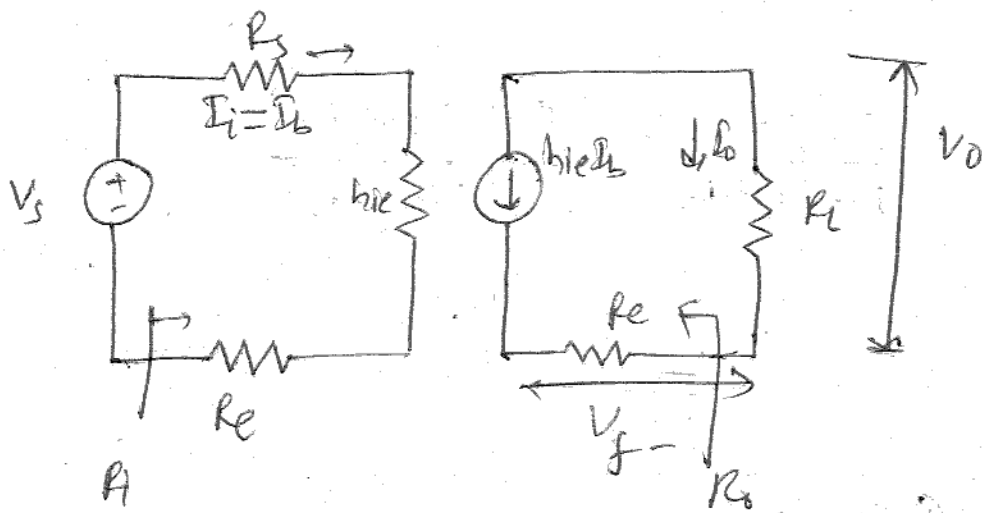


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$$A_{vf} = \frac{V_o}{V_s}$$

A_{vf} = gain voltage with feedback.

Voltage across load, $V_o = I_o R_L$

$$(b) \quad A_{vf} = \frac{I_o R_L}{V_s} = G_{mf} R_L$$

$$G_{mf} = \frac{I_o}{V_s} \quad \text{transconductance}$$

i) V_P resistance

$$R_i = R_s + h_{ie} + R_e$$

ii) Input resistance with feedback,

$$R_{if} = R_i (1 + \beta G_{mf})$$

$$= R_i \times D$$

D = Desensitivity

$$\Rightarrow R_{if} = R_i \times D$$

$R_o = \infty$ (for open ckt).

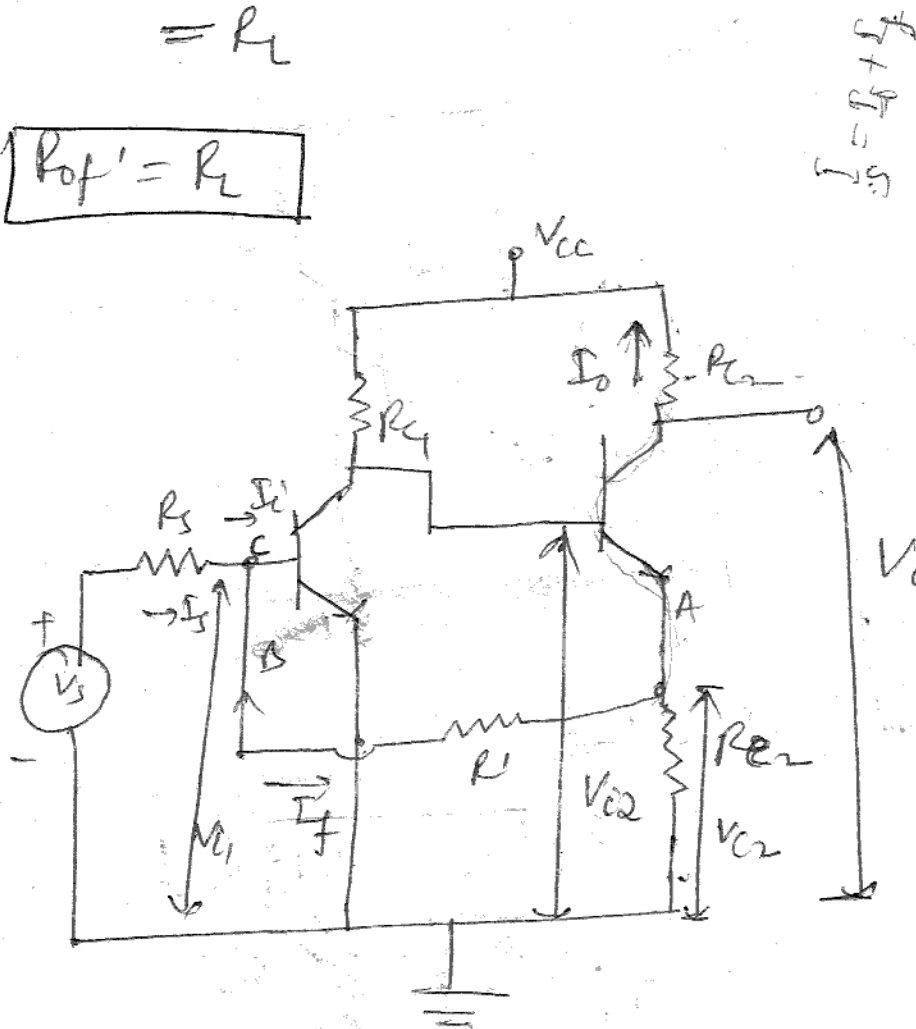
then, $R_{of} = \infty$

E/D/C

$$R_{of}' = R_{of} \parallel R_L = R_L$$

$$R_{of}' = R_L$$

$$I = \frac{V}{R}$$



Stage 1
 \Rightarrow It is current sampling.

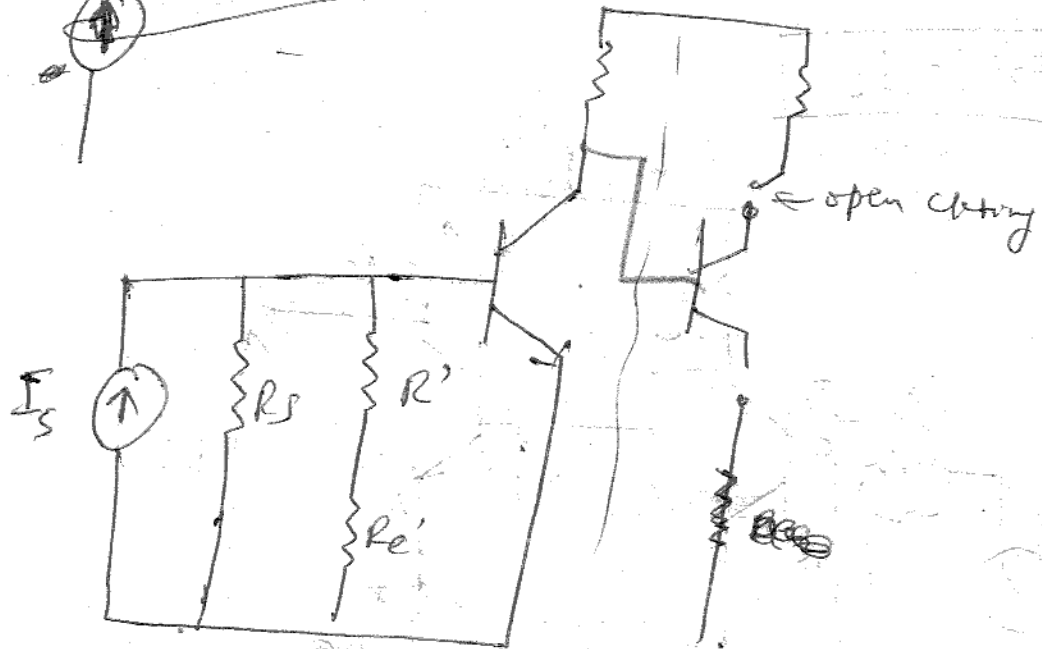
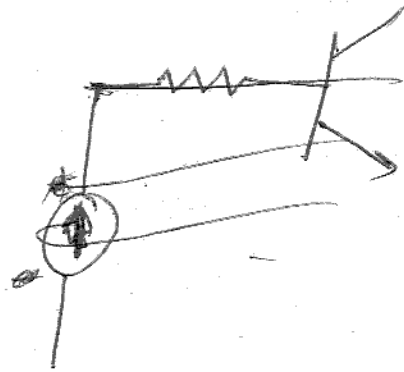
Since by making $I_o = 0$, i.e. open ckt, no current flows through A to B.

Stage 2 It is shunt mixing,
 Since at node c,
 apply KCL

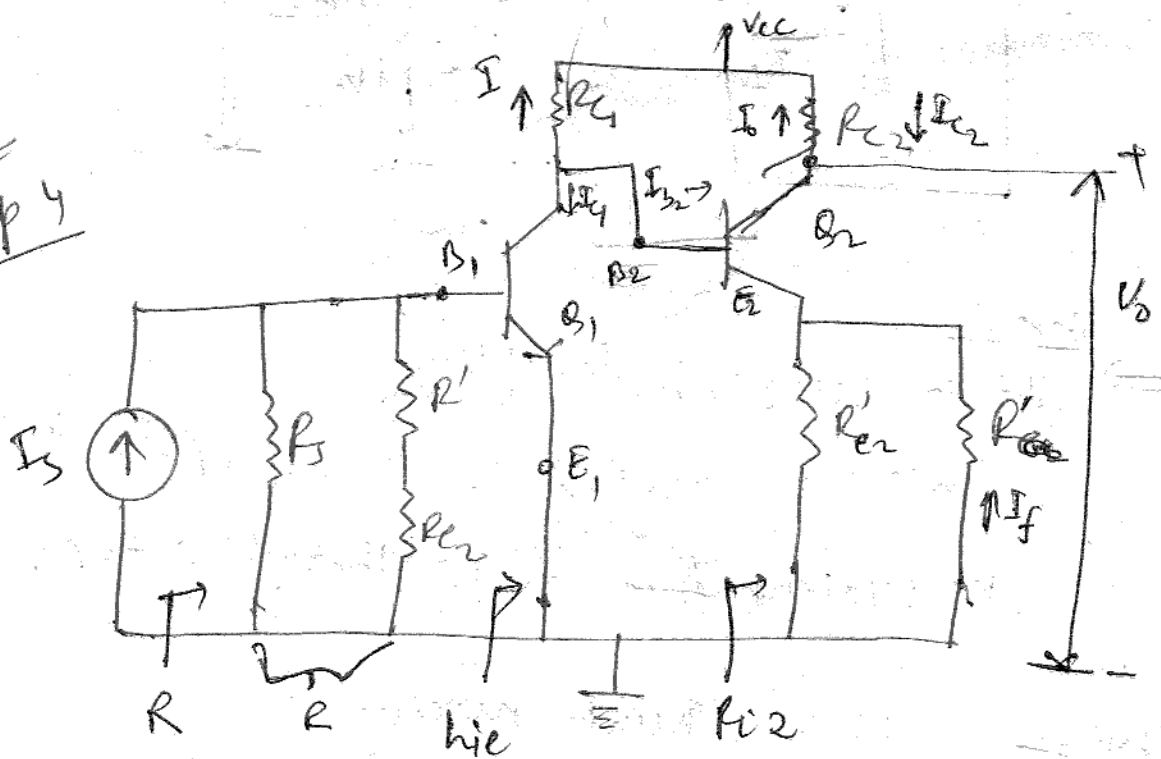
$$I_i = I_1 + I_2$$

$$\Rightarrow I_i = I_c - I_e$$

⇒ current shunt feedback amplifier



Step 4



$$\text{Gain} = \frac{O/P}{I/P} = \frac{I_o}{I_s} \Rightarrow A_I = \frac{I_o}{I_s}$$

$$A_I = \frac{-I_{C2}}{I_s}$$

$$= -\frac{I_{C2}}{I_{B2}} \times \frac{I_{B2}}{I_{C1}} \times \frac{I_{C1}}{I_{B1}} \times \frac{I_{B1}}{I_s}$$

h_{fe} = forward current gain transfer ratio

$$\frac{I_{C2}}{I_{B2}} = h_{fe} \quad \& \quad \frac{I_{C1}}{I_{B1}} = h_{fe}$$

$$A_I = -h_{fe} \times \frac{I_{B2}}{I_{C1}} \times h_{fe} \times \frac{I_{B1}}{I_s}$$

$$I_{B2} = \frac{I \times R_{C1}}{R_{C1} + R_{I2}} = -\frac{I_{C1} \times R_{C1}}{R_{C1} + R_{I2}}$$

$$\frac{I_{B2}}{I_{C1}} = -\frac{R_{C1}}{R_{C1} + R_{I2}}$$

$$\frac{I_{b1}}{I_s} = \frac{I_s \times R}{R + h_{ie}}$$

$$\frac{I_{b1}}{I_s} = \frac{R}{R + h_{ie}}$$

$$A_v = -h_{fe}^2 \times \left(\frac{-R_{c1}}{R_{c1} + R_{i2}} \right) \times \frac{R}{R + h_{ie}}$$

$$A_v = \frac{h_{fe}^2 \times R \times R_{c1}}{(R_{c1} + R_{i2})(R + h_{ie})}$$

$$\beta = \frac{I_f}{I_o} = \frac{I_f}{-I_E} \quad (\because I_o = -I_E)$$

$$\beta = \frac{I_f}{-I_E}$$

$$I_f = \frac{-I_E \times R_{E2}}{R_{E2} + R'}$$

$$\beta = \frac{I_f}{-I_E}$$

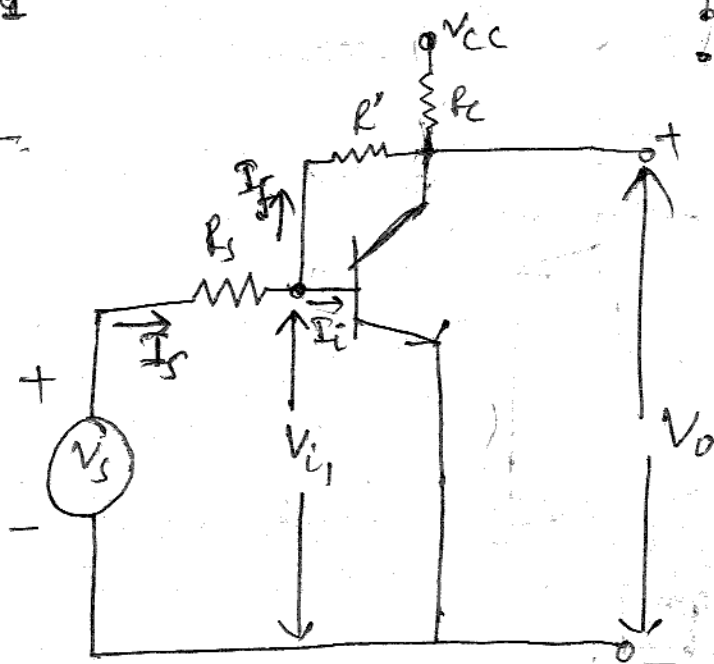
$$\beta = \frac{-I_E \times R_{E2}}{R_{E2} + R'} \times \frac{1}{-I_E}$$

$$\beta = \frac{R_c}{R_c + R'}$$

$$D = (1 + \beta) (1 + \beta A_I)$$

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Voltage shunt

Stage 2

Mixing n/w

Apply KVL

$$V_s - I_s R_s + I_f R' = 0$$

$$\Rightarrow V_s + V_f = I_s R_s$$

Instead of feedback signal subtracted from externally applied signal, it is added. So it is not series mixing. It is shunt mixing.

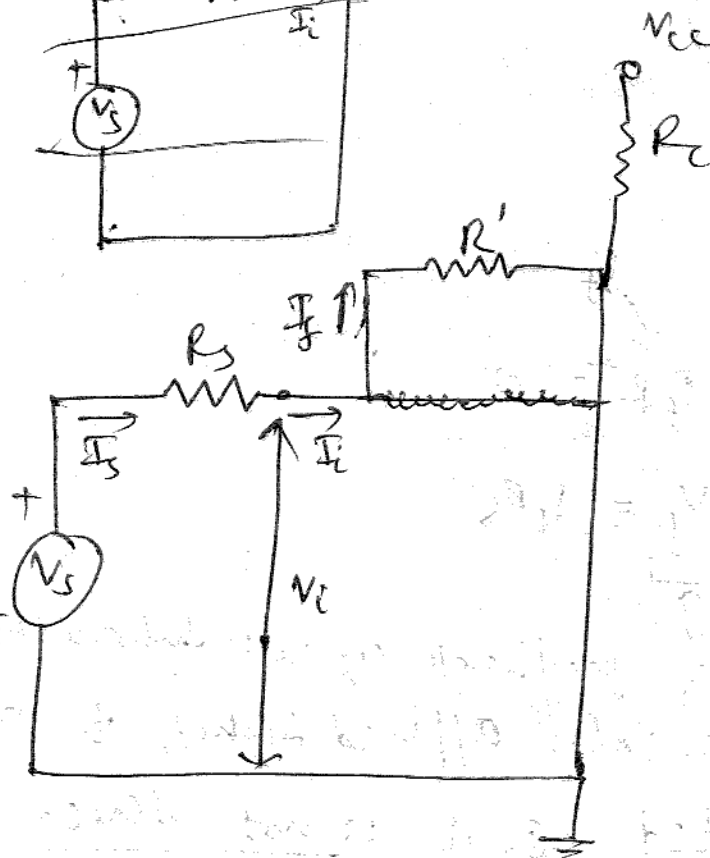
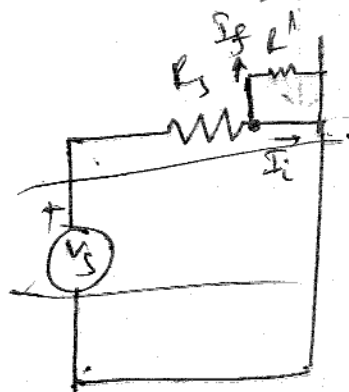
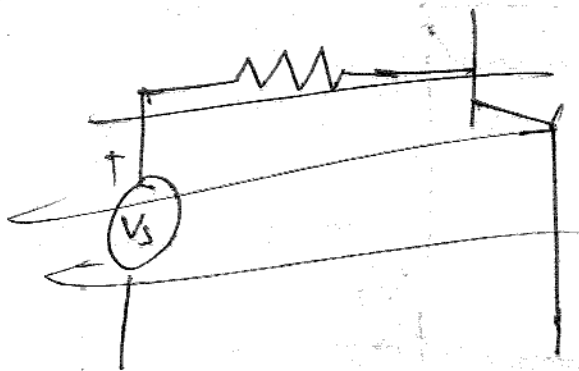
Applying KCL

$$I_S = I_i + I_f$$

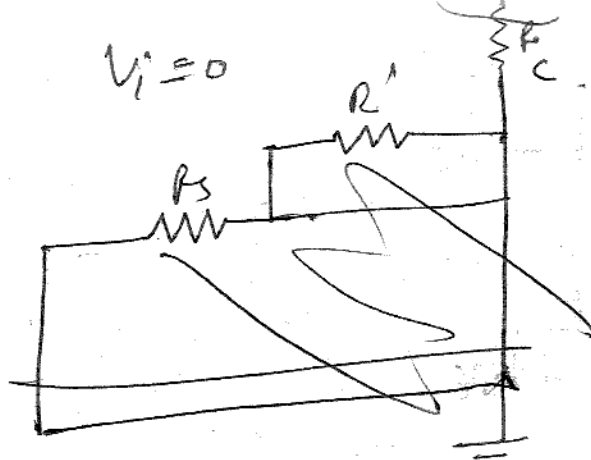
$$\Rightarrow I_S - I_f = I_i$$

\Rightarrow ~~error~~ shunt mixing

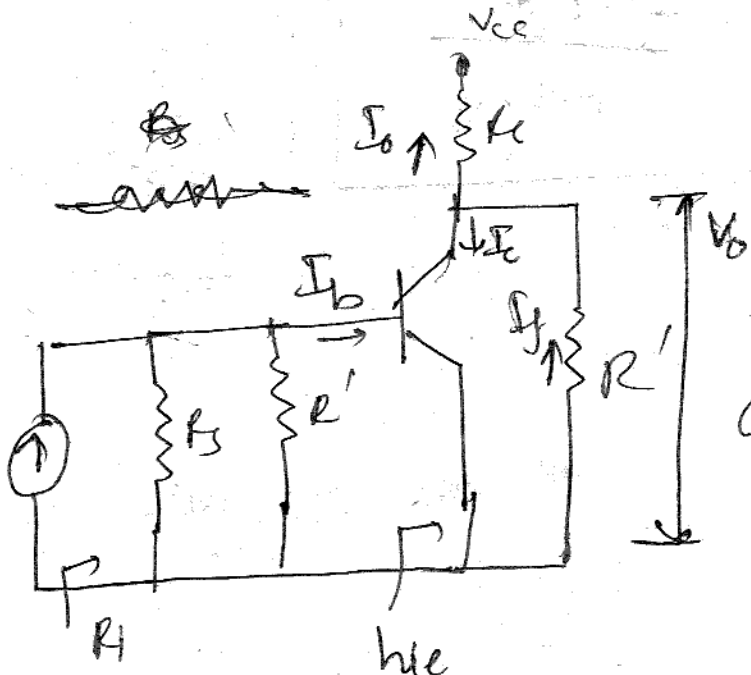
Step 2



Step 3



Step 4



t/p Current
o/p voltage.

Gain, $R_m = \frac{V_o}{I_i}$

$\Rightarrow V_o = R_m I_i$

also $V_o = I_f R'$

$$R_m = \frac{I_f R'}{I_{es}} = \frac{-I_o R'}{I} = \frac{-\beta R'}{\beta}$$

$$-\frac{\beta}{\beta} = \frac{-\beta}{I_b} \times \frac{I_b}{I_f} \quad \frac{\beta}{I_b} = h_{ie}$$

$$I_b = \frac{I_g \times R}{R + h_{ie}}$$

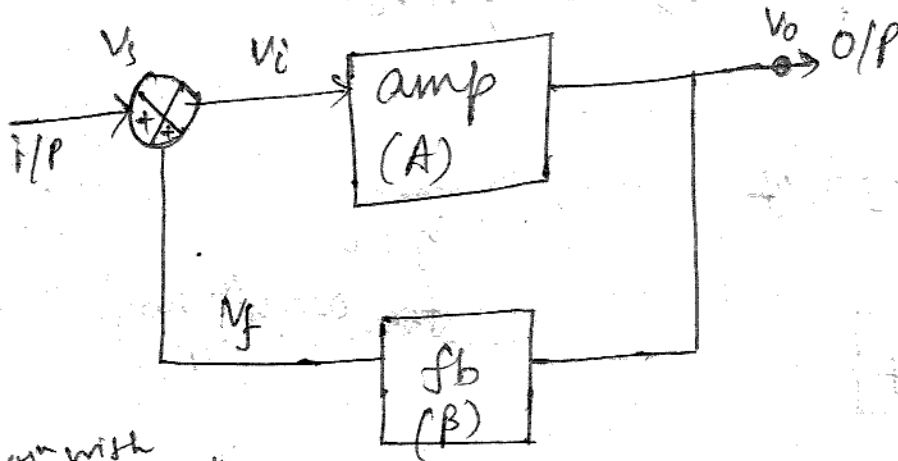
$$\frac{I_b}{I_g} = \frac{R}{R + h_{ie}}$$

$$\frac{I_c}{I_g} = \frac{-h_{ie} R}{R + h_{ie}}$$

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UNIT 2

OSCILLATORS

OSCILLATORS

gain with feedback

$$A_f = \frac{V_o}{V_s}$$

$$V_{in} = V_s + V_f = V_s + \beta V_o \Rightarrow \boxed{V_s = V_i - \beta V_o}$$

$$V_s =$$

$$\therefore A_f = \frac{V_o}{V_s}$$

$$= \frac{V_o}{V_i - \beta V_o}$$

$$= \frac{\frac{V_o}{V_i}}{1 - \beta \frac{V_o}{V_i}}$$

for oscillator

→ positive feedback

without i/p o/p is obtained

→ Dc Power supply & i/p.

$$\boxed{A_f = \frac{A}{1 - \beta A}}$$

$$\text{where } A = \frac{V_o}{V_i}$$

$$V_f = \beta V_o$$

$$V_o = A V_i$$

$$\therefore V_f = \beta (A V_i) = \beta A V_i$$

$$V_i = V_s + V_f$$

$$(\because V_s = 0$$

for oscillⁿ no
I/P)

$$\Rightarrow \boxed{V_i = V_f}$$

$$V_i = \beta A V_i$$

$$\Rightarrow$$

$$\boxed{\begin{array}{l} \beta A = 1 \\ |\beta A| = 1 \end{array}}$$

β = feedback factor.

A = amplifier gain

\Rightarrow for oscillators,

$$\boxed{\phi = 0^\circ, \text{ or } 360^\circ, \text{ or multiple of } 2\pi}$$

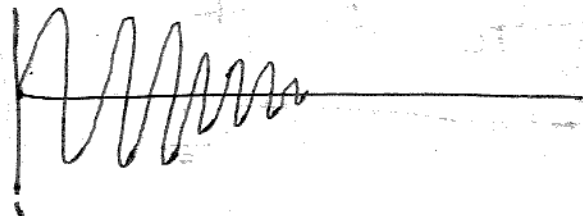
$$\boxed{|\beta A| = 1}$$

Barkhausen
Criterion.

2) If $\beta A < 1$

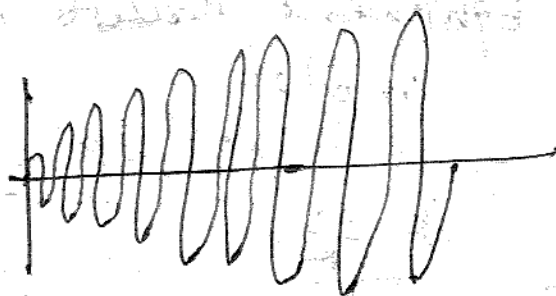
then

\Rightarrow

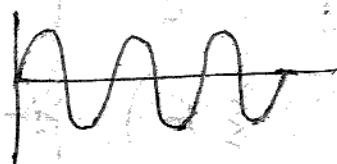


3) If $\beta A > 1$

then,

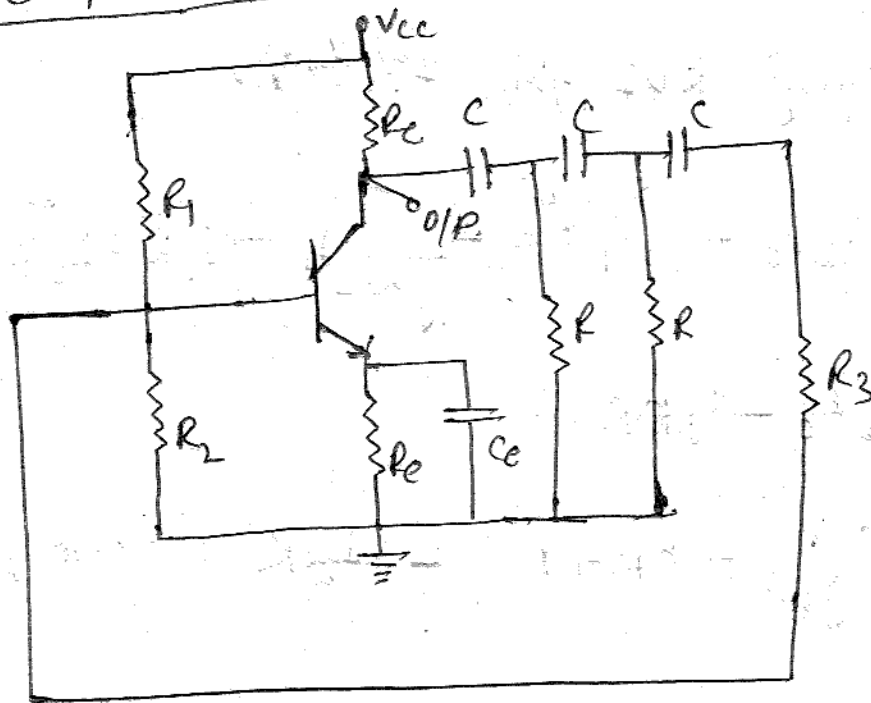


4) If $\beta A = 1$,



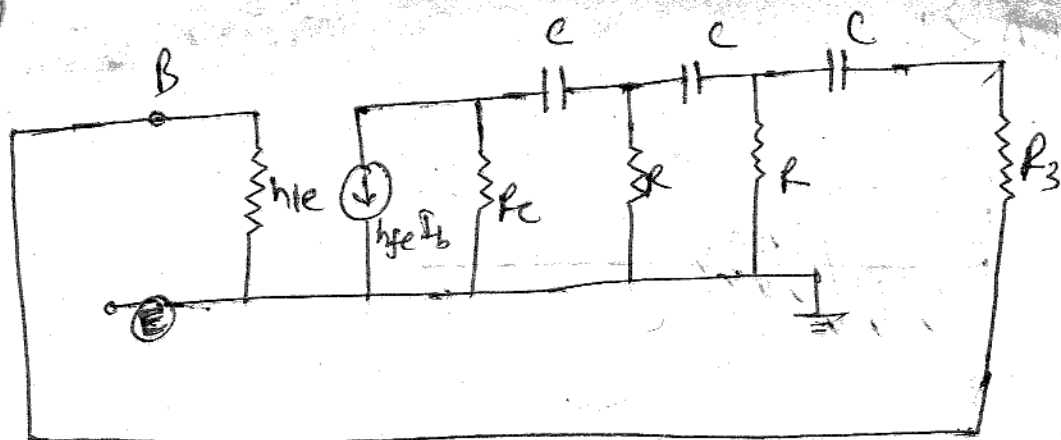
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RC Phase Shift Oscillator

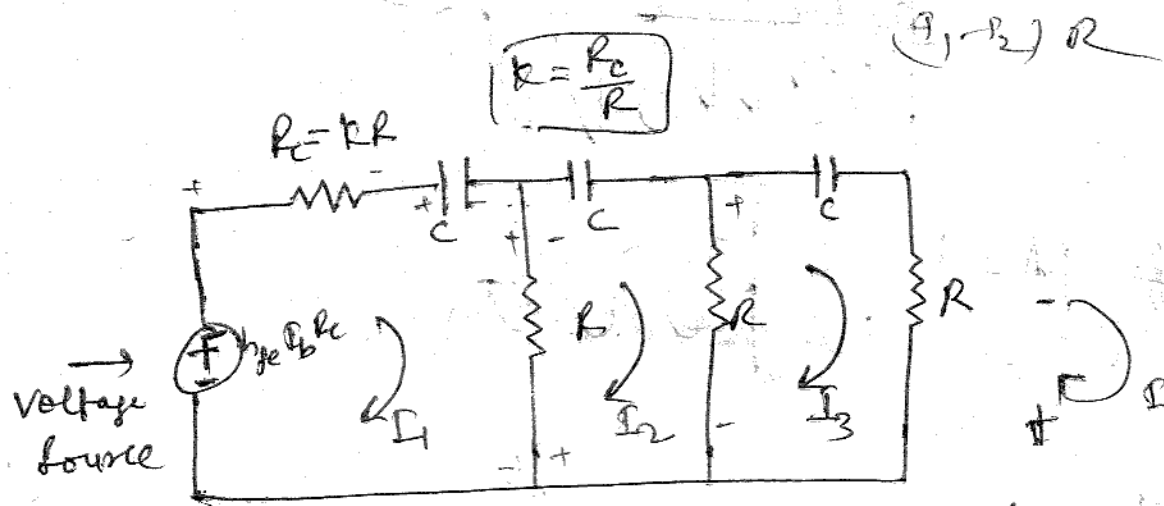


$$h_{ie} + R_3 = R$$

(B)



↑ Equivalent circuit h-parameter model.



⇒ modified h-parameter model.

Step 1:- Applying KVL for 1st loop,

$$\Rightarrow -h_{fe} I_b R_c - I_1 kR - \frac{1}{j\omega C} I_1 - I_1 R + I_2 R = 0$$

$$\Rightarrow -h_{fe} I_b R_c - I_1 kR$$

$$\Rightarrow I_1 \left(\frac{1}{j\omega C} + kR + R \right) - I_2 R = -h_{fe} I_b R_c$$

sub $j\omega \rightarrow s$

$$\Rightarrow I_1 \left(\frac{1}{sC} + kR + R \right) - I_2 R = -h_{fe} I_b R_c$$

$$\Rightarrow I_1 \left[(R+1)R + \frac{1}{sC} \right] - I_2 R = -h_{fe} I_b R_c \quad \text{--- (1)}$$

loop 2

$$-\frac{1}{j\omega C} I_2 - I_2 R + I_3 R + \cancel{I_2 R} - I_2 R + I_1 R = 0$$

$$\Rightarrow \frac{1}{j\omega C} I_2 + I_2 R - I_3 R + I_2 R - I_1 R = 0$$

$$\Rightarrow -I_1 R + I_2 \left(\frac{1}{j\omega C} + 2R \right) - I_3 R = 0 \quad \text{--- (2)}$$

$$\Rightarrow \text{Put } j\omega = s$$

$$\Rightarrow -I_1 R + I_2 \left(\frac{1}{sC} + 2R \right) - I_3 R = 0 \quad \text{--- (2) eqn}$$

$$\Rightarrow -I_3 R - I_3 R + I_2 R = 0$$

for loop 3

$$-\frac{1}{sC} I_3 - I_3 R - I_3 R + I_2 R = 0$$

$$\Rightarrow -I_2 R + I_3 \left(2R + \frac{1}{sC} \right) = 0 \quad \text{--- (3) eqn}$$

By Cramer's rule

	Coeff of I_1	I_2	I_3
for ①	$(K+1)R + \frac{1}{sC}$	$-R$	0
②	0	$(2R + \frac{1}{sC})$	$-R$
③	0	$-R$	$2R + \frac{1}{sC}$

$$I_1 = \frac{\begin{vmatrix} (2R + \frac{1}{sC})^2 - R^2 \\ (K+1)R + \frac{1}{sC} \end{vmatrix}}{\begin{vmatrix} (2R + \frac{1}{sC})^2 - R^2 \\ (K+1)R + \frac{1}{sC} \end{vmatrix}}$$

$$= \frac{4R^2 + \frac{1}{(sC)^2} + \frac{4R}{sC} - R^2}{(sC)^2}$$

$$= \frac{3R^2 + \frac{1}{(sC)^2}}{(sC)^2}$$

$$= \left[(K+1)R + \frac{1}{sC} \right] \left[3R^2 + \left(\frac{1}{sC} \right)^2 + \frac{4R}{sC} \right]$$

$$= \left[KR + R + \frac{1}{sC} \right] \left[3R^2 + \left(\frac{1}{sC} \right)^2 + \frac{4R}{sC} \right]$$

$$= 3KR^3 + \frac{KR}{s^2C^2} + \frac{4KR^2}{sC} + 3R^3 + \frac{R}{s^2C^2}$$

$$+ \frac{4R^2}{sC}$$

$$+ \frac{3R^2}{s^2C^2} + \frac{1}{s^2C^2} + \frac{4R}{sC}$$

$$= 3KR^3 + 3R^3 + \frac{4KR^2}{sc} + \frac{4R^2}{sc} + \frac{3R^2}{sc} +$$

$$\frac{KR}{s^2c^2} + \frac{R}{s^2c^2} + \frac{4R}{(sc)^2} + \frac{1}{(sc)^3}$$

$$\begin{aligned} &= \frac{s^3c^3R^3(4K+4) + s^2c^2R^2(4K+8) + sRc(5+K) + 1 - [2R^2 + sR^3c + KsR^3c]s^2c^2}{s^3c^3} \end{aligned}$$

Ans.

$$= 3KR^3 + R^3 + \frac{4KR^2}{sc} + \frac{4R^2}{sc} + \frac{3R^2}{sc} + \frac{KR}{s^2c^2} + \frac{R}{s^2c^2} + \frac{4R}{s^2c^2} + \frac{1}{(sc)^3}$$

$$\begin{aligned} &= \frac{3KR^3s^3c^3 + 3R^3s^3c^3 + 4KR^2s^2c^2 + 4R^2s^2c^2 + 3R^2s^2c^2 + KRs c + Rsc + 4Rsc + 1}{s^3c^3} \end{aligned}$$

$$\left[\frac{4R}{sc} \right]$$

$$\left[\frac{4R}{sc} \right]$$

$$\frac{R}{s^2c^2}$$

$$\frac{R}{s^2c^2}$$

$$D_3 = \begin{vmatrix} (K+1)R + \frac{1}{sC} & -R & -h_{fe} I_b R \\ 0 & 2R + \frac{1}{sC} & 0 \\ 0 & -R & 0 \end{vmatrix}$$

$$D_3 = -h_{fe} I_b R_c (R^2 - 0 \times 2R + \frac{1}{sC}) =$$

$$= -h_{fe} I_b R_c (R^3)$$

$$D_3 = -h_{fe} I_b R^3$$

$$I_3 = \frac{D_3}{D}$$

$$= \frac{-h_{fe} I_b R^3 s^3 C^3}{s^3 R^3 (4K+4) + s^2 C^2 R^2 (4K+4) + s R C (5+K) + 1 - [2R^2 + s R C + K s R^3 C] s^2}$$

$I_3 \rightarrow$ o/p current of amp/ A_b .

$I_b \rightarrow$ i/p \rightarrow amp.

$h_{fe} I_b \rightarrow$ i/p current for f_b .

$$\text{gain } A = \frac{I_3}{I_b} = \frac{\text{o/p}}{\text{i/p}} = \frac{D_3 h_{fe}}{h_{fe} I_b}$$

$$\beta = \frac{\text{o/p}}{\text{i/p at feedback}} = \frac{I_3}{h_{fe} I_b}$$

$$A_B = \frac{I_3}{I_b}$$

$$A_B = \frac{h_{fe} \times I_3}{h_{fe} I_b} = \frac{I_3}{I_b}$$

$$A_B = \frac{I_3}{I_b}$$

$$= \frac{-h_{fe} k R^3 s^3 c^3}{[s^3 c^3 R^3 (3k+1) + s^2 c^2 R^4 (4k+6) + s c R (5+k) + 1]}$$

$$\text{put } s = j\omega$$

$$= \frac{-h_{fe} k R^3 (j^3 \omega^3) c^3}{[j^3 \omega^3 c^3 R^3 (3k+1) + j^2 \omega^2 c^2 R^4 (4k+6) + j\omega c R (5+k) + 1]}$$

$$= \frac{h_{fe} k R^3 j \omega^3 c^3}{[-j \omega^3 c^3 R^3 (3k+1) - \omega^2 c^2 R^4 (4k+6) + j\omega c R (5+k) + 1]}$$

$$= \frac{h_{fe} k R^3 j \omega^3 c^3}{[}$$

$$= \frac{h_{fe} R R^3 j\omega^3 C^3}{1 - \omega^2 C^2 R^2 (4R+6) + j\omega CR(5+10) - j\omega^3 C^3 R^3 (5R+1)}$$

$$= \frac{j\omega^3 R R^3 C^3 h_{fe}}{(1 - 4R\omega^2 C^2 R^2 - 6\omega^2 C^2 R^2) - j\omega [3R\omega^2 R^3 C^3 + \omega^2 R^3 C^3 - 5RC - 10RC]}$$

Divide nr & dr by $j\omega^3 R^3 C^3$

$$= \frac{K h_{fe}}{}$$

$$\left(\frac{-1}{\omega^3 R^3 C^3} + \frac{4Rj}{\omega RC} - \frac{6j}{\omega CR} \right)$$