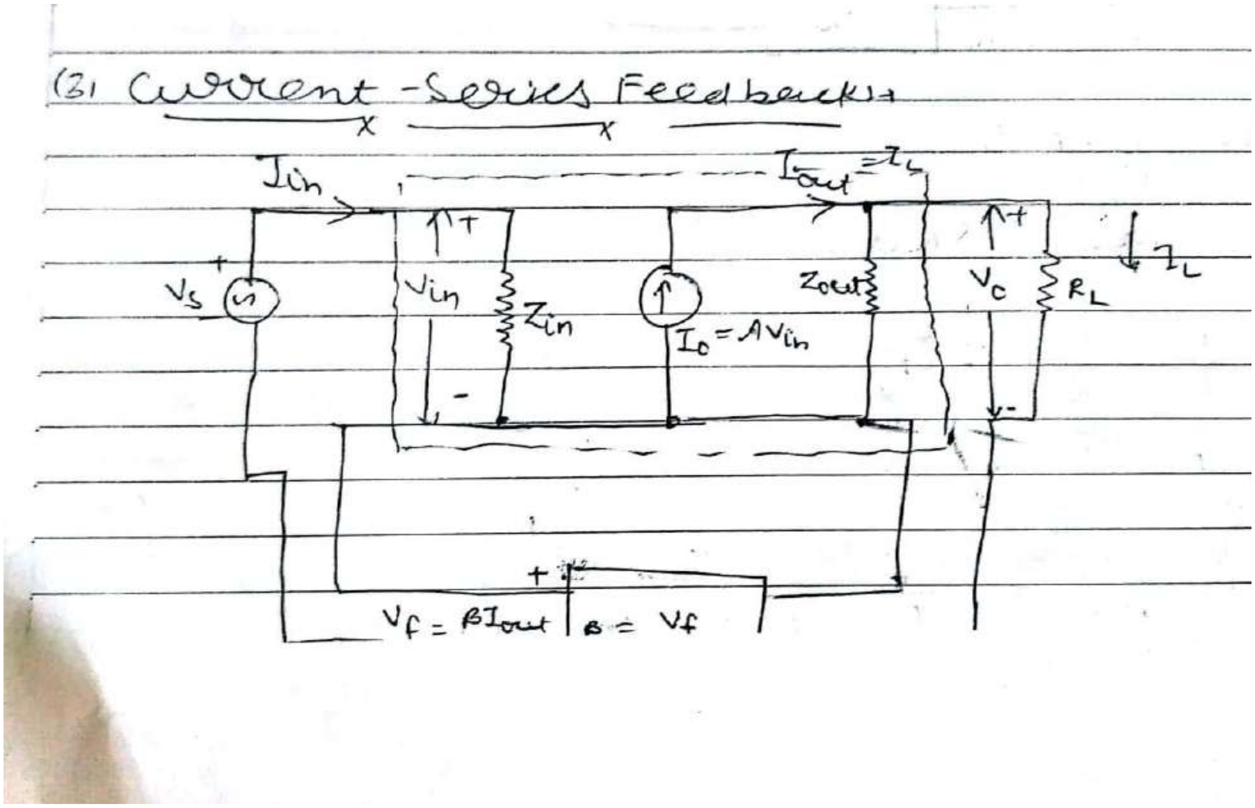
SET-B

SOLUTION-1



* Input impedance:- $Z_{in} = \frac{V_{in}}{I_{in}}$

$$= \frac{V_s - V_f}{I_{in}} = \frac{V_s - \beta I_{out}}{I_{in}}$$

$$Z_{in} = \frac{V_s - \beta A V_{in}}{I_{in}}$$

$$I_{in} Z_{in} = V_s - \beta A V_{in}$$

$$V_s = I_{in} Z_{in} + \beta A V_{in}$$

$$= I_{in} Z_{in} + \beta A I_{in} Z_{in}$$

$$\frac{V_s}{I_{in}} = Z_{in} + A\beta Z_{in}$$

$$Z_{inf} = Z_{in} \left[1 + A\beta \right]$$

* Output impedance:- The output impedance with current-series f/b can be determined by disconnecting load resistance R_L, applying a signal V to the O/P with V_s shorted out. The ratio of V to I gives the O/P impedance of the ckt. Now

$$I = \frac{V}{Z_{out}} - AV_{in}$$

$$= \frac{V}{Z_{out}} - AV_f = \cancel{\frac{V}{Z_{out}} - A\beta I_{out}}$$

$$\left[\because V_{in} = V_f = \beta I_{out} \right]$$

$$= \frac{V}{} - A\beta I_{out}$$

DATE (14)

$I = \frac{\cancel{A}V}{Z_{out}} - A\beta I$ $\quad [\because I_{out} = I]$

~~$I Z_{out} + A\beta I = V$~~

$I + A\beta I = \frac{V}{Z_{out}}$

$I(1+A\beta) = \frac{V}{Z_{out}}$

$Z_{out}(1+A\beta) I = V$

O/P impedance, $Z_{out\,f} = \frac{V}{I} = Z_{out}(1+A\beta)$ — (2)

O/P impedance is ↑ by the factor $(1+A\beta)$

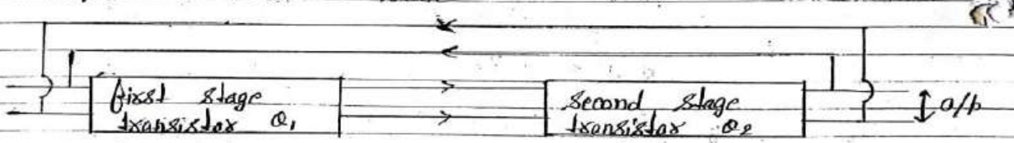
OR

SOLUTION-1

* Multivibrator →

A multivibrator is basically a two stage R-C coupled ampr with positive f/b from the o/p of one ampr to the i/p of the other. Multivibrator is a switching circuit and may be defined as an electronic circuit that generates non sinusoidal waves.

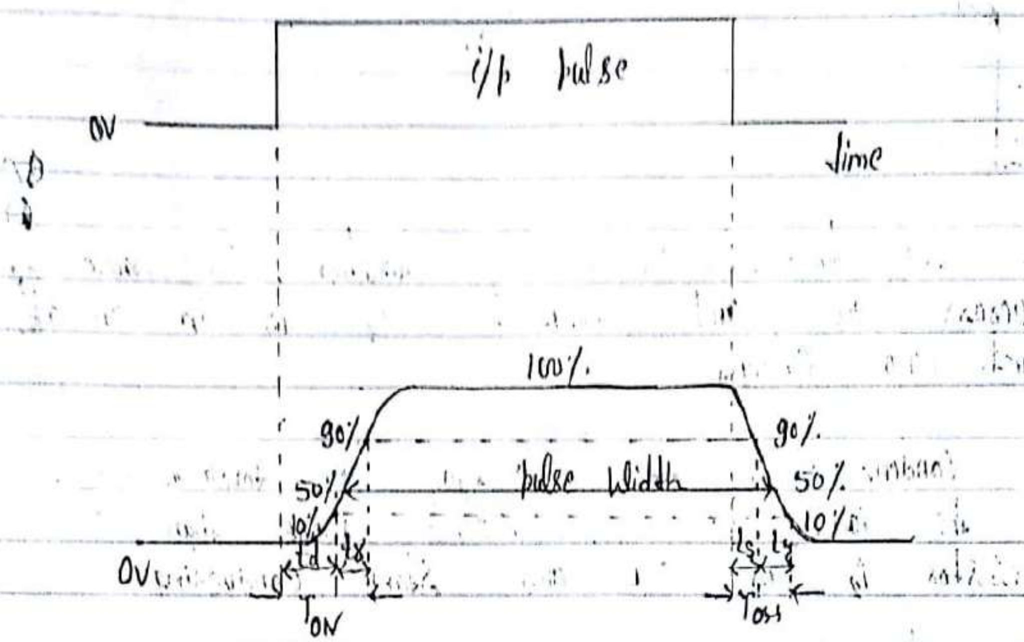
The circuit operate in two state on and off. The operation of circuit is such that when one ampr is cutoff, the positive f/b maintain the other ampr in a on state.



The state can be stable or unstable (quasi-stable). The stable state is defined as the state which is maintained by a multivibrator for infinite time period untill unless external pulse is applied. Un-stable state is a ...

circuit parameter, depending upon nature of state the multivibrator is classified as.

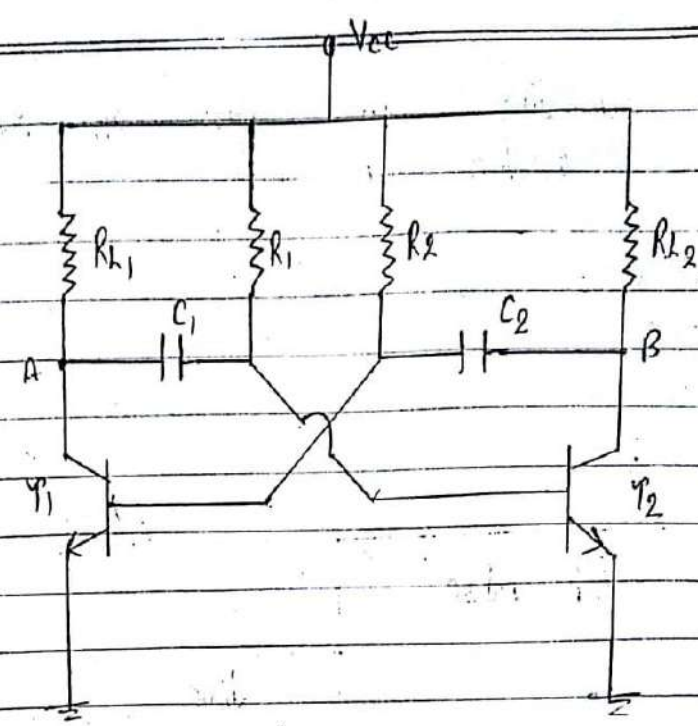
a.) Monostable multivibrator
b) Astable "
c.) Bistable "



a.) Astable multivibrator →

Astable multivibrator or free running multivibrator is a device which generate square wave of its own without any external triggering pulse.

There is no stable state, of course there are two quasi-stable state. In one quasi-stable state, one transistor ON state and the other being in OFF state for some time. After this time, in the second quasi stable state, the second transistor automatically turned ON while the first transistor automatically off.



i) When the transistor T_1 is in saturation, the whole V_{cc} drop across R_{L_1} and transistor T_2 is in cut off, it conduct no current.

ii) the condenser C_1 start charging R_1 towards V_{cc}. When the volt. across C_1 become more than 0.7 V the transistor T_2 is F.B. and start conducting.

iii) After few cycles, the transistor T_2 is in sat. state while the transistor T_1 become cut off.

iv) the condenser C_2 start charging through R_2 to potential V_{cc}. When the volt. across C_2 is more than 0.7 V, the transistor T_1 is F.B. and start conducting.

the ON time of transistor T_1 / off time of transistor T_2 ⇒

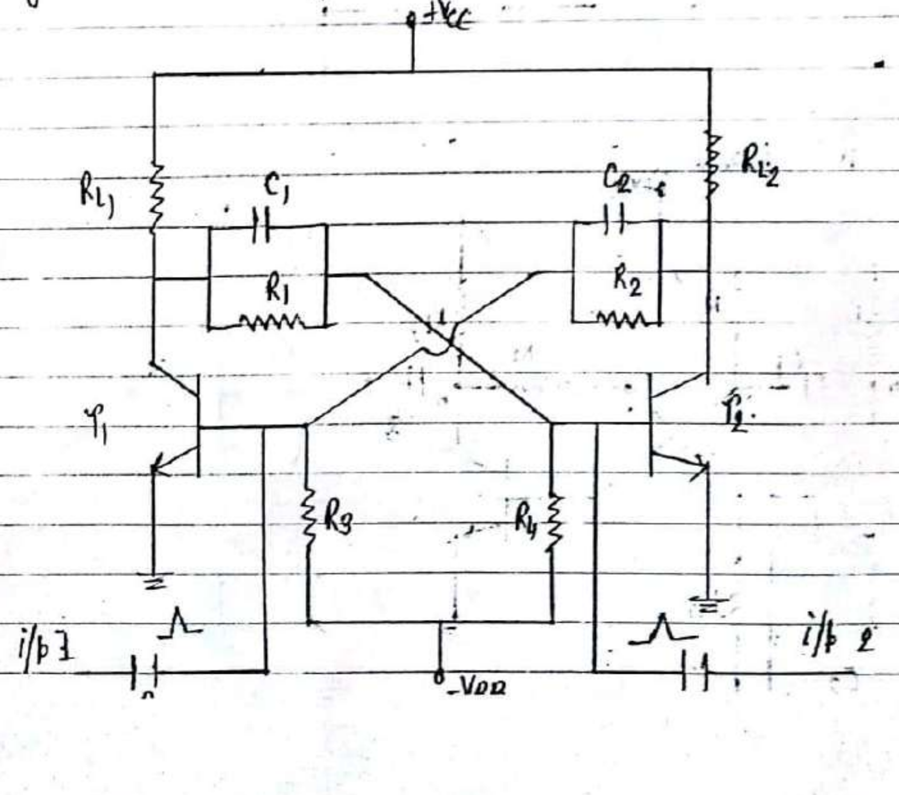
$$t_1 = 0.69 R_1 C_1$$

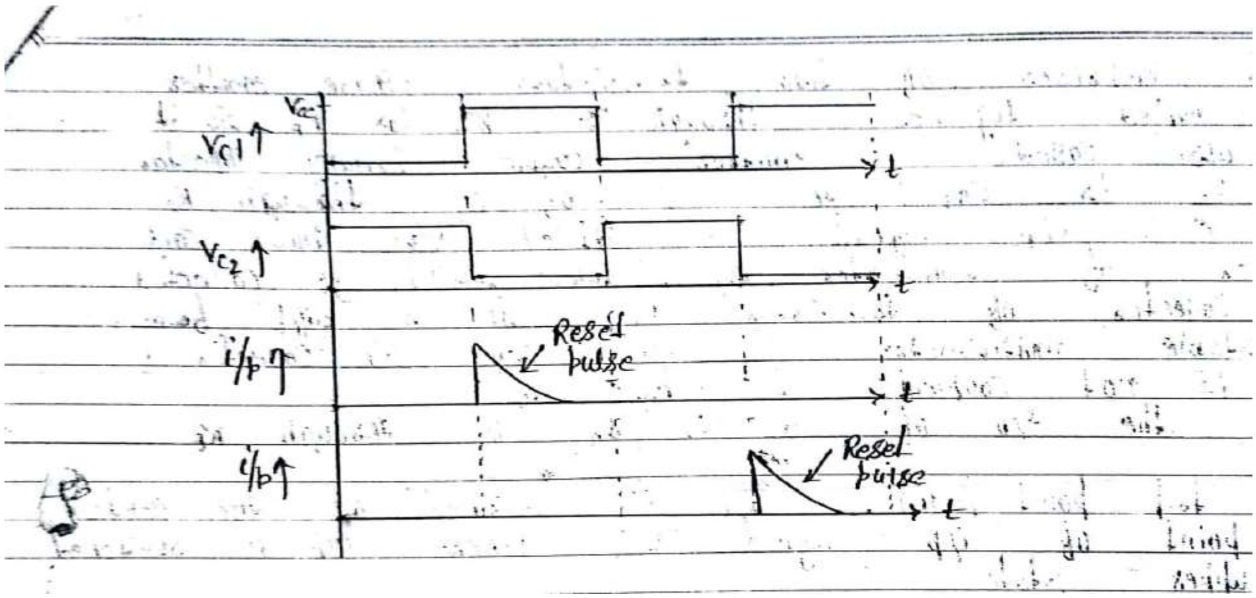
A monostable or one shot multivibrator has only one stable state i.e one transistor is conducting and the other is non-conducting. When the external triggering pulse is applied, the multivibrator changes stable state to a quasi-stable state. After a certain time, the multivibrator returns to its original stable state automatically and remain until triggering pulse applied.

The width of o/p pulse is determined by the time of C_1R_1. The duration of the pulse is given by $T = 0.69\ C_1R_1$.

c) Bistable multivibrator :-

A bistable multivibrator has two stable state. When an external pulse is applied the circuit changes from one stable state to another stable state. When another triggering pulse is applied only then it goes back to its original state.

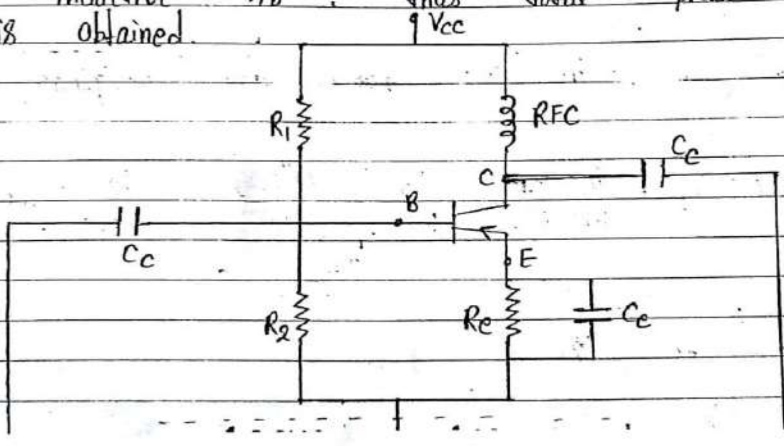




SOLUTION-2

* Hartely oscillator →

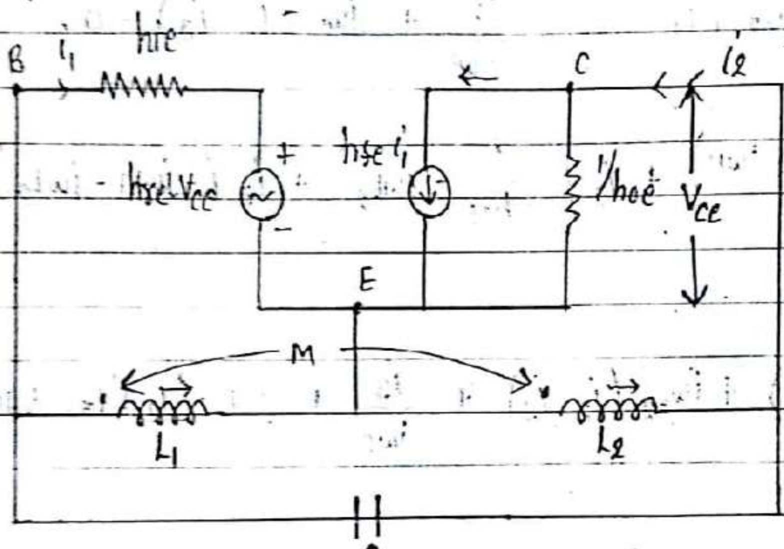
In this osc^{r}, Volt. divider bias is provided by resistor R_1 and R_2. 'C_E' is a bypass resistor. 'C_C' is a coupling resistor. Tuned circuit is formed by inductor L_1, L_2 and capacitor C. Mutual coupling b/w inductors is M. V_{CC} is applied to collector through radio freq^n choke (RFC), which permits an easy flow of current. Transistor (CE type) produces a phase shift of 180° and another phase shift of 180° is provided by inductive f/b, thus total phase shift of 360° is obtained.



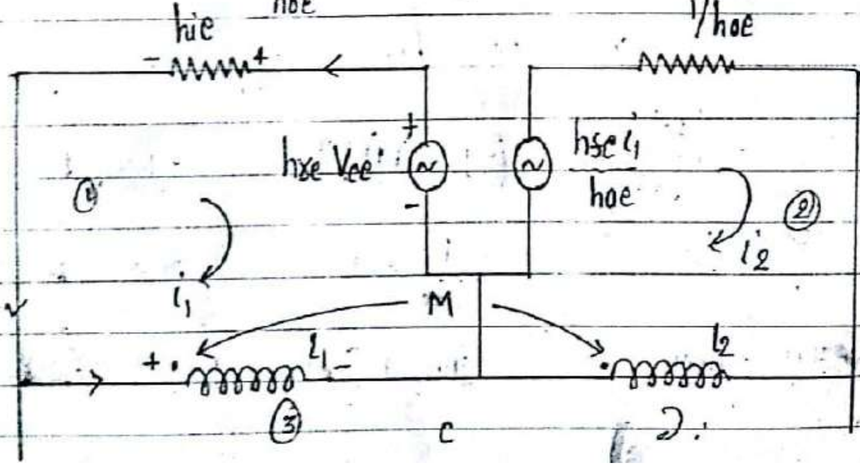
Working →

As Supply is switched ON, Capacitor c is charged through Vcc. this capacitor discharge through L_1 and L_2 and oscillation appear in tank circuit, this oscillation are applied to i/p of transistor and appear in amplified form in o/p ckt. this amplified o/p volt. is applied again to tuned circuit and it shows that Sinusoidal oscillations are undamped

Ac equivalent ckt →



$$V_{ce} = \frac{i_2 - h_{fe} i_1}{h_{oe}} \quad \text{(apply kcl at node, collector)}$$



from loop - ①

$$I_1 h_{ie} + h_{re} V_{ce} + j\omega L_1 (i_1 - i_3) - j\omega M (i_2 + i_3) = 0$$

$$i_1 \left(h_{ie} + j\omega L_1 - \frac{h_{fe} h_{re}}{h_{oe}} \right) + i_2 \left(-j\omega M + \frac{h_{re}}{h_{oe}} \right) + i_3 \left(-j\omega L_1 - j\omega M \right) = 0 \quad \text{---} (i)$$

from loop - ②

$$\frac{h_{fe}}{h_{oe}} i_1 - j\omega L_2 (i_2 + i_3) - \frac{i_2}{h_{oe}} + j\omega M (i_1 - i_3) = 0$$

$$\Rightarrow i_1 \left(\frac{h_{fe}}{h_{oe}} + j\omega M \right) + i_2 \left(-\frac{1}{h_{oe}} - j\omega L_2 \right) + i_3 \left(-j\omega M - j\omega L_2 \right) = 0 \quad \text{---} (ii)$$

from loop - ③

$$j\omega L_1 (i_3 - i_1) + j\omega L_2 (i_2 + i_3) + \frac{i_3}{j\omega C} + j\omega M (i_2 + i_3) + j\omega M (i_3 - i_1) = 0$$

$$\Rightarrow i_1 (-j\omega L_1 - j\omega M) + i_2 (j\omega L_2 + j\omega M) + i_3 (j\omega L_1 + j\omega L_2 + 1/j\omega C + 2j\omega M) = 0 \quad \text{---} (iii)$$

eq^n (i), (ii), (iii) in matric form -

$$\begin{bmatrix} h_{ie} + j\omega L_1 - \frac{h_{fe} h_{re}}{h_{oe}} & (-j\omega M + 1)\frac{h_{re}}{h_{oe}} & -j\omega L_1 - j\omega M \\ \frac{h_{fe}}{h_{oe}} + j\omega M & -\frac{1}{h_{oe}} - j\omega L_2 & -j\omega M - j\omega L_2 \\ -j\omega L_1 - j\omega M & j\omega L_2 + j\omega M & j\omega L_1 + j\omega L_2 + 2j\omega M + 1/j\omega C \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = 0$$

Under resonant condition, Sum of inductive and capacitive reactance will be zero ⇒

$$\Rightarrow j\omega L_1 + j\omega L_2 + \frac{1}{j\omega C} + j\,2\omega M = 0$$

$$\omega = \frac{1}{\sqrt{C}\sqrt{L_1 + L_2 + 2M}}$$

taking $\frac{h_{re}}{h_{oe}}$ common ⇒

$$\frac{h_{re}}{h_{oe}}\begin{bmatrix} (h_{ie} + j\omega L_1)\frac{h_{oe}}{h_{re}} - h_{fe} & -j\omega M + 1 & -j\omega(L_1+M)\frac{h_{oe}}{h_{re}} \\ \left(\frac{h_{fe}}{h_{oe}} + j\omega M\right) & -\left(\frac{1}{h_{oe}} + j\omega L_2\right) & -j\omega(M + L_2) \\ -j\omega(L_1+M) & j\omega(L_2+M) & 0 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = 0$$

Neglect the term h_{oe} and h_{re} ⇒

$$\begin{bmatrix} -h_{fe} & -j\omega M + 1 & 0 \\ j\omega M & -j\omega L_2 & -j\omega(M+L_2) \\ -j\omega(L_1+M) & j\omega(L_2+M) & 0 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = 0$$

equating determinant to zero ⇒

$$h_{fe}\left(\omega^2(L_2+M)^2\right) - (-j\omega M + 1)(L_1+M)(L_2+M) = 0$$

equating real terms to zero ⇒ $h_{fe} = \frac{L_1+M}{L_2+M}$

for oscillation, $A\beta = 1$ (Current gain, $h_{fe} = A$)

OR

SOLUTION-2

Solution.

(*i*) Gain without feedback, $A_v = 100$

Gain with feedback, $A_{vf} = 50$

Let m_v be the fraction of the output voltage fedback.

Now
$$A_{vf} = \frac{A_v}{1 + A_v\, m_v}$$

or
$$50 = \frac{100}{1 + 100\, m_v}$$

or
$$50 + 5000\, m_v = 100$$

or
$$m_v = \frac{100 - 50}{5000} = \mathbf{0.01}$$

(*ii*)
$$A_{vf} = 75\ ; \quad m_v = 0.01\ ; \quad A_v = ?$$

$$A_{vf} = \frac{A_v}{1 + A_v\, m_v}$$

or
$$75 = \frac{A_v}{1 + 0.01\, A_v}$$

or
$$75 + 0.75\, A_v = A_v$$

$\therefore$
$$A_v = \frac{75}{1 - 0.75} = \mathbf{300}$$

SOLUTION-3

Solution.
$$A_{vf} = \frac{A_v}{1 + A_v\, m_v}$$

or
$$25 = \frac{50}{1 + 50\, m_v}$$

or
$$m_v = 1/50$$

(*i*) **Without feedback.** The gain of the amplifier without feedback is 50. However, due to ageing, it falls to 40.

$\therefore$ %age reduction in stage gain $= \frac{50 - 40}{50} \times 100 = \mathbf{20\%}$

(*ii*) **With negative feedback.** When the gain without feedback was 50, the gain with negative feedback was 25. Now the gain without feedback falls to 40.

$\therefore$ New gain with negative feedback $= \frac{A_v}{1 + A_v\, m_v} = \frac{40}{1 + (40 \times 1/50)} = 22.2$

$\therefore$ %age reduction in stage gain $= \frac{25 - 22.2}{25} \times 100 = \mathbf{11.2\%}$

OR

SOLUTION-3

Solution.

$$R_1 = R_2 = R = 220\ \text{k}\Omega = 220 \times 10^3\ \Omega$$
$$C_1 = C_2 = C = 250\ \text{pF} = 250 \times 10^{-12}\ \text{F}$$

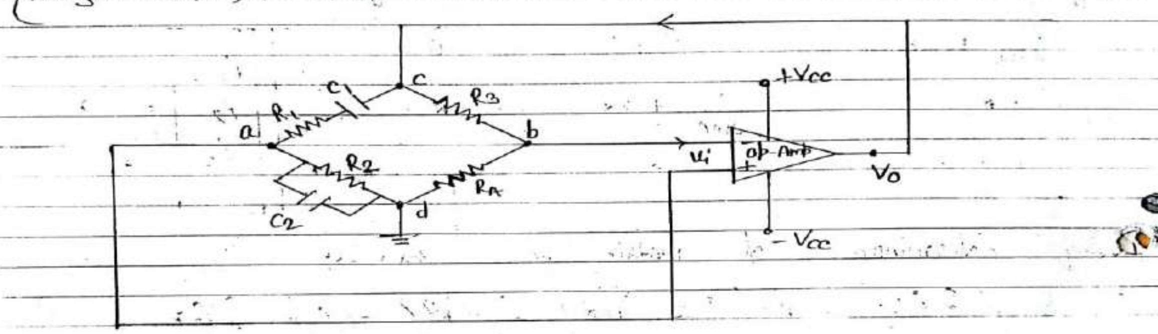
Frequency of oscillations, $$f = \frac{1}{2\pi RC}$$

$$= \frac{1}{2\pi \times 220 \times 10^3 \times 250 \times 10^{-12}}\ \text{Hz}$$

$$= \mathbf{2892\ Hz}$$

SOLUTION-4

* Wein's bridge oscillator → Wein's bridge osc^r is one of the most popular osc^r. It is used for audio freq^n range (20 Hz to 20 kHz)



Inverting end of op-amp is connected to 'b' point and Non-Inverting end of op-amp is connected to 'a' point.
So volt. drop across R_A produces negative f/b. Similarly, f/b signal causes a volt. drop across branch ad so volt. drop across R_2 produces

tive, Which is an essential condition of oscillation under balance condition.

$$P/Q = R/S \quad \text{- - - (i)}$$

Where $P = R_1 + 1/j\omega C_1$, $Q = R_2 \parallel C_2 = \frac{R_2}{1 + j\omega C_2 R_2}$

$R = R_3$, $S = R_4$

So from eq^n (i)

$$\left(R_1 + 1/j\omega C_1\right) R_4 = R_3 \cdot \frac{R_2}{1 + j\omega C_2 R_2}$$

$$\Rightarrow \left(1 + j\omega C_1 R_1\right)(R_4)\left(1 + j\omega C_2 R_2\right) = j\omega C_1 R_2 R_3$$

equating imaginary part of both side of eq^n -

$$\frac{R_3}{R_4} = \frac{R_1}{R_2} + \frac{C_2}{C_1}$$

equating real part of both side of eq^n -

$$\omega = \frac{1}{(R_1 R_2 C_1 C_2)^{1/2}}$$

$$\Rightarrow V_{ad} = V_0 \cdot \frac{Q}{P+Q} \quad \text{- - - (a)}$$

$$V_{ad} = V_0 \frac{R/1 + j\omega RC}{\frac{R}{1 + j\omega RC} + \frac{1}{j\omega C} + R} \qquad V_0/3$$

Now i/p f/b $\Rightarrow$

$$V_i' = V_{ad} - V_{bd}$$
$$= V_0/\alpha$$

f/b factor $\beta = \frac{V_i'}{V_0} = 1/\alpha$

So $A\beta = \alpha \cdot 1/\alpha = 1$

OR

SOLUTION-4

1. Identify topology (type of feedback)
a) To find the type of sampling network.
b) To find the type of mixing network
2. Find the input circuit.
3. Find the output circuit.
4. Replace each active device by its h-parameter model at low frequency.
5. Find the open loop gain (gain without feedback), A of the amplifier.
6. Indicate X_f and X_o on the circuit and evaluate $\beta = X_f X_O$.
7. Calculate A, and β, find D, A_i,R_{if},R_{of},and R_{of}’.

Characteristics	Topology			
	Voltage series	Current series	Current shunt	Voltage shunt
Sapling signal, X_O	Voltage	Voltage	Current	Current
Mixing signal	Voltage	Current	Current	Voltage
To find input loop, Set	$V_0=0$	$I_0= 0$	$I_0=0$	$V_0=0$
to find output loop, set	$I_i=0$	$I_i = 0$	$V_i = 0$	$V_I = 0$
Signal source	Thevenin	Thevenin	Norton	Norton
$\beta = X_f / X_0$	V_f / V_0	V_f/I_0	I_f/I_0	I_f/I_0
$A=X_0/X_i$	$A_V=V_0/V_i$	$G_M=I_0/V_i$	$A_I=I_0/I_i$	$R_M=V_0/I_i$
$D=1+ \beta A$	$1+ \beta A_v$	$1+ \beta G_M$	$1+ \beta A_I$	$1+ \beta R_M$
A_f	A_V/D	G_M/D	A_I/D	R_M/D
R_{if}	R_iD	R_iD	R_i/D	R_i/D
R_{Of}	$R_0/(1+\beta A_V)$	$R_0(1+\beta G_M)$	$R_0(1+\beta A_I)$	$R_0/(1+\beta R_M)$
R_{Of}'	$R_0'/(1+\beta A_V)$	$R_0(1+\beta A_V)$ $/(1+\beta A_V)$	$R_0(1+\beta A_V)/$ $(1+\beta A_V)$	$R_0'/(1+\beta R_M)$