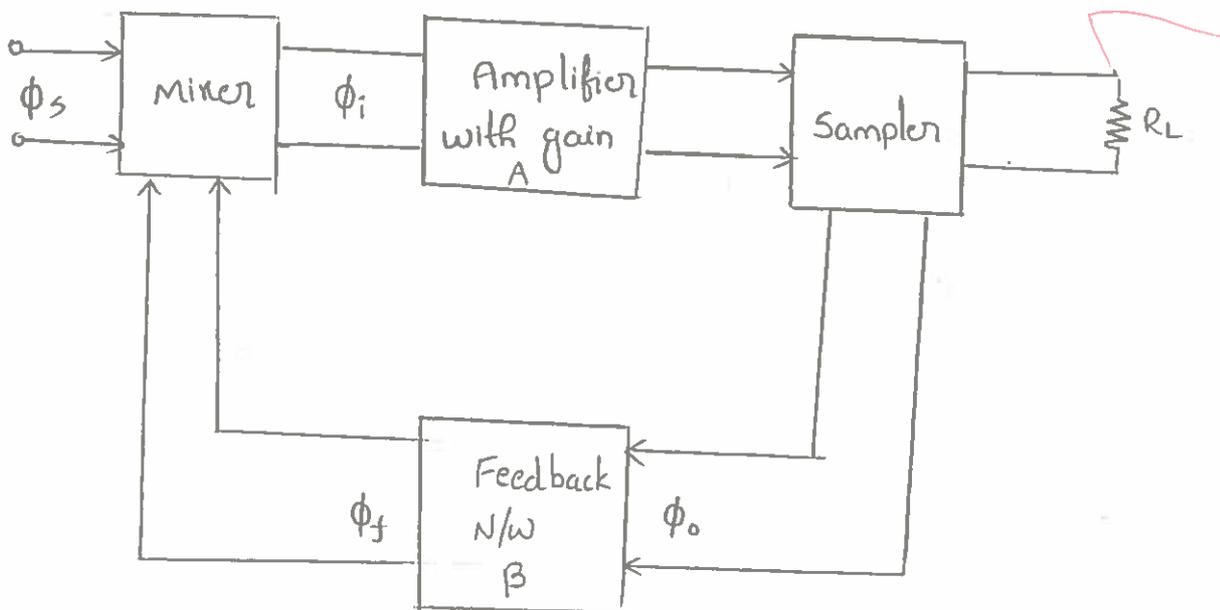


## Feedback Amplifiers...

Feedback plays a very important role in electronic circuits such as input impedance, output impedance, current gain, voltage gain and bandwidth may altered by use of feedback for a given amplifier.

In large signal amplifiers and electronic measuring instruments the major problem is distortion by using feedback, this distortion can be reduced.

Basic feedback circuit:-



The output quantity (either voltage or current) is sampled by a suitable sampler which is of 2 types, voltage sampler and current sampler and feed it to the feedback network selects the amount of output and sent that o/p to mixer circuit. The mixer circuit add or subtract feedback signal from source signal - mixer also known as comparator is of 2 types series mixer and shunt mixer.

The parameters  $A$ , gain without feedback

$\phi_o \rightarrow$  o/p voltage or current

$\phi_f \rightarrow$  feedback voltage or current

$\beta \rightarrow$  feedback ratio

$$\beta = \frac{\phi_f}{\phi_o}$$

$\phi_s \rightarrow$  source signal

$\phi_i \rightarrow$  i/p signal

$A_f \rightarrow$  gain with feedback

$$A_f = \frac{\phi_o}{\phi_s}$$

## Positive feedback:-

If the feedback signal " $\phi_f$ " is in phase with i/p signal  $\phi_s$ , then the net effect of feedback will increase and the i/p signal is given to the amplifier that is,  $\phi_i = \phi_s + \phi_f$ .

This type of feedback is known as positive feedback (or) regenerative feedback.

The gain with feedback,  $A_f = \frac{\phi_o}{\phi_s}$

We know that  $\phi_i = \phi_s + \phi_f$

$$\phi_s = \phi_i - \phi_f$$

$$A_f = \frac{\phi_o}{\phi_i - \phi_f}$$

$$A_f = \frac{1}{\frac{\phi_i}{\phi_o} - \frac{\phi_f}{\phi_o}}$$

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

$$\Rightarrow \boxed{A_f = \frac{A}{1 - AB}}$$

The product of open loop gain feedback factor is called loop gain.

If  $|AB| = 1$ , then  $A_f = \infty$ . Hence the gain of amplifier with +ve feedback is ' $\infty$ ' and the amplifier use o/p gives o/p without i/p signal.

The amplifier acts as an oscillator when  $|AB| = 1$ .

Negative Feedback :-

If the feedback signal ' $\phi_f$ ' is outphase with i/p signal  $\phi_s$ . then the net effect of feedback will decrease and the i/p signal is given to the amplifier that is,

$$\phi_i = \phi_s - \phi_f$$

This type of feedback is known as -ve feedback.

The gain with feedback,  $A_f = \frac{\phi_o}{\phi_s}$

We know that  $\phi_i = \phi_s - \phi_f$

$$\begin{aligned} A_f &= \frac{\phi_o}{\phi_i + \phi_f} \\ &= \frac{1}{\frac{\phi_i}{\phi_o} + \frac{\phi_f}{\phi_o}} \end{aligned}$$

$$= \frac{1}{\frac{1}{A} + B}$$

$$A_f = \frac{A}{1 + AB}$$

In this case, the feedback gain is less than open loop gain.

If  $|AB| \gg 1$  then  $A_f = \frac{A}{AB} = \frac{1}{B}$ .

Hence, the gain depends on operating potentials. The stabilization of DC operating point of a transistor is done by the use of '-ve' feedback. '-ve' feedback is used to improve the performance of amplifiers. It increases the bandwidth, decreases distortion and noise and also it modifies i/p & o/p resistance.

Effect of Negative feedback:-

Stabilization of gain:-

We know that gain of amplifier with feedback

$$A_f = \frac{A}{1 + AB}$$

Differentiate the equation w.r. to 'A'.

$$\frac{dA_f}{dA} = \frac{d}{dA} \left[ \frac{A}{1+AB} \right]$$

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

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

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

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

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

$$\frac{\frac{dA_f}{A_f}}{\frac{dA}{A}} = \frac{1}{1+AB}$$

The term  $\frac{1}{1+AB}$  is called sensitivity.

It is defined as the ratio of % change in voltage gain with feedback to the % change in voltage gain without feedback.

The reciprocal of sensitivity is called 'd' sensitivity

$$d \text{ sensitivity} = 1 + AB$$

→ An amplifier has open loop gain of 1000 and feedback ratio 0.04. If the open loop gain changes by 10% due to temperature. Find the % change in gain of the amplifier with feedback.

Sol:-

Given

$$A = 1000$$

$$B = 0.04$$

$$\frac{dA}{A} = 10\%$$

$$\frac{\frac{dA_f}{A_f}}{\frac{dA}{A}} = \frac{1}{1+AB}$$

$$\frac{dA_f}{A_f} = \frac{dA}{A} \cdot \frac{1}{1+AB}$$

$$= 0.1 \cdot \frac{1}{1+1000 \times 0.04}$$

$$= \frac{0.1}{41}$$

$$\frac{dA_f}{A_f} = 0.2\%$$

Increase of Bandwidth:-  
 $\frac{mm \cdot mm}{m}$        $\frac{mm \cdot mm}{mm \cdot mm}$

The bandwidth of an amplifier is the difference between upper cut off frequency  $f_2$  and lower cut-off frequency  $f_1$ . The product of voltage gain and bandwidth of amplifier with feedback remains same.

$$A_f \times BW_f = A \times BW.$$

As the voltage gain of feedback amplifier reduces by the factor  $\frac{1}{1+AB}$ . Its bandwidth will be increased by  $1+AB$ .

$$\text{i.e. } BW_f = A(1+AB).$$

Due to negative feedback the upper cutoff frequency is increased by factor of  $1+AB$ .

$$\Rightarrow \boxed{f_{2f} = f_2(1+AB)}$$

and lower cut-off frequency decreased by factor of  $1+AB$

$$\frac{f_{1f}}{f_1} = \frac{\cancel{1+AB}}{\cancel{1+AB}}$$

$$\Rightarrow \boxed{f_{1f} = \frac{f_1}{1+AB}}$$

\* An amplifier has a midband gain 125 and bandwidth of 250kHz.

a) 4% negative feedback is introduced find the new bandwidth and gain.

b) If B.W is to be restricted to 1MHz. Find the feedback ratio.

a) Given that

$$\text{midband gain } A = 125$$

$$\text{Bandwidth} = 250\text{kHz}$$

$$B = 4\%$$

$$= \frac{4}{100}$$

$$= 0.04$$

$$B_{wf} = (1 + AB) B.W$$

$$= 1 + (125 \times 0.04) 250 \times 10^3$$

$$= 1500000$$

$$B_{wf} = 1.5\text{MHz}$$

$$A_f = \frac{A}{1 + AB}$$
$$= \frac{125}{1 + 125(0.04)}$$

$$A_f = 20.83$$

b) Bandwidth = 1 MHz

$$BW_f = (1 + AB)BW$$

$$1 \times 10^6 = 1 + (125 \times \beta') 250 \times 10^3$$

$$1 + 125\beta' = \frac{1 \times 10^6}{250 \times 10^3}$$

$$125\beta' + 1 = 4$$

$$125\beta' = 4 - 1$$

$$125\beta' = 3$$

$$\beta' = \frac{3}{125}$$

$$= 0.024$$

$$\beta' = 2.4\%$$

Decreased Distortion:-

Consider, an amplifier with open loop voltage gain and total harmonic distortion 'D' then with negative feedback, the distortion will reduced to

$$D_f = \frac{D}{1+A\beta}$$

Decreased Noise:-

There are many sources of noise in an amplifier depending upon active device used. with the use of 've' feedback, the noise can be reduced by a factor of  $\frac{1}{1+A\beta}$

$$N_f = \frac{N}{1+A\beta}$$

Increase in input resistance:-

An amplifier should have high i/p impedance. so that it will not load the proceeding stage on i/p voltage source. Such characteristic can be achieved with the help of '-ve' series feedback the input impedance with feedback is given by

$$Z_{if} = Z(1+A\beta)$$

Decrease in output Impedance:-

An amplifier with low o/p impedance is capable of delivery maximum power to the load without any lose. Such characteristic is achieved by using voltage feedback in amplifiers. The o/p impedance with feedback is given by,

$$Z_{of} = \frac{Z_o}{1+A\beta}$$

Types of -ve feedback connections:-

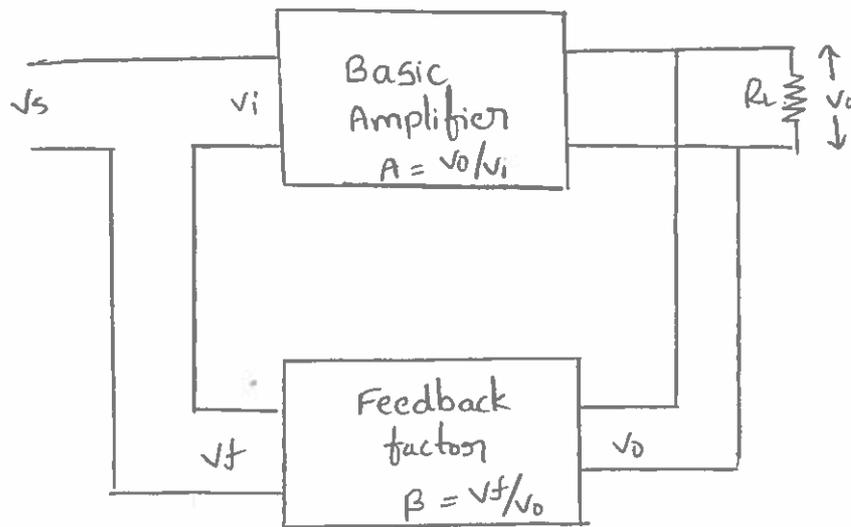
There are 4 different combinations, in which '-ve' feedback may be used.

- i) voltage series.
- ii) voltage shunt.
- iii) current series.
- iv) current shunt.

The series feedback connection tend to increase the i/p resistance and shunt feedback connection tend to decrease the i/p resistance.

The voltage feedback tends to decrease o/p resistance and current feedback tends to increase o/p resistance.

# i) voltage series feedback Amplifiers:-



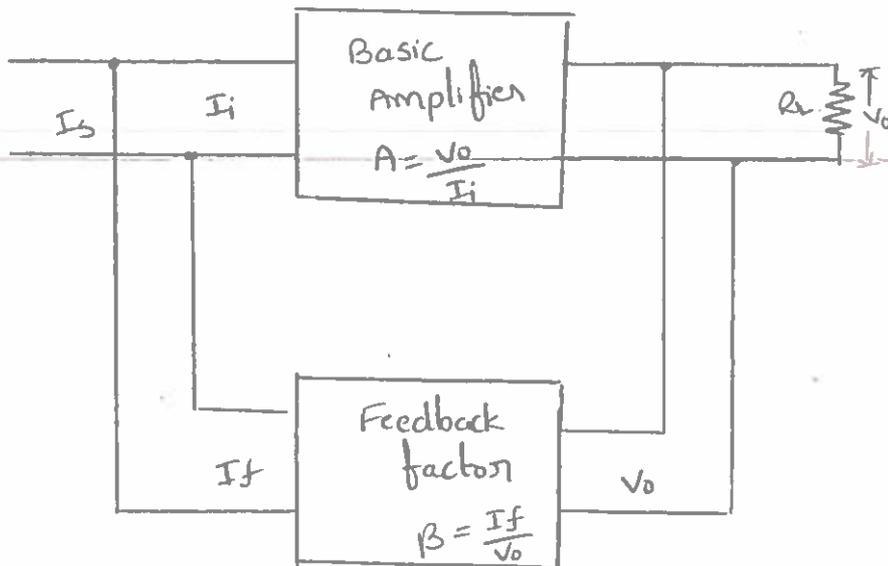
The i/p to the feedback network is in parallel with the o/p of the amplifier. A fraction of o/p voltage through feedback network is applied in series with the i/p voltage of the amplifier.

The shunt connection at the o/p, reduces the o/p resistance  $R_o$ , the series connection at the i/p increases the i/p resistance. The voltage series feedback amplifier is called pure voltage amplifier. For this amplifier, the gain

$$A_v = \frac{v_o}{v_i}$$

feedback factor  $\beta = \frac{v_f}{v_o}$

ii) voltage shunt feedback Amplifier:—



The input to the feedback network is parallel with the o/p of the amplifier. A fraction of o/p voltage through feedback network is applied in parallel with the i/p voltage of the amplifier.

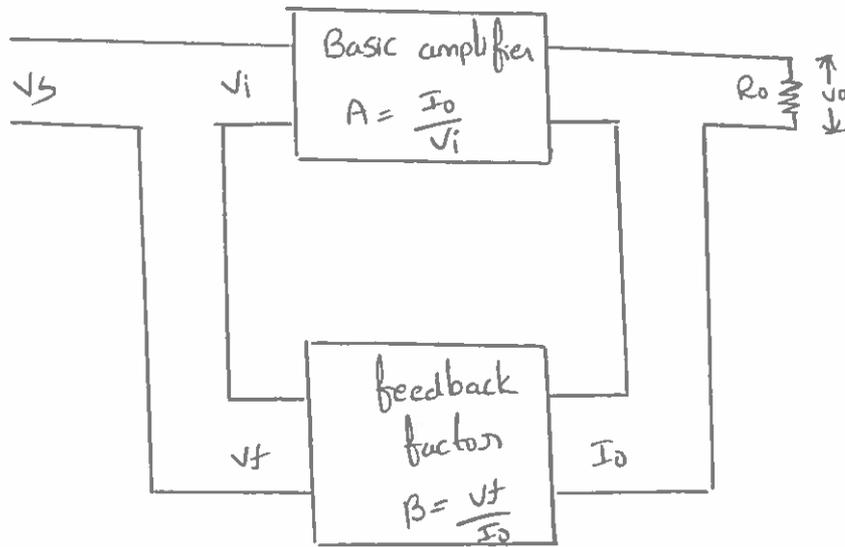
The shunt connection of the o/p, reduces the o/p resistance  $R_o$ , the shunt connection of the i/p decreases, the i/p resistance. The voltage shunt feedback amplifier is called trans resistance.

For this Amplifier the gain

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

Feedback amplifier,  $\beta = \frac{I_f}{V_o}$ .

### iii) Current Series feedback Amplifier:-

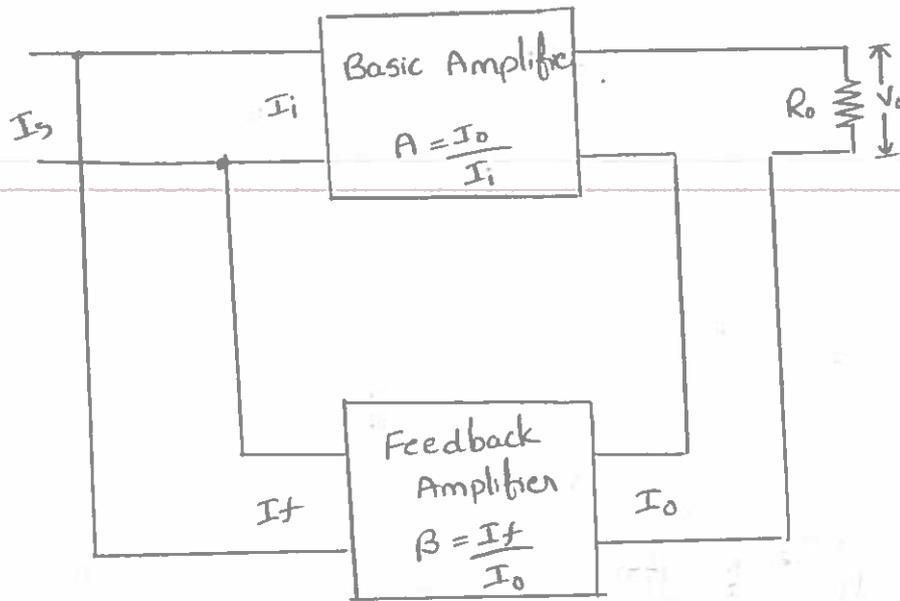


The i/p to the feedback network is in series with the o/p of the amplifier. A fraction of o/p voltage through feedback network is applied in series with the i/p voltage of the amplifier.

The series connection of the o/p increases o/p resistance  $R_o$ . The series connection of the increases the input resistance. The current series feedback is called pure current amplifier for this amplifier, the gain,  $A_v = \frac{I_o}{V_i}$

feedback factor  $B = \frac{V_f}{I_o}$

## n) Current shunt feedback amplifier:-



The i/p to the feedback network is parallel with the o/p of the amplifier. A fraction of o/p voltage through feedback network is applied in series with the i/p voltage of the amplifier.

As the feedback circuit is connected in series with the output, the o/p resistance is increased and due to the parallel connection with the i/p, the input resistance is decreased. The current shunt feedback amplifier is called transconductance.

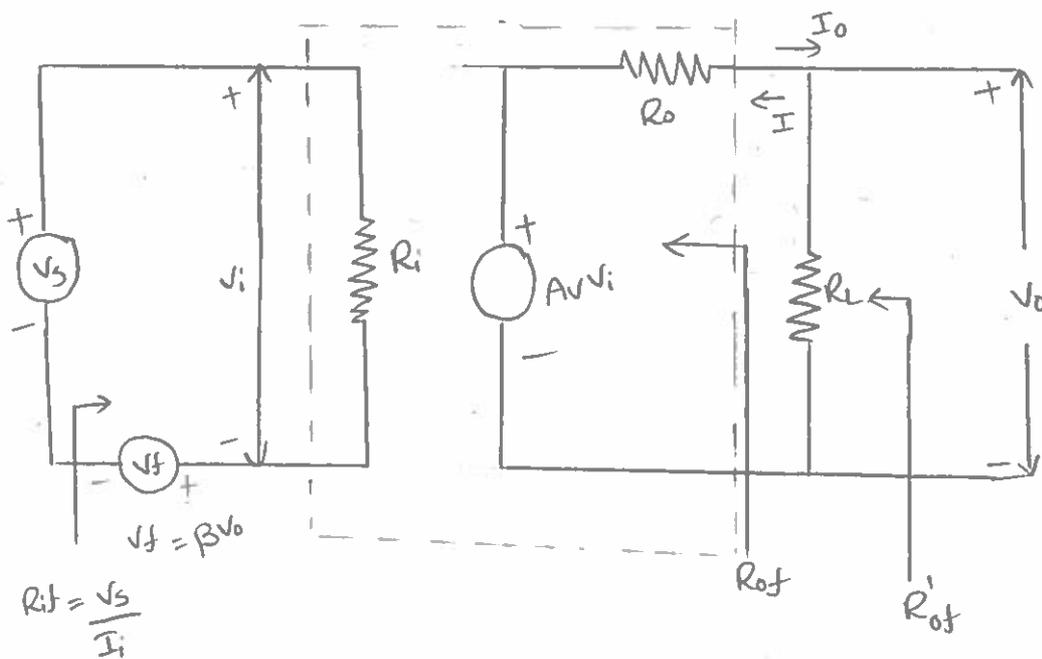
for this amplifier, gain  $A_v = \frac{I_o}{I_i}$

feedback amplifier  $\beta = \frac{I_f}{I_o}$

# Input and Output resistance of feedback Amplifiers

Voltage series feedback Amplifier:-

In voltage series feedback amplifier, the feedback voltage is connected in series with source voltage. So, the i/p resistance will be increased.



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

$$V_i = V_s - V_f$$

$$V_s = V_i + V_f$$

$$V_s = I_i R_i + \beta V_o$$

$$V_s = I_i R_i + \beta A V_i$$

$$V_s = I_i R_i + \beta A V_i R_i$$

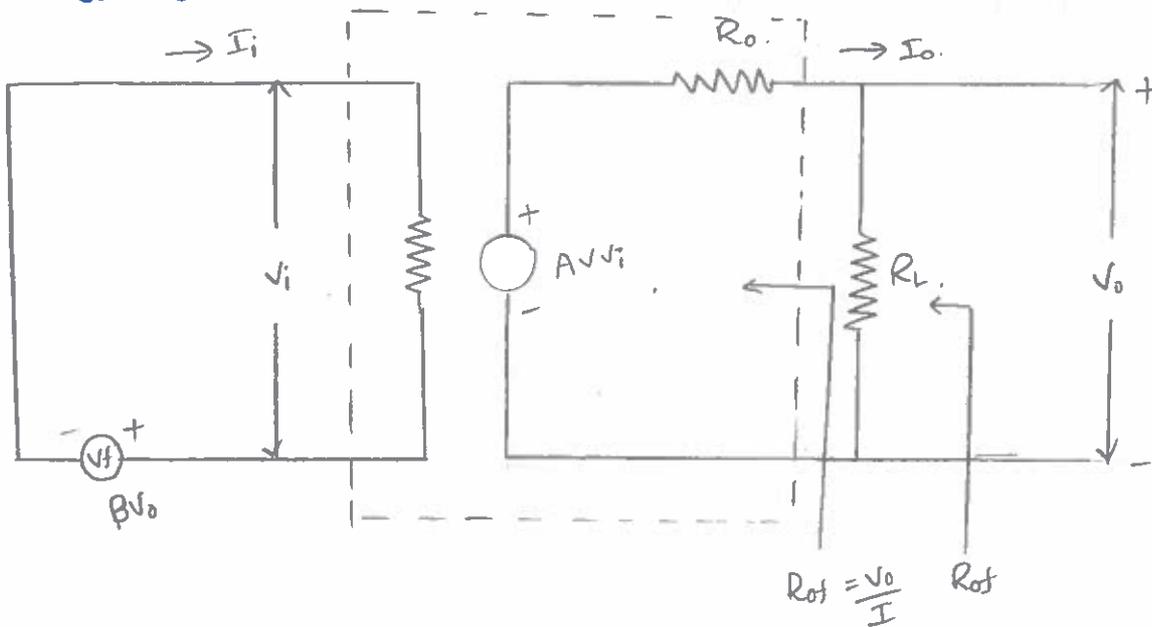
$$V_s = I_i R_i (1 + \beta A)$$

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

$$= \frac{I_i R_i (1 + \beta A)}{I_i}$$

$$R_{if} = R_i(1 + AB)$$

In voltage series amplifier the o/p is connected in parallel. So the output voltage is decreased to find o/p resistance with feedback i/p must be short circuited.



$$A_v V_i = (R_o + R_L) I_o$$

$$A_v V_i = I_o R_o + I_o R_L$$

$$I_o R_L = V_o$$

$$I_o = -I$$

$$A_v V_i = -I R_o + V_o$$

$$V_o = A_v V_i + I R_o$$

$$V_i = V_s - V_f$$

$$V_i = -V_f$$

$$V_i = -\beta V_o$$

$$V_o = -A_v \beta V_o + I R_o$$

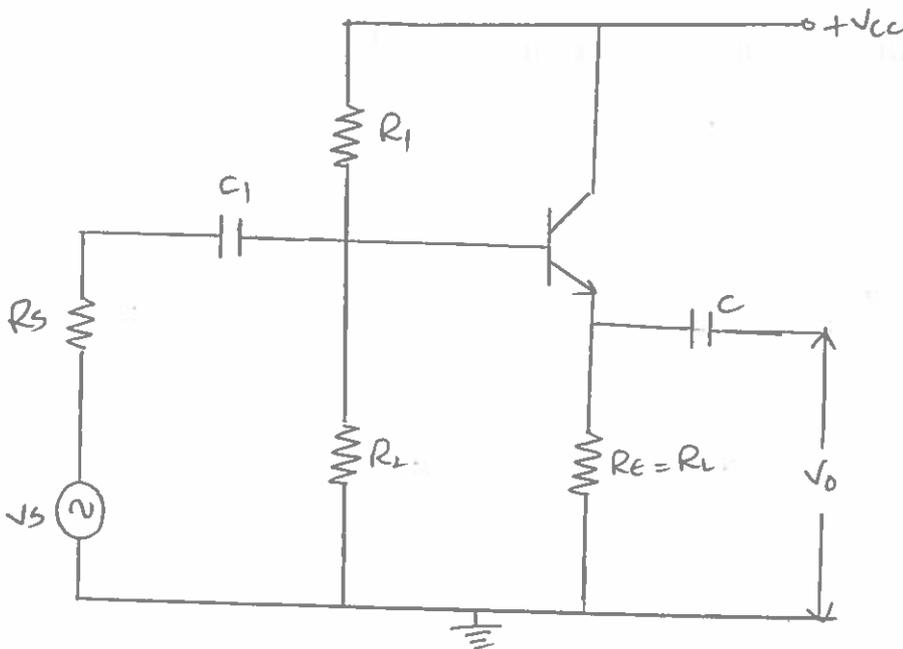
$$V_o + A_v \beta V_o = I R_o$$

$$R_{if} = 18k\Omega$$

$$R_{of} = \frac{R_o}{1 + A_v \beta}$$
$$= \frac{20}{1 + 500(0.01)}$$

$$R_{of} = 3.33k\Omega$$

Example for voltage series feedback Amplifier [Emitter follower].



The voltage developed in the o/p is in series with the i/p voltage. This is the single stage RC coupled amplifier without emitter bypass capacitor across  $R_E$ .  $R_1$  &  $R_2$  provides bias. The emitter follower exhibits 100% '-ve' feedback since the voltage at emitter follows the i/p voltage.

$$V_o(1+AB) = IR_o$$

$$V_o = \frac{IR_o}{1+AB}$$

$$R_{of} = \frac{V_o}{I} = \frac{R_o}{1+AB}$$

→ A voltage series '-ve' feedback amplifier has voltage gain without feedback is 500. i/p resistance  $3k\Omega$ .

O/P resistance  $20k\Omega$  and feedback ratio 0.01.

Calculate voltage gain, i/p resistance, o/p resistance with feedback.

Given

$$A_v = 500$$

$$R_i = 3k\Omega$$

$$R_o = 20k\Omega$$

$$\beta = 0.01$$

$$\begin{aligned} A_f &= \frac{A_v}{1+AB} \\ &= \frac{500}{1+(0.01)500} \end{aligned}$$

$$A_f = 83.33$$

$$\begin{aligned} R_{if} &= R_i(1+AB) \\ &= 3 \times 10^3(1+500(0.01)) \end{aligned}$$

As the o/p voltage is taken across  $R_E$  then feedback ratio  $\beta = \frac{R_E}{R_L} = 1$ .

$\therefore$  The overall voltage gain  $A_f = \frac{A}{1+A}$

The emitter follower simultaneously increases the i/p resistance and decreases the o/p resistance.

Characteristics of an emitter follower:-

Current gain  $A_i = \frac{I_e}{I_b}$

$$= \frac{I_c + I_b}{I_b}$$

$$= \frac{h_{fe} I_b + I_b}{I_b}$$

$$\boxed{A_i = 1 + h_{fe}}$$

$$\therefore \beta = \frac{I_c}{I_b}$$

$$\beta = h_{fe}$$

i/p resistance,  $R_i = h_{ie} + (1 + h_{fe}) R_L$

voltage gain,  $A_v = A_i \cdot \frac{R_L}{R_i}$

$$= (1 + h_{fe}) \cdot \frac{R_L}{h_{ie} + (1 + h_{fe}) R_L}$$

$$= \frac{(1 + h_{fe}) R_L}{h_{ie} + (1 + h_{fe}) R_L}$$

$$A_v = 1 - \frac{h_{ie}}{R_i}$$

$$\text{o/p resistance, } R_o = \frac{h_{ie} + R_s}{1 + h_{fe}}$$

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

→ Emitter follower has  $R_s = 600\Omega$ ,  $R_L = 2k\Omega$ ,  $h_{fe} = 80$  and  $h_{ie} = 5k\Omega$ . Calculate  $A_i$ ,  $R_i$ ,  $A_v$ ,  $R_o$  and  $R_{of}$ .

$$\text{Given } R_s = 600\Omega$$

$$R_L = 2k\Omega$$

$$h_{fe} = 80$$

$$h_{ie} = 5k\Omega$$

$$A_i = 1 + h_{fe}$$

$$\Rightarrow \boxed{A_i = 81}$$

$$R_i = h_{ie} + (1 + h_{fe})R_L$$

$$= 5 + (1 + 80)2$$

$$= 5 + 162$$

$$\Rightarrow \boxed{R_i = 167k\Omega}$$

$$A_v = 1 - \frac{5}{167}$$

$$\boxed{A_v = 0.97}$$

$$R_o = \frac{5 + 600}{1 + 80}$$

$$R_o = 67.46$$

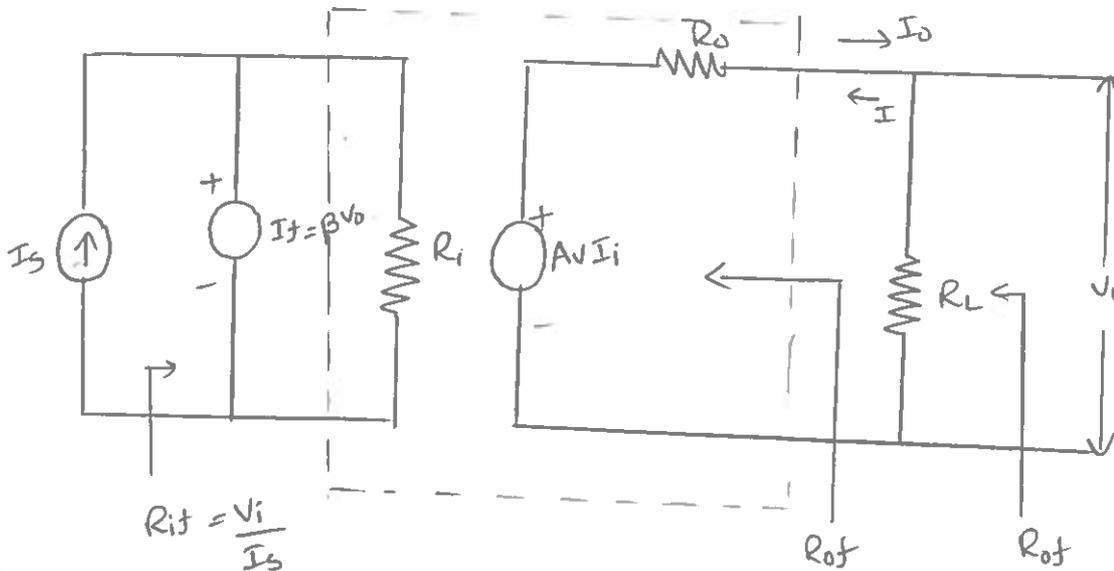
$$R_{of} = R_o \parallel R_L$$

$$= 69.1 // 2$$

$$= \frac{69.1 \times 2 \times 10^3}{69.1 + 2 \times 10^3}$$

$$R_{of} = 68.5$$

Voltage shunt feedback Amplifier:-



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

$$I_i = I_s - I_f$$

$$I_s = I_i + I_f$$

$$I_f = \beta V_o$$

$$I_s = I_i + \beta V_o$$

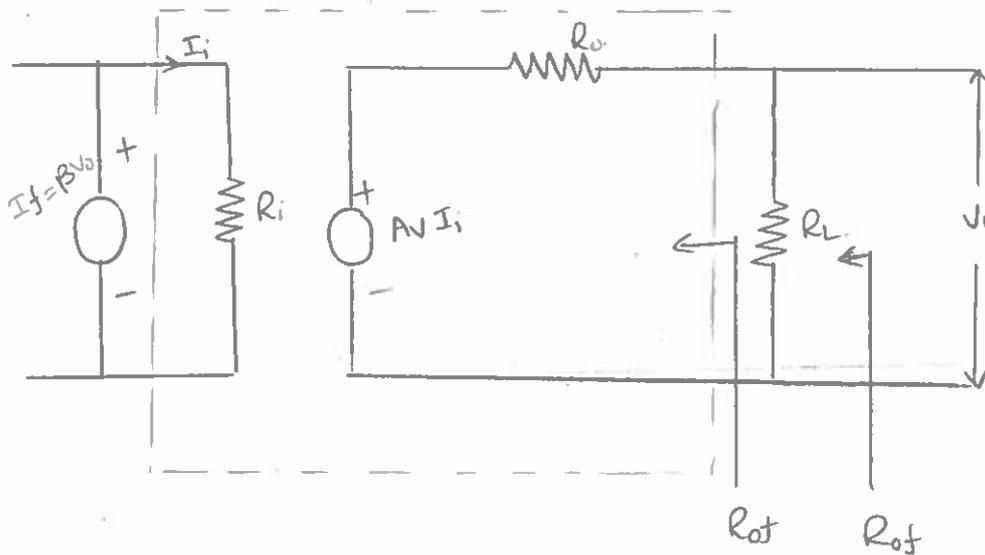
$$I_s = \frac{V_i}{R_i} + \beta V_o$$

$$I_s = \frac{A I_i}{R_i} + \beta A I_i$$

$$I_s = \frac{A I_i}{R_i} + \beta A I_i$$

$$I_s = \frac{V_i}{R} (1 + \beta A)$$

$$R_{if} = \frac{V_i}{I_s} = \frac{R_i}{1 + \beta A}$$



$$V_o = A I_i + I R_o$$

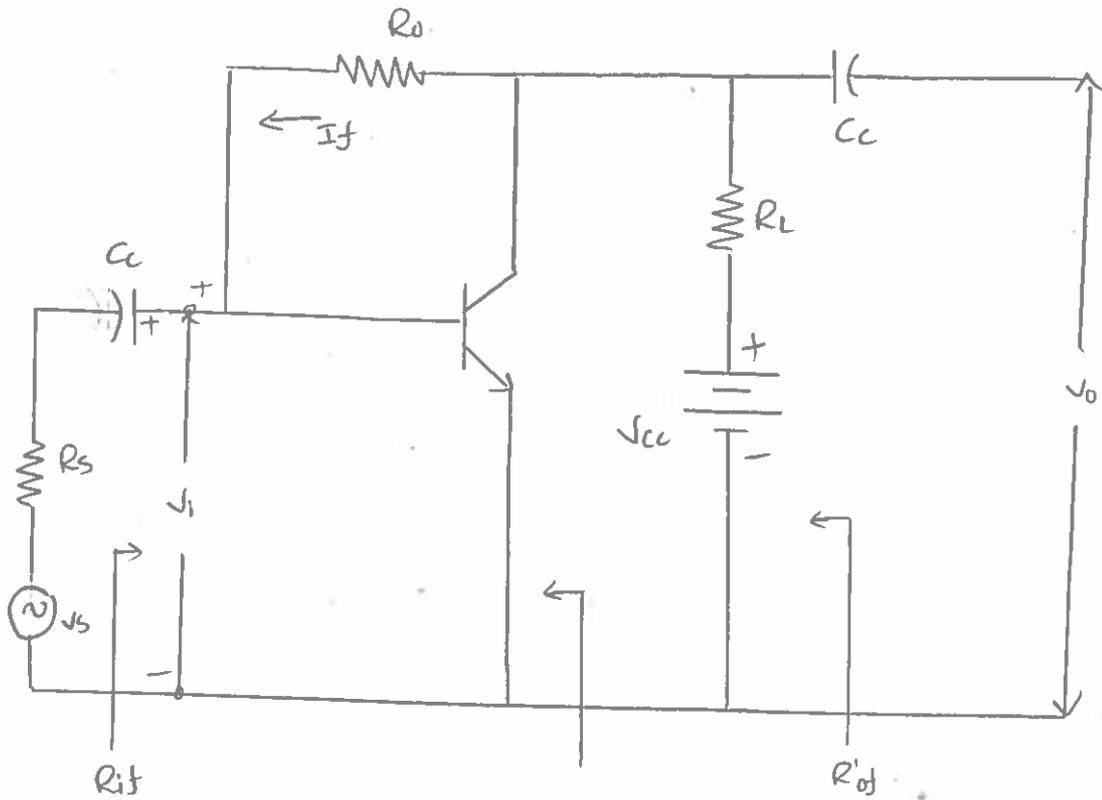
$$V_o = -\beta V_o A + I R_o$$

$$V_o + \beta V_o A = I R_o$$

$$(1 + \beta A) V_o = I R_o$$

$$R_{of} = \frac{V_o}{I} = \frac{R_o}{1 + \beta A}$$

CE amplifier with voltage shunt feedback



Here, a current which is proportional to the o/p voltage is feedback to the i/p. since  $v_o$  is very much greater than  $v_i$ , the feedback current

$$I_f = \frac{v_o}{R_f}$$

So, that, the feedback ratio,  $\beta = \frac{1}{R_f}$

The reduction in i/p and o/p resistance occurs due to miller effect because of  $R_f$ .

$$R_{it} = h_{ie} \parallel \frac{R_f}{1-A_v}$$

$$A_v = \frac{v_o}{v_i} = \frac{-h_{fe}R'_L}{h_{ie}}$$

$$R_L' = R_B \parallel R_L$$

$$A_{if} = \frac{V_o}{V_s} = A_v \cdot \frac{R_{if}}{R_s + R_{if}}$$

$$R_{of} = \frac{R_B}{R_s} \times \frac{R_s + h_{ie}}{h_{fe}}$$

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

→ The CE amplifier with voltage shunt feedback has  
 $R_s = 600\Omega$ ,  $h_{ie} = 5k\Omega$ ,  $h_{fe} = 80$ ,  $R_L = 2k\Omega$ ,  $R_B = 40k\Omega$   
Calculate  $A_v$ ,  $R_{if}$ ,  $R_{of}$ ,  $A_{vf}$  and  $R_{of}'$ .

$$R_{if} = h_{ie} \parallel \frac{R_B}{1 - A_v}$$

$$A_v = \frac{-h_{fe} R_L'}{h_{ie}}$$

$$R_L' = R_B \parallel R_L$$

$$= \frac{2 \times 40}{2 + 40}$$

$$= \frac{80}{42}$$

$$\boxed{R_L' = 1.904}$$

$$A_v = \frac{-80 \times 1.90}{5}$$

$$\boxed{A_v = -30.4}$$

$$R_{if} = 5 \times 10^3 \parallel \frac{40 \times 10^3}{1 + 30.4}$$

$$= 5 \parallel \frac{40}{31.4}$$

$$= 5 \parallel 1.27$$

$$= \frac{5 \times 1.27}{5 + 1.27}$$

$$R_{if} = 1.01 \text{ k}\Omega$$

$$A_{vf} = A_v \cdot \frac{R_{if}}{R_s + R_{if}}$$

$$= -30.4 \frac{1.01 \times 10^3}{600 + 1.01 \times 10^3}$$

$$A_{vf} = -19 \text{ k}\Omega$$

$$R_{of} = \frac{R_B}{R_s} \times \frac{R_s + h_{ie}}{h_{fe}}$$

$$= \frac{40 \times 10^3}{600} \times \frac{600 + 5 \times 10^3}{80}$$

$$R_{of} = 4666.66 \Omega$$

$$R_{of} = 4.66 \text{ k}\Omega$$

$$R_{of}' = R_{of} // R_L$$

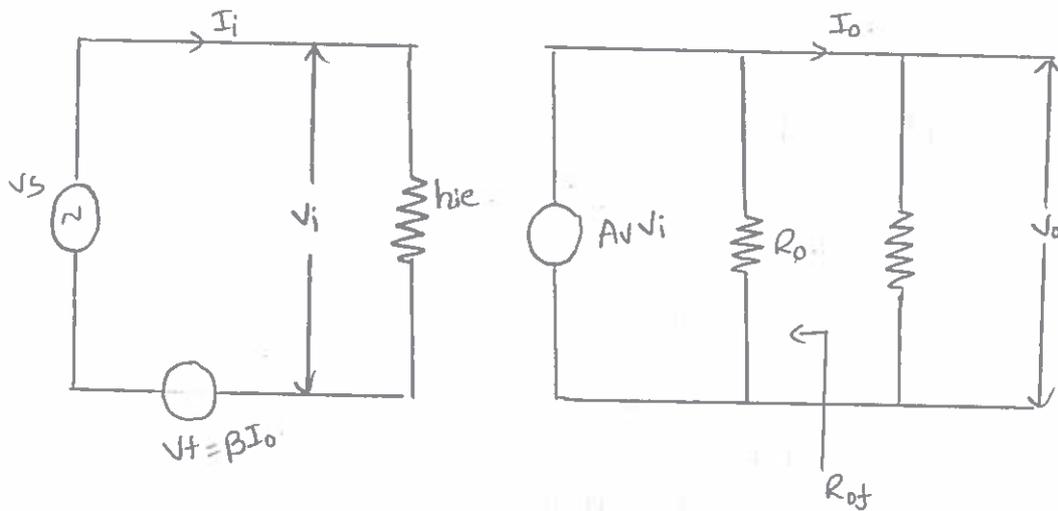
$$= 4.66 // 2$$

$$= \frac{4.66 \times 2}{4.66 + 2}$$

$$= 1.39$$

$$R_{of}' = 1.39$$

Current Series feedback Amplifier



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

$$V_i = V_s - V_f$$

$$V_s = V_i + V_f$$

$$V_i = I_i R_i$$

$$V_s = I_i R_i + \beta I_o = I_i R_i + \beta A V_i$$

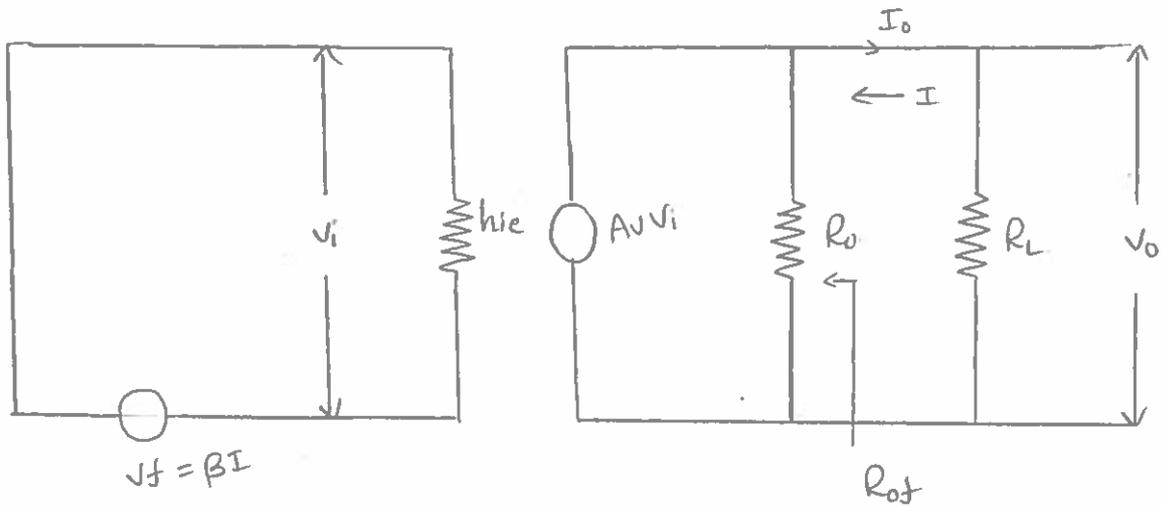
$$R_{if} = \frac{V_s}{I_i}$$

$$= \frac{I_i R_i + \beta A V_i}{I_i}$$

$$R_{if} = \frac{I_i R_i + \beta A R_i I_i}{I_i}$$

$$R_{if} = R_i(1+AB)$$

To find the o/p resistance with feedback i/p must be short circuited.



$$R_{of} = \frac{v_o}{I}$$

$$I = A v_i + \frac{v_o}{R_o}$$

$$v_i = v_s - v_f$$

$$v_i = -v_f = -\beta I$$

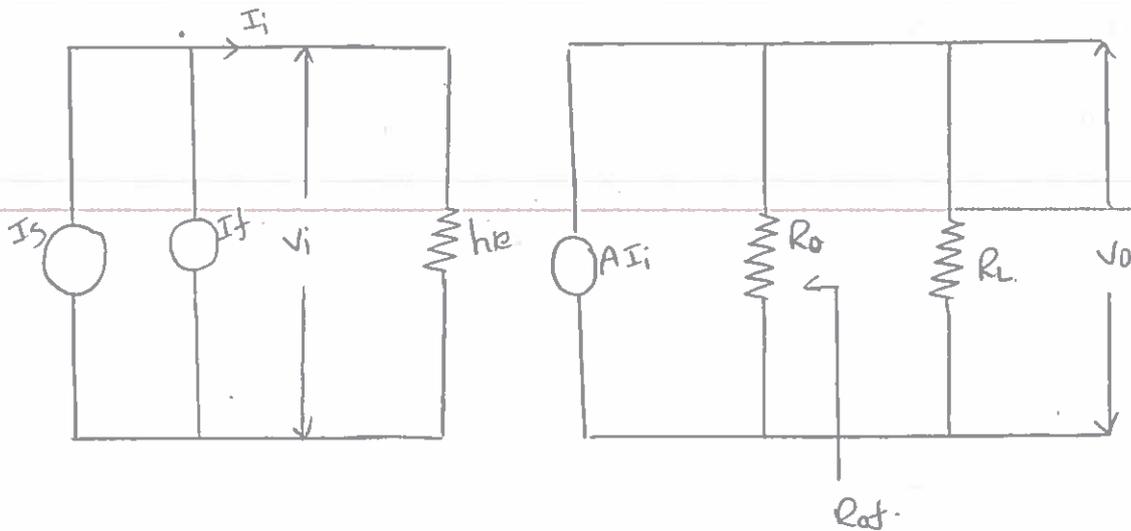
$$I = A(-\beta I) + \frac{v_o}{R_o}$$

$$I = -A\beta I + v_o/R_o$$

$$\frac{v_o}{R_o} = I(AB+1)$$

$$R_{of} = \frac{v_o}{I} = R_o(1+AB)$$

Current Shunt feedback Amplifier:-



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

$$v_i = I_i h_{ie}$$

$$I_s - I_f = I_i$$

$$I_s = I_i + I_f$$

$$I_f = \beta I_o$$

$$A = \frac{I_o}{I_i}$$

$$I_i = \frac{v_i}{R_i}$$

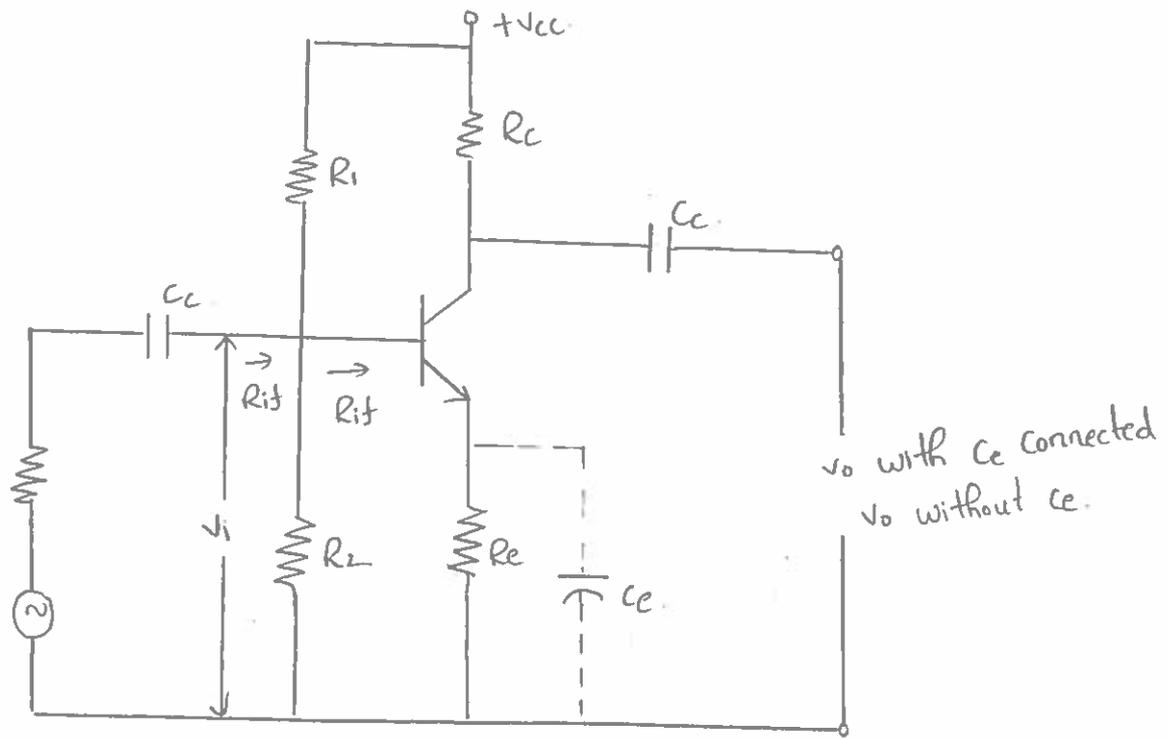
$$I_s = \frac{v_i}{R_i} + \beta I_o$$

$$I_s = \frac{v_i}{R_i} + A \beta \frac{v_i}{R_i}$$

$$I_s = \frac{v_i}{R_i} (1 + A\beta)$$

$$R_{if} = \frac{v_i}{I_s} = \frac{R_i}{(1 + A\beta)}$$

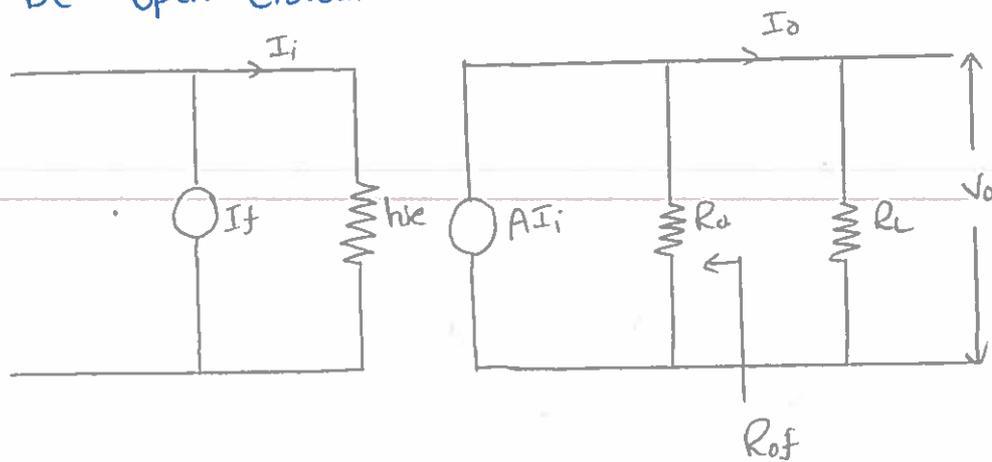
# Example of Current series feedback Amplifier:—



One of the most common method of applying current series feedback is to place a resistor  $R_e$  b/w emitter of CE amplifier and ground, as the common emitter amplifier has a high gain and mostly used with series feedback. So that gain will be reduced. When  $R_e$  proper biypassed with large capacitor  $C_e$ . The o/p voltage is  $V_0$  the voltage gain without feedback is A.

When capacitor  $C_e$  is removed an AC voltage will developed across  $R_e$  due to emitter current and this current approximately equal to collector current. This voltage drop will serve to decrease the i/p voltage b/w base & emitter. So, that o/p voltage will decreased to ' $V_0$ '. The gain of the amplifier with -ve feedback

To find o/p resistance with feedback amplifier i/p must be open circuited.



$$R_{of} = \frac{V_o}{I}$$

$$I = AI_i + \frac{V_o}{R_o}$$

$$I_i = I_s - I_f$$

$$I_i = -I_f = -BI$$

$$I = A(-BI) + \frac{V_o}{R_o}$$

$$I = -ABI + \frac{V_o}{R_o}$$

$$\frac{V_o}{R_o} = I + ABI$$

$$\frac{V_o}{R_o} = I(1+AB)$$

$$R_{of} = \frac{V_o}{I} = R_o(1+AB)$$

12 A\$

$$\text{feedback ratio, } \beta = \frac{R_e}{R_L}$$

$$\text{I/P resistance } R_i = h_{ie}$$

$$R_{if} = h_{ie} + (1+h_{fe})R_e.$$

If bias resistance is consider

$$\text{let us assume } R = R_1 \parallel R_2$$

$$R = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_{if}' = R \parallel R_{if}$$

voltage gain

$$\text{voltage gain without feedback } A = \frac{-h_{fe} R_L}{h_{ie}}$$

$$\text{with feedback } A_f = \frac{A R_L}{R_{if}}$$

$$A_i = -h_{fe}$$

$$\text{o/p resistance, } R_{of} = \frac{1}{h_{ob}} (\text{or}) R_o (1+AB)$$

$$R_{if} = R_i (1+AB).$$

→ The current series feedback type of transistor amplifier has following parameters.  $R_1 = 20k\Omega$ ,  $R_2 = 20k\Omega$ ,  $h_{ie} = 2k\Omega$ ,  $R_L = 1k\Omega$ ,  $R_e = 100\Omega$  &  $h_{fe} = 80$ . Calculate  $A$ ,  $\beta$ ,  $R_{if}$ ,  $A_f$  & loop gain in decibels.

$$A = \frac{-h_{fe}R_L}{h_{ie}}$$
$$= \frac{-80 \times 1 \times 10^3}{2 \times 10^3}$$

$$A = -40$$

feedback ratio  $\beta = \frac{R_e}{R_L}$

$$= \frac{100}{1 \times 10^3}$$

$$= \frac{100}{1000}$$

$$\beta = 0.1$$

$$R_{if} = h_{ie} + (1+h_{fe})R_e$$

$$= 2000 + (1+80)100$$

$$= 2000 + 8100$$

$$R_{if} = 10.1 \text{ k}\Omega$$

$$A_f = \frac{A R_L}{R_{if}}$$

$$A_i = -h_{fe}$$

$$A_i = -80$$

$$A_f = \frac{-80 \times 10^3}{10.1 \times 10^3}$$

$$A_f = -7.9$$

$$\begin{aligned} \text{loop gain} &= A\beta \\ &= (-40)(0.1) \\ &= -4 \end{aligned}$$

$$\begin{aligned} \text{loop gain in decibels} &= 20 \log_{10} (|A\beta|) \\ &= 20 \log_{10} (4) \\ &= 12.04 \text{ dB} \end{aligned}$$

Effect of negative feedback on amplifier characteristics

(cont)

Comparison b/w feedback Amplifiers:-

Characteristics	Current Series	Current Shunt	Voltage series	Voltage shunt
Voltage gain	Decreasing	Decreasing	Decreasing	Decreasing
Bandwidth	Increase	Increase	Increase	Increase
Distortion	Decreasing	Decreasing	Decreasing	Decreasing
Noise	Decreasing	Decreasing	Decreasing	Decreasing
Input resistance	Increase	Decrease	<del>Decrease</del> Increase	Decrease
O/P resistance	Increase	Increase	Decrease	Decrease

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