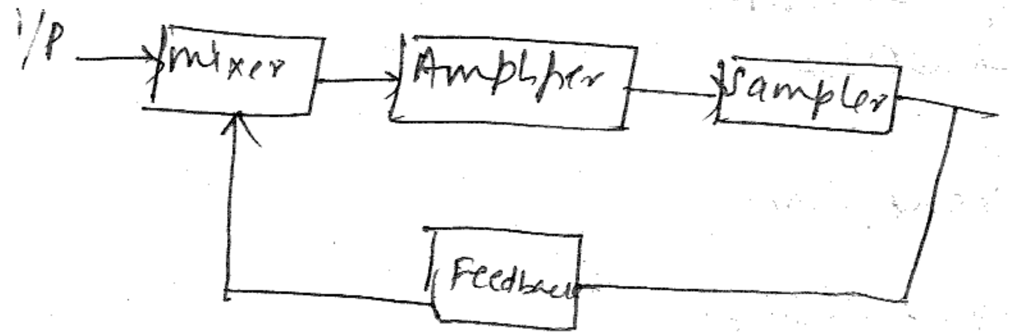
20/6/11 UNIT I FEEDBACK AMPLIFIER



(i) positive feedback :-
when i/p & sample o/p are in samephase.
⇒ used in oscillator.

(ii) negative feedback :- when i/p & sample o/p are in 180' out of phase.
⇒ used in Amplifiers.

	Gain
i) Voltage Amplifier	$A_V = \frac{V_o}{V_i}$
ii) Current Amplifier	$A_I = \frac{I_o}{I_i}$
iii) Transistance Amplifier	$R_m = \frac{V_o}{I_i}$ where R_m is gain
Transconductance Amplifier	$G_m = \frac{I_o}{V_i}$

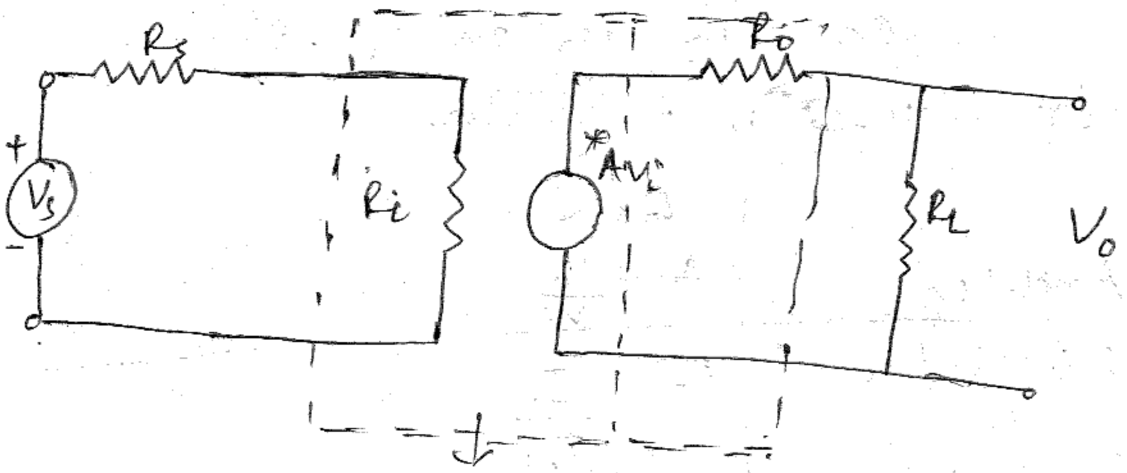
Feedback Amplifiers :-

(i) Voltage Series
(ii) Voltage Shunt
~~Current Series~~

(iii) Current series

(iv) Current Shunt

Hybrid Model for Voltage Amplifier :



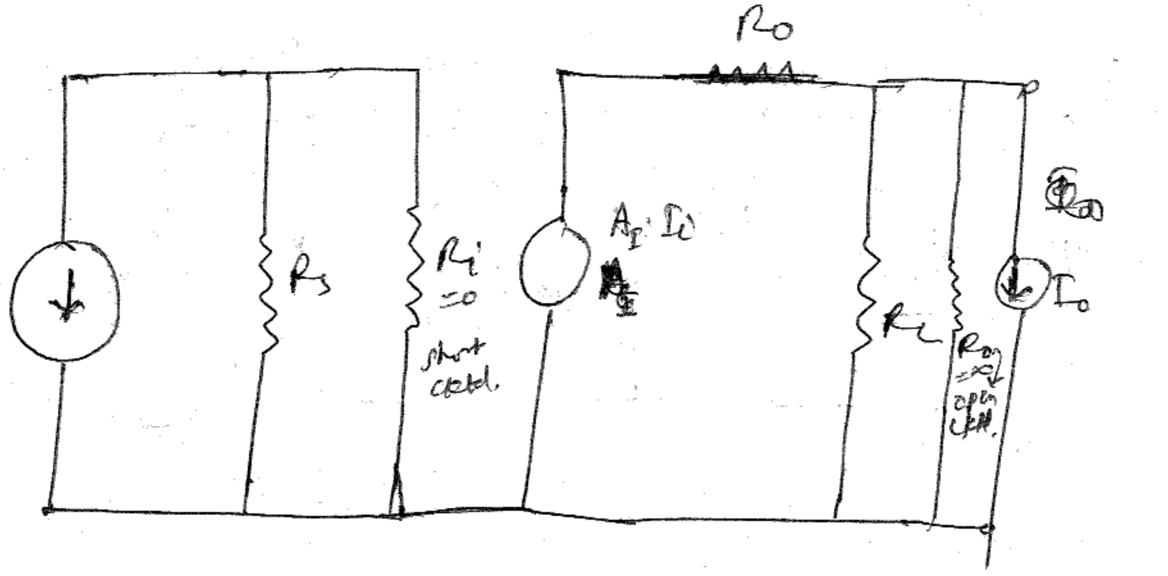
Amplifier Section

*A → Amplification factor

$$A_v = \frac{V_o}{V_i}$$

$$\Rightarrow \boxed{V_o = A_v V_i}$$

Current Amplifier Ckt:-



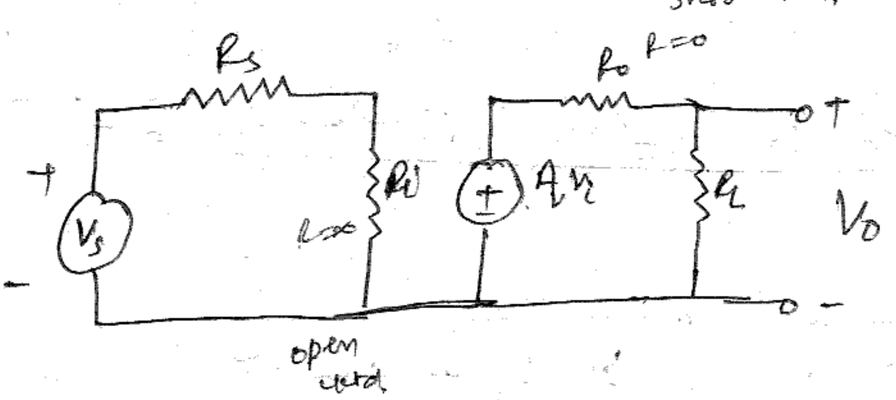
open ckt - High resistance
Short ckt - Low resistance.

$I_o = A_I \cdot I_i$

Transresi

21/6/11

Voltage Amplifier:-



O.C

$V_{in} \uparrow$

$I = 0$

$R = \infty$

S.C.

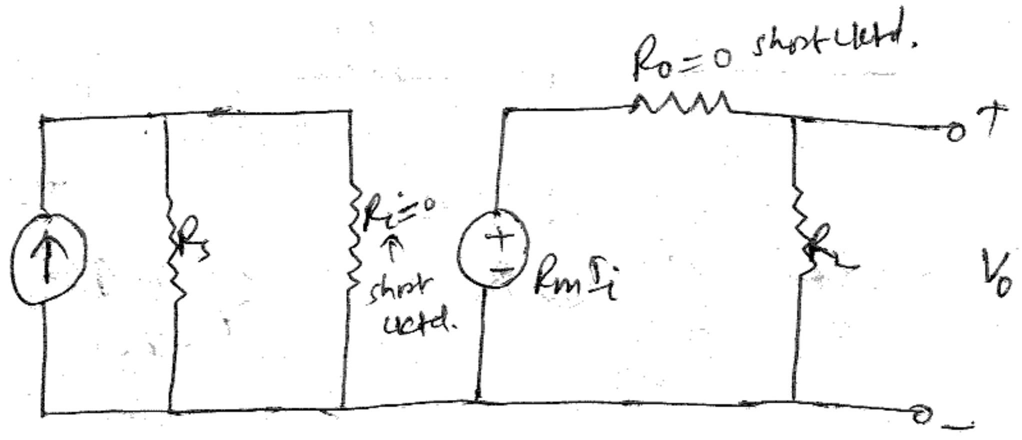
$V_i = 0$

$I = max$

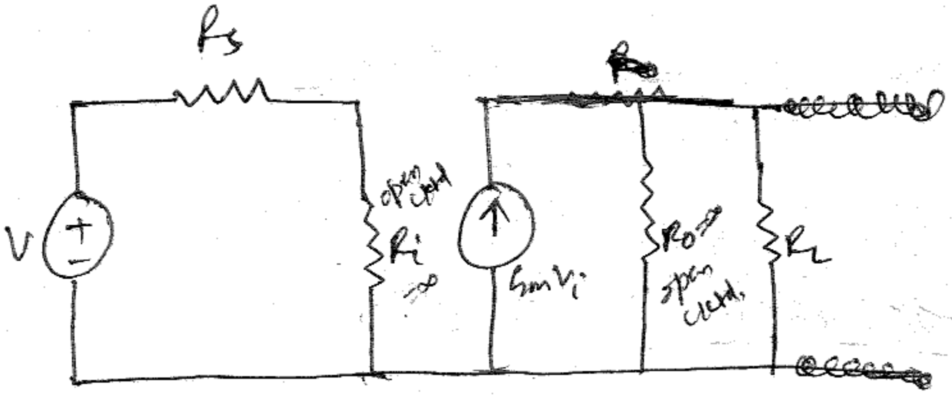
$R = 0$

Transresistance Amplifier :- $R_m = \frac{V_o}{I_i}$

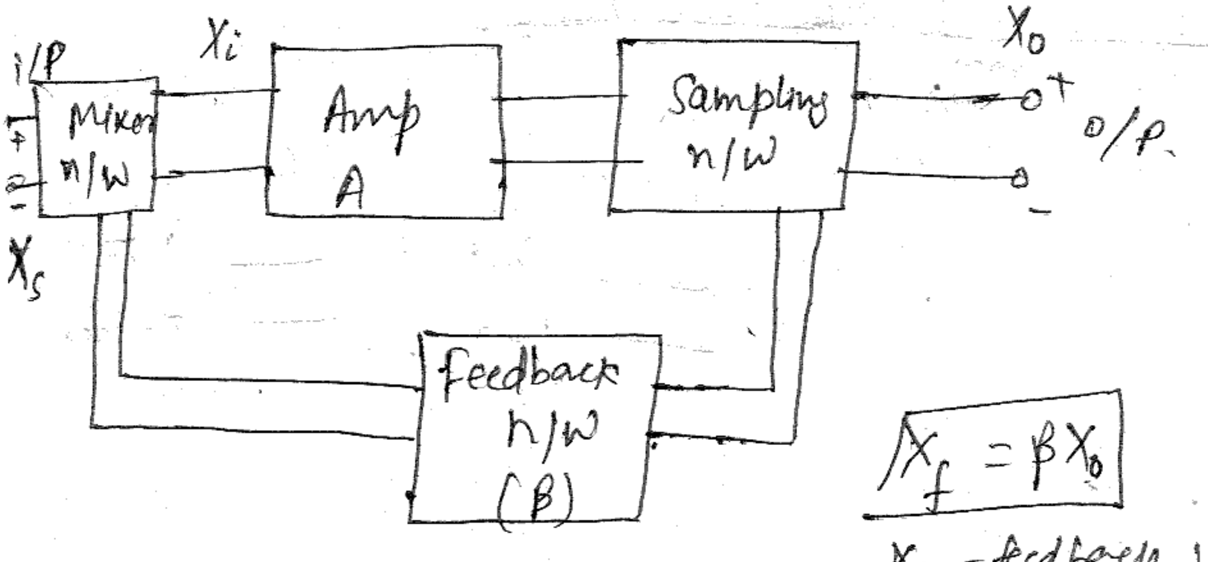
$I = \frac{V}{R}$



Transconductance Amplifier :- $G_m = \frac{I_o}{V_i}$



23/6/14 **Effect of Negative feedback :-**



$$\boxed{X_f = \beta X_o}$$

X_f = feedback voltage or current

$X_i = X_s + (-X_f)$ —①

where

$A_f = \frac{X_o}{X_s}$ —② , A_f = feedback amplifier gain

α =

β = feedback gain

feedback factor

A, Gain = $\frac{O/P}{I/P} = \frac{X_o}{X_i}$ gain without feedback or openloop ckt.

from ①,

$X_s = X_i + X_f$.

Sub these in ②

$$A_f = \frac{X_o}{X_s} = \frac{X_o}{X_i + X_f}$$

Dividing N^r & denom^r by X_i

$$A_f = \frac{X_o / X_i}{1 + \frac{X_f}{X_i}} \Rightarrow A_f = \frac{A}{1 + \frac{X_f}{X_i}}$$

$\because X_f = \beta X_o$

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

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

$\Rightarrow$ without ~~with~~ feedback A_f is more.

with feedback A_f is less.

Stability of gain

Step 1:- Write the gain of your feedback Amplifier.

$$\boxed{A_f = \frac{A}{1+\beta A}} \quad -(1)$$

Step 2 Diff (1) w.r.to A,

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

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

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

Step3 :-

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

Step4. Dividing both sides by A_f.

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

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

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

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

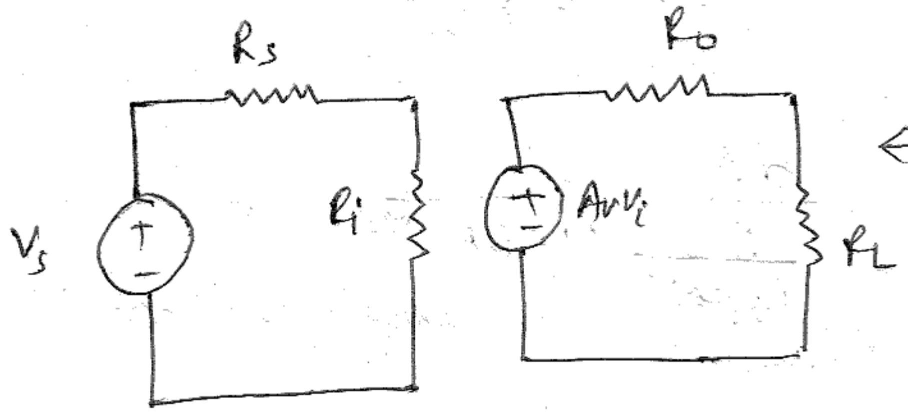
$$\boxed{S = \frac{\frac{dA_f}{A_f}}{\frac{dA}{A}} = \frac{1}{1+\beta A}}$$

S= sensitivity.

$$\boxed{\text{Desensitivity, } D = \frac{1}{S} = 1+\beta A}$$

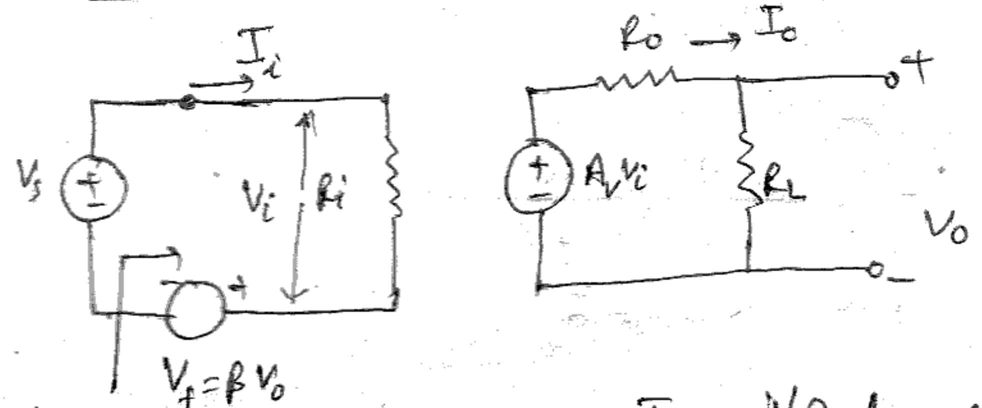
Effect of -ve feedback in I/P & O/P resistance :-

(1) Voltage series feedback Amplifier :-



← Voltage series Amplifier without feedback

Calculation of I/P resistance :-



$$\boxed{R_{if} = \frac{V_s}{I_i}}$$

I_i = I/P current

I_o = O/P current

R_{if} = I/P resistance with feedback

Applying KVL to I/P loop :-

Sum of all voltage sources = Sum of voltage drops.

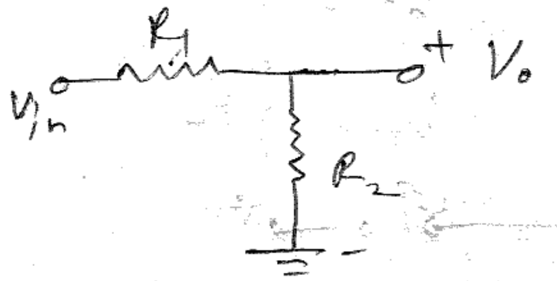
$$V_s - R_i I_i - V_f = 0$$

$$\Rightarrow V_s = R_i I_i + V_f$$

$\Rightarrow V_s = R_i I_i + \beta V_o \quad -①$

~~Applying KVL to O/P~~

Voltage Divider Rule



$$\boxed{V_O = \frac{V_{in} R_2}{R_1 + R_2}}$$

$$V_O = \frac{A_v V_i R_L}{R_o + R_L} \qquad \text{where, } AV = \frac{A_v R_L}{R_o + R_L}$$

$$= \left(\frac{A_v R_L}{R_o + R_L}\right) V_i = AV \cdot V_i \quad -②$$

$$= AV \cdot (I_i R_i)$$

Put ② in ①

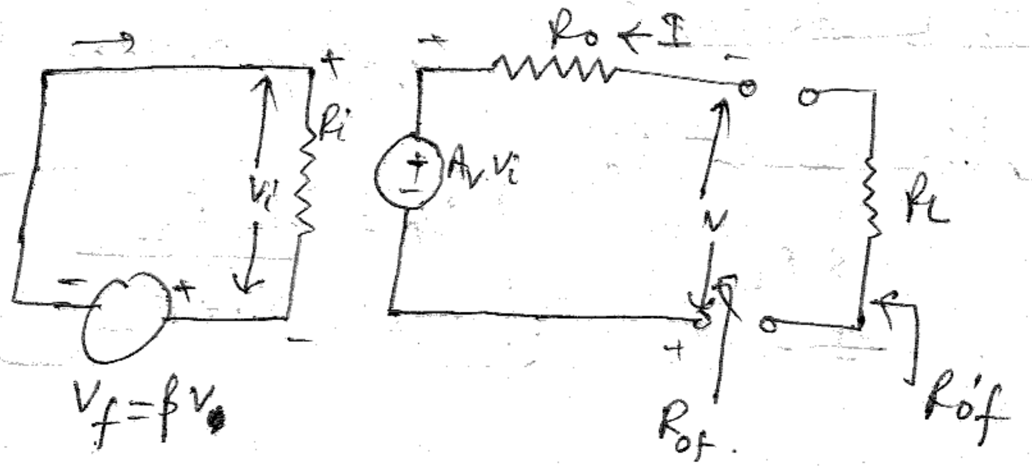
$$V_s = R_i I_i + \beta \cdot AV \cdot I_i R_i$$

$$= R_i I_i (1 + \beta AV)$$

$$\therefore R_{if} = \frac{V_s}{I_i} = \frac{R_i \cancel{I_i} (1 + \beta AV)}{\cancel{I_i}}$$

$$\boxed{R_{if} = R_i (1 + \beta AV)}$$

Calculation of O/P resistance :-



Make source = 0
and disconnect load resistance

Applying KVL to O/P loop

$$A_v V_i + I R_o - V = 0$$

$$\Rightarrow \cancel{A_v V_i - V = I R_o}$$

$$\Rightarrow \underline{I =}$$

$$I R_o = V - A_v V_i$$

$$I = \frac{V - A_v V_i}{R_o}$$

applying
I/P KVL

$$-V_i - V_f = 0$$

$$\Rightarrow V_i = -V_f = -\beta V_o$$

$$\Rightarrow V_i = -\beta V_o$$

$$I = \frac{V - A_i(-\beta V_o)}{R_o}$$

$$= \frac{V + \beta A_i V_o}{R_o}$$

$$= \frac{V(1+\beta A_i)}{R_o}$$

$$\Rightarrow R_o = \frac{V}{I}(1+\beta A_i)$$

$$\Rightarrow \frac{V}{I} = \frac{R_o}{1+\beta A_i}$$

$$\Rightarrow \boxed{R_{of} = \frac{R_o}{1+\beta A_i}}$$

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

$$= \frac{R_{of} R_L}{R_{of} + R_L}$$

$$= \frac{\dfrac{R_o R_L}{1+\beta A_i}}{\dfrac{R_o}{1+\beta A_i} + R_L} = \frac{\dfrac{R_o R_L}{1+\beta A_i}}{\dfrac{R_o + R_L(1+\beta A_i)}{(1+\beta A_i)}}$$

$$= \frac{R_o R_L}{\cancel{1+\beta A_i}} \times \frac{\cancel{1+\beta A_i}}{R_o + R_L(1+\beta A_i)}$$

$$\boxed{R'_{of} = \frac{R_o R_L}{R_o + R_L(1+\beta A_i)}}$$

$$\Rightarrow R'_{of} = \frac{R_o R_L}{R_o + R_L + \beta A_v \cdot R_L}$$

Dividing N^r & denom^r by $(R_o + R_L)$

$$R'_{of} = \frac{\frac{R_o R_L}{R_o + R_L}}{\frac{R_o + R_L}{R_o + R_L} + \frac{\beta A_v \cdot R_L}{R_o + R_L}}$$

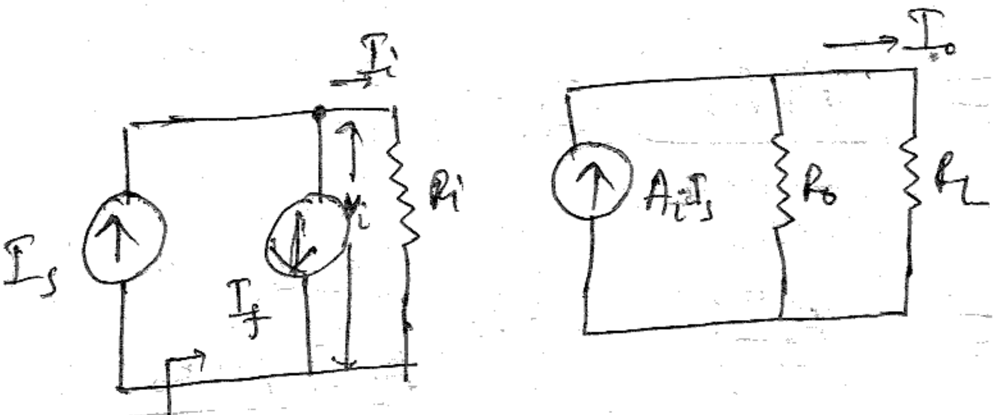
$$\boxed{R'_{of} = \frac{R'_o}{1 + \beta A_V}}$$

where,

$$R'_o = \frac{R_o R_L}{R_o + R_L}$$

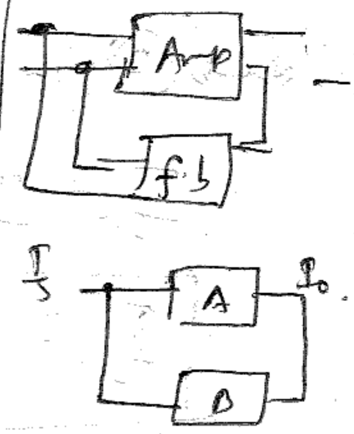
$$\& \; A_V = \frac{A_v \cdot R_L}{R_o + R_L}.$$

Current Shunt feedback Amplifier



$R_{if} = \frac{V_i}{I_s}$

$I_f = \beta I_o$



$I_f = \beta I_o$

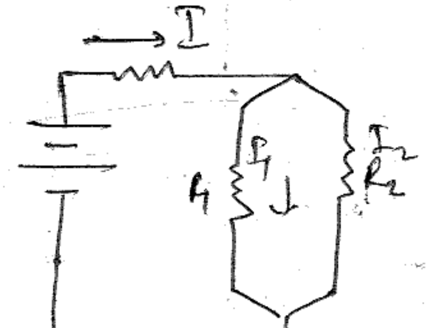
Applying KCL,

[Sum of incoming current = Sum of outgoing current]

$$I_s = I_f + I_i = \beta I_o + I_i \quad (i)$$

Current divider rule in o/p loop.

Current ~~across~~ flowing through R_1



$$\boxed{\begin{aligned} I_1 &= \frac{I R_2}{R_1 + R_2} \\ I_2 &= \frac{I R_1}{R_1 + R_2} \end{aligned}}$$

$$\therefore \quad I_o = \frac{A_i I_i R_o}{R_o + R_L}$$

$$= \left(\frac{A_i R_o}{R_o + R_L} \right) I_i$$

$$= A_I I_i$$

where, $A_I = \frac{A_i R_o}{R_o + R_L}$

$$\Rightarrow \boxed{I_o = A_I I_i} \quad — ②$$

Sub ② in ①

$$I_s = I_i + \beta (A_i I_i)$$

$$\boxed{I_s = I_i (1 + \beta A_i)}$$

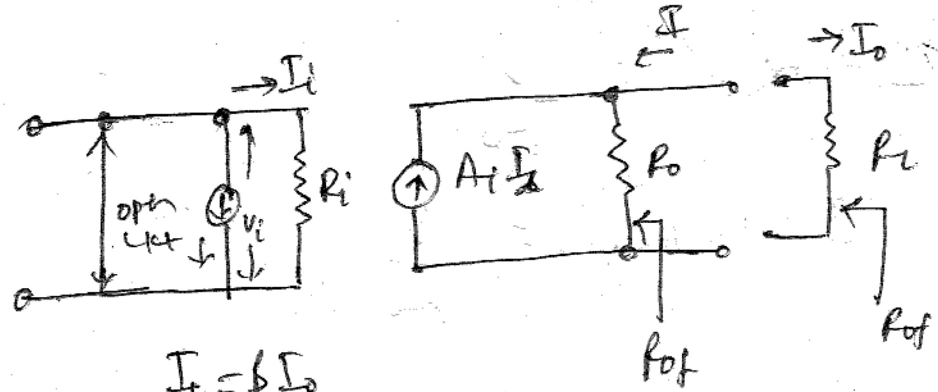
$$R_{if} = \frac{V_i}{I_s} = \frac{V_i}{I_i (1 + \beta A_i)}$$

$$\boxed{R_{if} = \frac{R_i}{1 + \beta A_i}}$$

where $R_i = \frac{V_i}{I_i}$

O/P resistance :-

Make source = 0
and disconnect the load resistance



$I_f = \beta I_o$

Applying KCL to o/p loop.

$$A_i I_i + I = \frac{V}{R_o}$$

$$\Rightarrow I = \frac{V}{R_o} - A_i I_i \quad \text{—(1)}$$

Applying KVL to i/p port,

$$I_f + I_i = 0$$

$$I_f = -I_i$$

$$\Rightarrow \beta I_o = -I_i$$

$$\Rightarrow I_i = -\beta I_o$$

$$= -\beta(-I)$$

$$I_i = \beta I \quad \text{—(2)}$$

Sub ② in ①

$$I = \frac{V}{R_o} - A_i \beta I$$

$$\Rightarrow I + A_i \beta I = \frac{V}{R_o}$$

$$\Rightarrow I(1 + A_i\beta) = \frac{V}{R_o}$$

$$\cancel{R_{of} = \frac{V}{R_{oi}}}$$

$$\Rightarrow \frac{V}{I} = R_o(1+\beta A_i)$$

$$\Rightarrow \boxed{R_{of} = R_o(1+\beta A_i)}$$

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

$$= \frac{R_{of} R_L}{R_{of} + R_L}$$

$$= \frac{R_o(1+\beta A_i) R_L}{R_o(1+\beta A_i) + R_L}$$

$$= \frac{R_o R_L (1+\beta A_i)}{R_o + R_L + \beta A_i R_o}$$

$$= \frac{\frac{R_o R_L}{R_o + R_L}(1+\beta A_i)}{\frac{R_o + R_L}{R_o + R_L} + \frac{\beta A_i R_o}{R_o + R_L}}$$

$$= \frac{R_o'(1+\beta A_i')}{1+\beta A_i I_i}$$