## SET-A

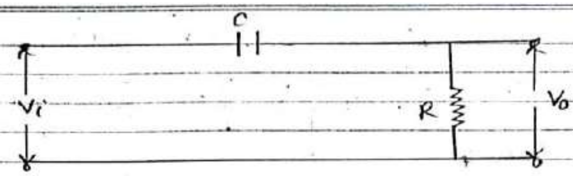
### SOLUTION-1

* R-C phase shift osc$^r$ → –

L-C osc$^r$ can't be used for generating low freq$^n$ oscillation

$f \propto 1/\sqrt{L}$

∴ generating low freq$^n$ signal requires high value of L means it require bulky and massive inductors, which is expensive. So for generating audio freq$^n$ signal, R-C osc$^r$ are used, they have good freq$^n$ response and better stability.



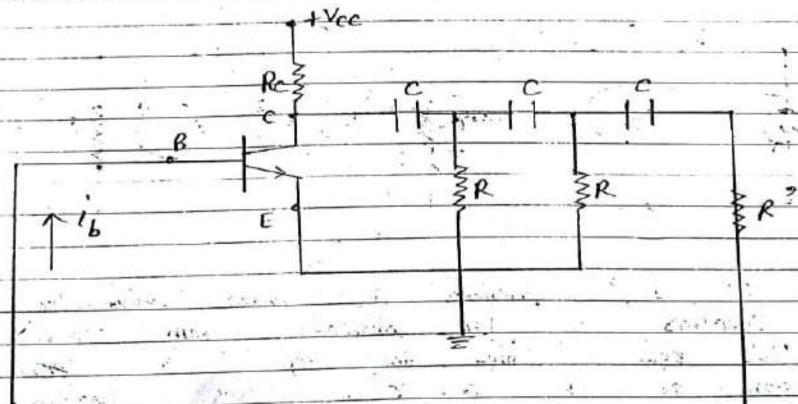

$$\frac{V_o}{V_i} = \frac{R}{R + 1/j\omega C} = \frac{j\omega CR}{1 + j\omega CR}$$

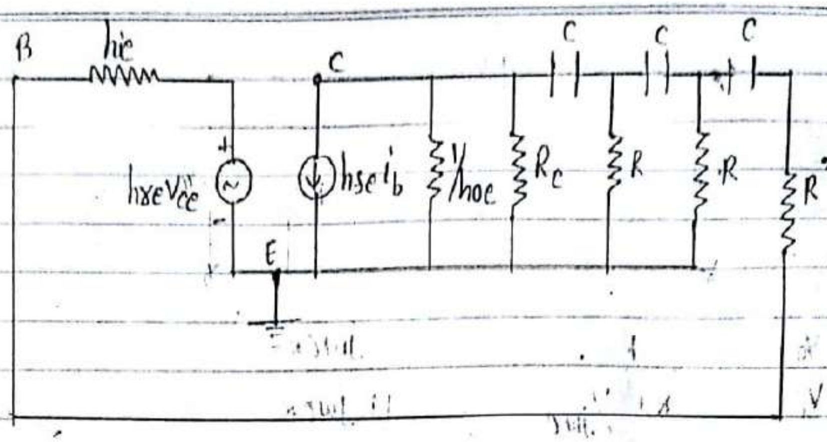
$$= \frac{\omega CR \angle 90^\circ}{\sqrt{1+\omega^2C^2R^2} \angle \tan^{-1}\omega CR} = \frac{\omega CR}{\sqrt{1+\omega^2C^2R^2}} \angle 90^\circ - \tan^{-1}\omega CR$$

$\phi = 90^\circ - \tan^{-1}\omega CR$

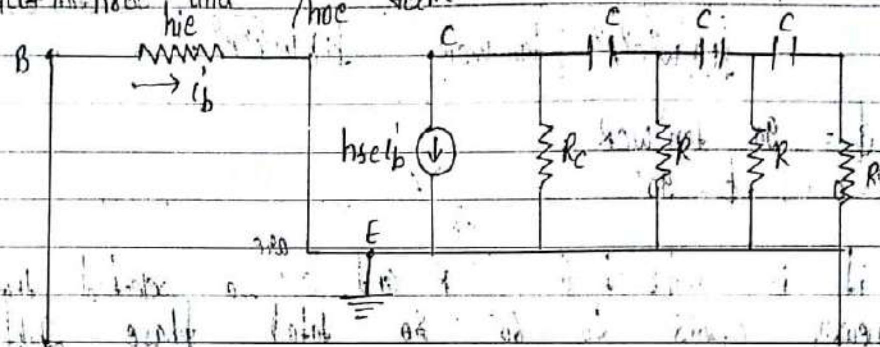
for $R = 0$, $\phi = 90^\circ$

but it is impractical, R and C are so selected that $\phi$ is nearly equals to $60^\circ$, so total phase shift required is $180^\circ$, so three such sections are connected in cascade.

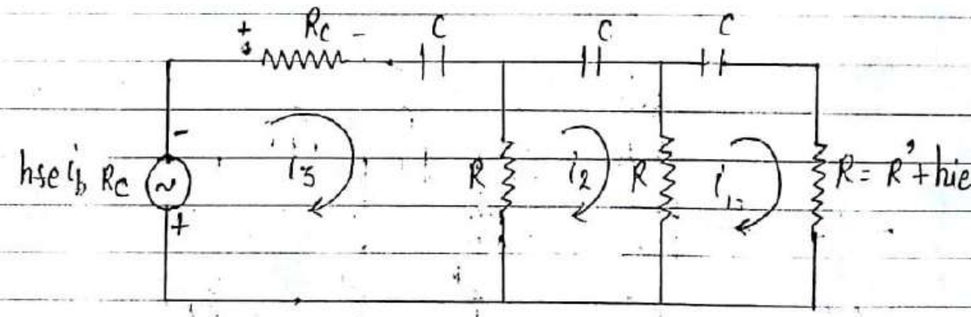





neglect hre and 1/hoe term




Convert norton form in thevinin form →




Working →

CE amp^r provides a phase shift of 180°, so o/p at collector is 180° shifted from i/p at base. Remaining 180° phase shift to o/p is provided by three section of R and C. every section provides

KVL for loop - ①

$i_1\left(\frac{1}{j\omega c} + R\right) + (i_1 - i_2)R = 0$

$\Rightarrow i_1\left(\frac{1}{j\omega c} + 2R\right) + i_2(-R) = 0$ ——— (i)

KVL for loop - ②

$i_2\left(\frac{1}{j\omega c}\right) + (i_2 - i_1)R + (i_2 - i_3)R = 0$ ——— (ii)

KVL for loop - ③

$\Rightarrow h_{fe} i_1 R_C + i_3\left(R_C + \frac{1}{j\omega c}\right) + (i_3 - i_2)R = 0$

$i_1(h_{fe} R_C) + i_2(-R) + i_3\left(R_C + \frac{1}{j\omega c} + R\right) = 0$ —— (iii)

writing eqn (i), (ii), (iii) in matrix form →

$$\begin{bmatrix} \frac{1}{j\omega c} + 2R & -R & 0 \\ -R & \frac{1}{j\omega c} + 2R & -R \\ h_{fe} R_C & -R & \frac{1}{j\omega c} + R_C + R \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = 0$$

putting determinant of matrix to zero →

$$\Rightarrow \left(\frac{1}{j\omega c} + 2R\right)\left\{\left(\frac{1}{j\omega c} + 2R\right)\left(\frac{1}{j\omega c} + R + R_C\right) - R^2\right\} - (-R)\left\{(-R)\left(\frac{1}{j\omega c} + R + R_C\right) - (-R)(h_{fe} + R_C)\right\} = 0$$

equating imaginary part to zero.

$6R^2 - \frac{1}{\omega^2 c^2} + 4R_C R = 0$

$$\Rightarrow \omega = \frac{1}{RC\sqrt{6+4a}} \qquad \left(a = R_C/R\right)$$

Now equating real part to zero

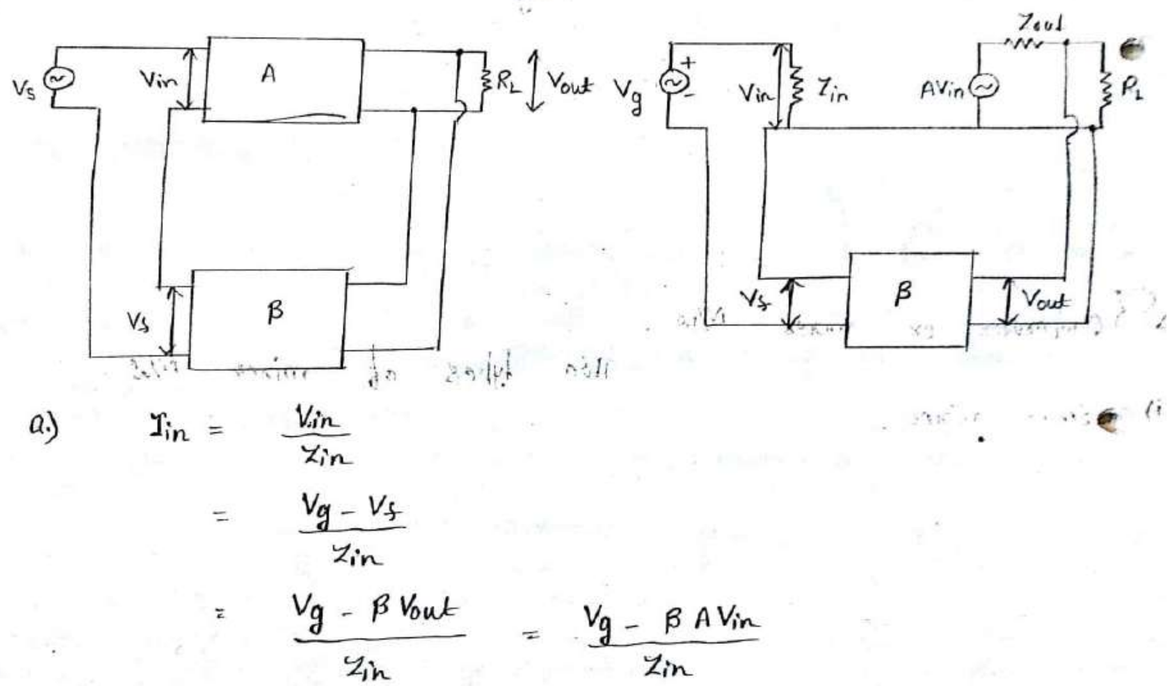
$$h_{fe} = 23 + 29\frac{R}{R_C} + 4\frac{R_C}{R}$$

$$= 23 + 29/a + 4a.$$

**OR**

**SOLUTION-1**

i) Voltage- series f/b →




a.) $$I_{in} = \frac{V_{in}}{Z_{in}}$$

$$= \frac{V_g - V_f}{Z_{in}}$$

$$= \frac{V_g - \beta V_{out}}{Z_{in}} = \frac{V_g - \beta A V_{in}}{Z_{in}}$$

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

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

$$Z_{inf} = Z_{in}(1+A\beta)$$

b) $V_{out} = I_{out} Z_{out} + A V_{in}$

$= I_{out} Z_{out} - AV_f \quad (V_{in} = -V_f)$

$= I_{out} Z_{out} - A(\beta V_{out})$

$V_{out} + A\beta V_{out} = I_{out} Z_{out}$

$V_{out}(1+A\beta) = I_{out} Z_{out}$

$$\frac{V_{out}}{I_{out}} = \frac{Z_{out}}{1+A\beta}$$

$$Z_{out,f} = \frac{Z_{out}}{1+A\beta}$$

**SOLUTION-2**

(6) Effect of Negative f/b on B.W:+

The voltage gain with f/b is given as

$$A_{vf} = \frac{A_v}{1+A_v\beta} \simeq \frac{1}{\beta} \text{ if } \beta A_v >> 1 \quad (1)$$

When negative f/b is applied in an amp^r, of (1+Aβ) while upper cut off freq. is raised by the same factor (1+Aβ).

(i) Lower cut-off freq $f_1$:- The voltage gain at a freq f in low freq. range of R-C coupled ampr is given as.

$$A_{vl} = \frac{A_{Vmid}}{1 - j\frac{f_1}{f}} \quad \text{—(1)}$$

where $f_1$ is the lower cut-off freq and $j = \sqrt{-1}$.

$A_{Vmid}$ = voltage gain in mid freq range
$A_{vl}$ = " " at low "
when negative f/b is applied

$$A_{vmf} = \cancel{\frac{A_{vm}}{1+\beta A_{vm}}} \quad \frac{A_{vm}}{1+\beta A_{vm}} \quad \text{—(2)}$$

and $A_{vlf} = \frac{A_{vl}}{1+\beta A_{vl}}$ —(3)

Substituting the value of $A_{vl}$ from eq (i) in eqn (3)

$$A_{vlf} = \frac{\dfrac{A_{vm}}{1 - j\frac{f_1}{f}}}{1 + \beta \dfrac{A_{vm}}{1 - j\frac{f_1}{f}}} = \frac{A_{vm}}{1 - j\frac{f_1}{f} + \beta A_{vm}}$$

or $A_{vlf} = \frac{A_{vm}}{\ldots}$

By dividing numerator and denominator by ~~1+AB~~ $1+\beta A_{vm}$, the eqn may be re-written as.

$$A_{vlf} = \frac{A_{vmf}}{1 - j\, f_1'/f} \quad \text{---} (4)$$

where $A_{vmf} = \dfrac{A_{vm}}{1+\beta A_{vm}}$ and $f_1' = f_1/1+\beta A_{vm}$ — (5)

So, the midband amplification with f/b $A_{vmf}$ equals the midband amplification without f/b divided by $1+A_{vm}\beta$. Also the lower freq. with f/b $f_1'$ equals the lower cutoff freq. without ~~fee~~ f/b $f_1$ divided by the same factor $(1+\beta A_{vm})$ i.e. lower cut off freq is reduced when negative f/b is applied.

(II) Upper cut-off frequency:-

The voltage gain at freq $f$ in the high frequency range of R-C coupled ampr is given by

$$A_{vh} = \frac{A_{vm}}{1 + j\frac{f}{f_2}} \quad \text{---} (1)$$

where $f_2$ = upper cut off freq. without using f/b.

$A_{vm}$ - Voltage gain in mid freq.

when negative f/b is applied

$$A_{v_{hf}} = \frac{A_{v_h}}{1+\beta A_{v_h}} \quad — (2)$$

substituting the value of $A_{v_h}$ from (1) to (2).

$$A_{v_{hf}} = \frac{\dfrac{A_{v_m}}{1+jf/f_2}}{1+\beta\dfrac{A_{v_m}}{1+j\frac{f}{f_2}}}$$

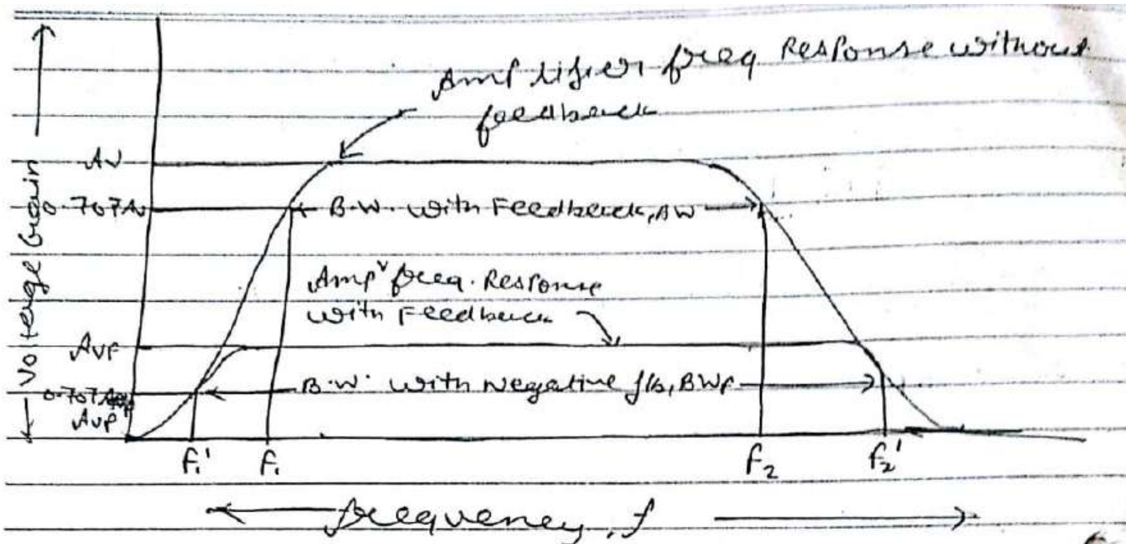
$$A_{v_{hf}} = \frac{A_{v_m}}{1+\beta A_{v_m} + j\frac{f}{f_2}}$$

By dividing the numerator and denominator by $1+\beta A_{v_m}$, the above eqn may be rewritten as

$$A_{v_{hf}} = \frac{A_{v_{mf}}}{1+jf/f_2'} \quad — (3)$$

where ~~$A_{v_{mf}} = A_v$~~

$$A_{v_{mf}} = \frac{A_{v_m}}{1+\beta A_{v_m}} \quad — (4)$$




* Amp^r Frequency Response with and without Negative feedback →

Thus we see that upper cutoff freq. equals the corresponding cut off freq. without f/b $f_2$ multiplied by the factor $(1+\beta A_{vm})$ i.e. upper cutoff freq. is raised when -ive f/b is applied in an amp^r.

* Bandwidth:- The B.W. with negative f/b is given as

$$BW_f = f_2' - f_1'$$
$$= f_2(1+\beta A_{vm}) - \frac{f_1}{1+\beta A_{vm}} \quad \text{—(1)}$$

It's very clear that $(f_2' - f_1') > (f_2 - f_1)$

and hence B.W. of amplifier with f/b is greater than B.W. of amp^r without feedback.

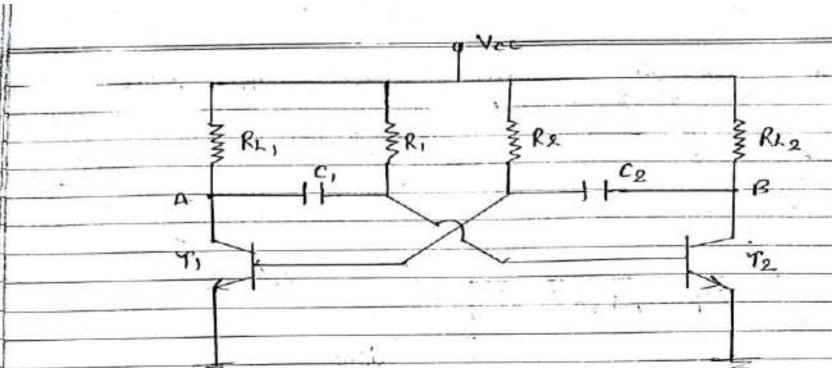
OR

**SOLUTION-2**

$T_{ON}$ $T_{off}$

c) 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 same 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 $R_1$, 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 $C_1$ became 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 $T_2$ →

$$t_1 = 0.69\, R_1 C_1$$

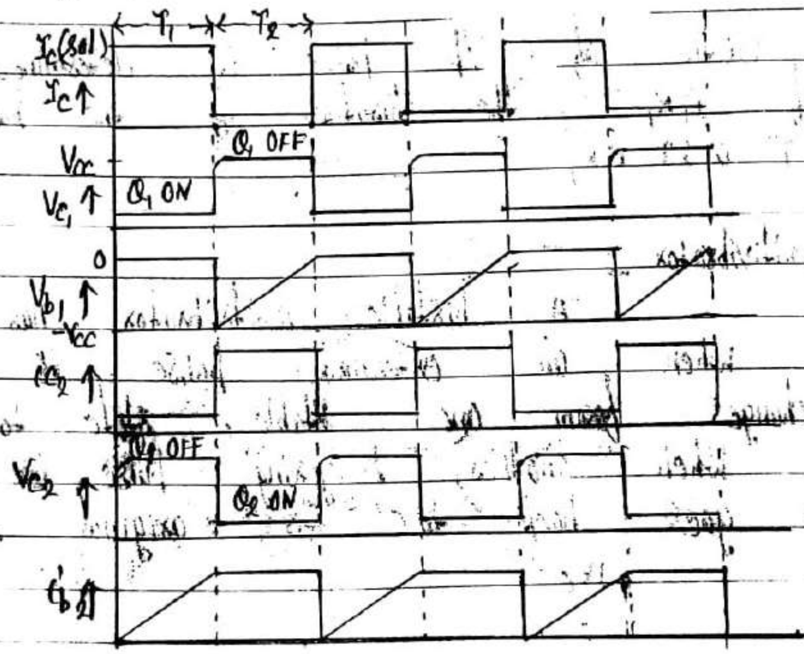
For ($T_2$) →

$t_2 = 0.69\ R_2 C_2$

Total time period of square wave,

$t = t_1 + t_2 = 0.69\ (R_1 C_1 + R_2 C_2)$

Freq$^n$ of square wave $f = 1/t$




**SOLUTION-3**

**Solution.** $A_v = 3000, \quad m_v = 0.01$

$\therefore$ Voltage gain with negative feedback is

$$A_{vf} = \frac{A_v}{1 + A_v\, m_v} = \frac{3000}{1 + 3000 \times 0.01} = \frac{3000}{31} = \mathbf{97}$$

OR

SOLUTION -3

**Solution.** $A_v = 140, \quad A_{vf} = 17.5$

Let $m_v$ be the feedback fraction. Voltage gain with negative feedback is

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

or $$17.5 = \frac{140}{1 + 140\, m_v}$$

or $$17.5 + 2450\, m_v = 140$$

$\therefore$ $$m_v = \frac{140 - 17.5}{2450} = \mathbf{\frac{1}{20}}$$

SOLUTION-4

**Solution.** $L_1 = 58.6\ \mu H = 58.6 \times 10^{-6}\ H$

$C_1 = 300\ pF = 300 \times 10^{-12}\ F$

Frequency of oscillations, $$f = \frac{1}{2\pi\sqrt{L_1 C_1}}$$

$$= \frac{1}{2\pi\sqrt{58.6 \times 10^{-6} \times 300 \times 10^{-12}}}\ \text{Hz}$$

$$= 1199 \times 10^{3}\ \text{Hz} = \mathbf{1199\ kHz}$$

OR

SOLUTION-4

**Solution.**

$R_1 = R_2 = R_3 = R = 1\ M\Omega = 10^6\ \Omega$

$C_1 = C_2 = C_3 = C = 68\ pF = 68 \times 10^{-12}\ F$

Frequency of oscillations is

$$f_o = \frac{1}{2\pi RC\sqrt{6}}$$

$$= \frac{1}{2\pi \times 10^6 \times 68 \times 10^{-12}\sqrt{6}}\ \text{Hz}$$

$$= \mathbf{954\ Hz}$$