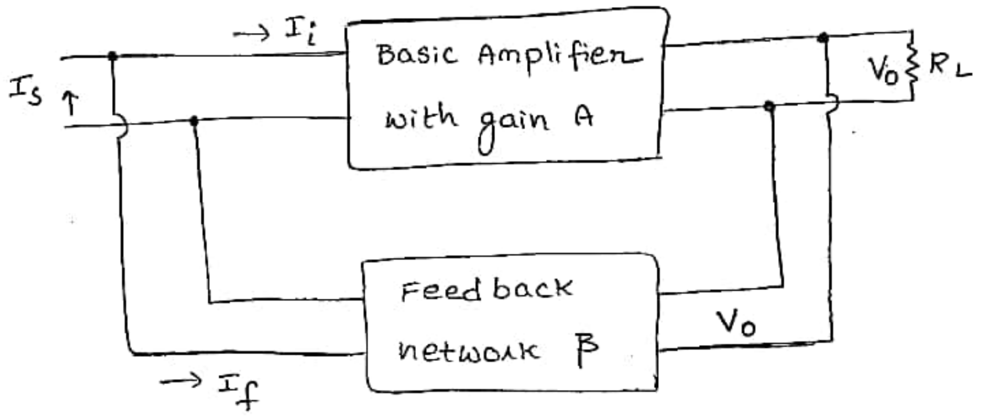
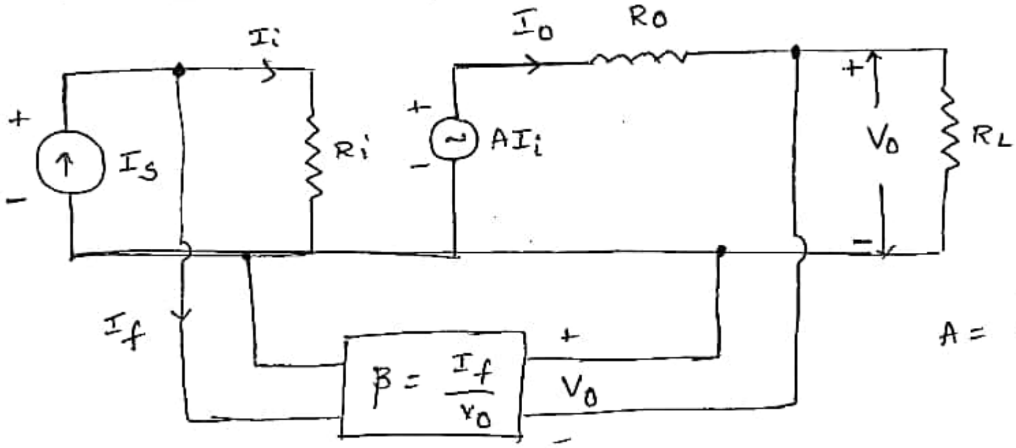
2) <u>Voltage shunt feedback</u> :-

A Voltage shunt feedback is illustrated in figure below. Here a fraction of the output voltage is supplied in parallel with the input voltage through the feedback network. The feedback signal I_f is proportional to the output voltage V_0. Therefore the feedback factor is given by $\beta = \frac{I_f}{V_0}$. This type of amplifier is called a trans resistance amplifier. The voltage - shunt feedback provides a stabilised overall gain and decreases both input and output resistances by a factor $(1 + A\beta)$

$$R_{if} = \frac{R_I}{1 + A\beta} \quad \text{and} \quad R_{of} = \frac{R_o}{1 + A\beta}$$



Input and output resistances :-



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

Fig : Equivalent circuit of voltage shunt feedback.

$$R_{if} = \frac{V_i}{I_s} = \frac{V_i}{I_i + I_f} = \frac{V_i}{I_i + \beta V_o} = \frac{V_i / I_i}{1 + \beta \frac{V_o}{I_i}}$$

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

thus the input impedance gets reduced by a factor $(1 + A\beta)$

$\cancel{-A I_i + I_o R_o + V_o = 0}$

$\cancel{V_o =}$

output Impedance :

$$V_o = I_o R_o + A I_i$$

For $I_s = 0$ $\quad I_i = -I_f$, then

$$V_0 = I_0 R_0 - A I_f$$

$$V_0 = I_0 R_0 - A \beta V_0$$

$$V_0 (1 + A\beta) = I_0 R_0$$

$$R_{of} = \frac{V_0}{I_0} = \frac{R_0}{1 + A\beta}$$

3. <u>Current series feedback Amplifier</u>

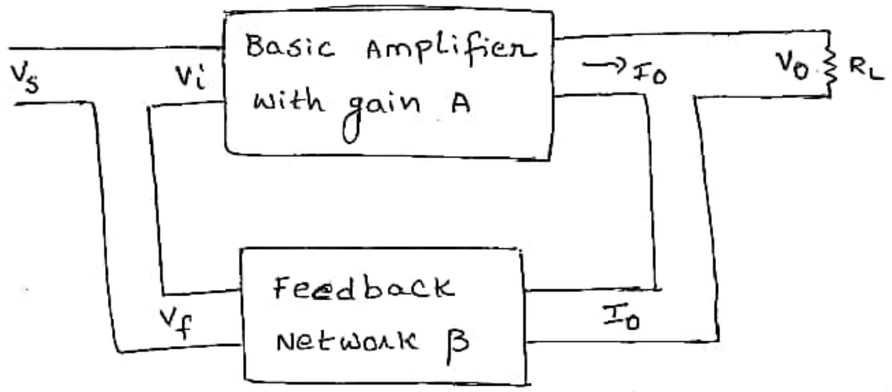
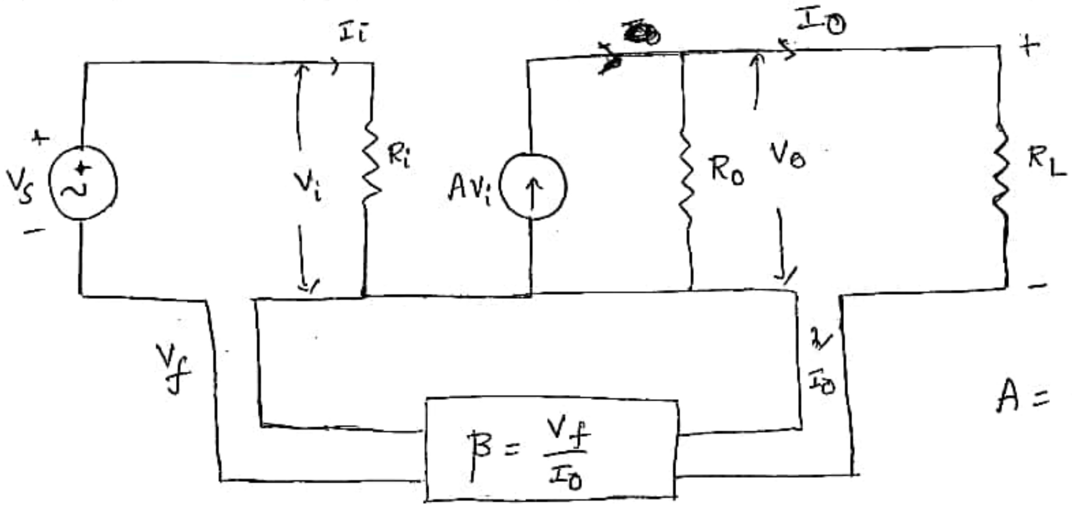


Fig: Block diagram of the current series feedback.

A block diagram of a current series feedback is illustrated in figure above. In current series feedback, a voltage is developed which is proportional to the output current. This is called current feedback even though it is a voltage that subtracts from the input voltage. Because of the series connection at the input and output, the input and output resistances get increased. This type of amplifier is called transconductance amplifier. The transconductance feedback factor β is given by $\beta = V_f / I_0$

Input and output resistances :



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

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

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

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

$$\frac{V_s}{I_i} = R_i (1 + A\beta) \Rightarrow \boxed{R_{if} = R_i (1 + A\beta)}$$

To obtain the output impedance assume that source voltage is transfered to output terminals, with V_s short circuited ie $V_s = 0$, resulting in a current I_o in to the circuit.

$$V_s = V_i + V_f \quad \text{if } V_s = 0 \text{ then } V_i = -V_f$$

$$I_o = AV_i + \frac{V_o}{R_o} = -AV_f + \frac{V_o}{R_o}$$

$$I_o = -A\beta I_o + \frac{V_o}{R_o}$$

$$\frac{V_o}{R_o} = I_o (1 + A\beta) \Rightarrow \frac{V_o}{I_o} = (1 + A\beta) R_o$$

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

4) Current - shunt feedback :

The block diagram of current shunt feedback is shown in figure below

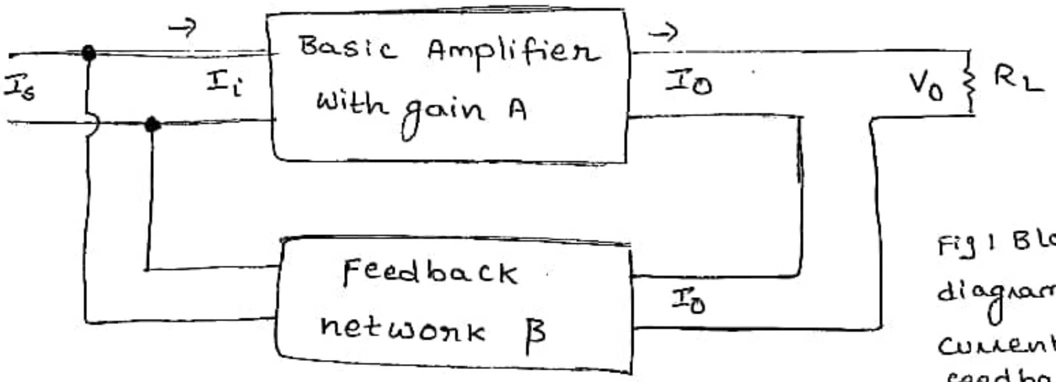


Fig 1 Block diagram of current shunt feedback

The shunt connection at the input reduces the input resistance and the series connection at the output increases the output resistance. This is a true current amplifier. The current feedback factor is given by $\beta = \frac{I_f}{I_o}$

Here Amplifier gain $A = \frac{I_o}{I_i}$

Input and output resistances :

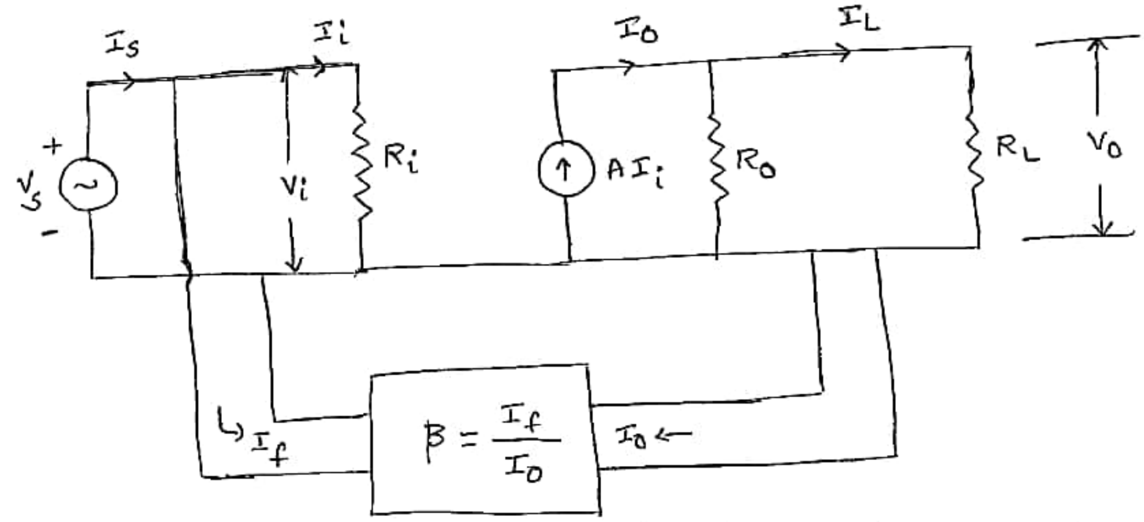


Fig : Equivalent circuit of current shunt feedback connection

Input Resistance

From the Equivalent circuit

$$I_s = I_i + I_f$$

$$I_s = \frac{V_i}{R_i} + \beta I_o \qquad \left[\because \beta = \frac{I_f}{I_o}\right]$$

$$I_s = \frac{V_i}{R_i} + \beta A I_i \qquad \left[\because A = \frac{I_o}{I_i}\right]$$

$$I_s = \frac{V_i}{R_i} + \beta A \frac{V_i}{R_i} \qquad \left[\because I_i = \frac{V_i}{R_i}\right]$$

$$I_s = \frac{V_i}{R_i}\left[1 + A\beta\right]$$

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

Output resistance:

we know that

$$I_s = I_i + I_f$$

For $I_s = 0$, $I_i = -I_f$

From the equivalent circuit $I_o = A I_i + \frac{V_o}{R_o}$

$$I_o = \frac{V_o}{R_o} - A I_f = \frac{V_o}{R_o} - A\beta I_o$$

$$\frac{V_o}{R_o} = I_o + A\beta I_o \Rightarrow \frac{V_o}{I_o} = (1 + A\beta) R_o$$

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

$$\therefore \boxed{R_{of} = (1 + A\beta) R_o}$$

Problem:

When a negative feedback is applied to an Amplifier of gain 100, the overall gain falls to 50. calculate (i) the feedback factor β (ii) If the same feedback factor maintained, the value of the amplifier gains required if the overall gain is to be 75

Solution: (i) $A = 100$, $A_f = 50$

$$A_f = \frac{A}{1 + A\beta} \Rightarrow \beta = 0.01$$

(ii) $A_f = 75$

$$A_f = \frac{A}{1+A\beta} \Rightarrow 75 = \frac{A}{1+0.01A}$$

$$\Rightarrow A = 300.$$

Problem:

The gain of the amplifier without feedback is 50 whereas with ~~without~~ -ve feedback ~~is~~ it falls to 25. If due to ageing, the amplifier gain falls to 40. Find the percentage reduction in gain

i) without feedback (ii) with negative feedback.

Solution: $A_f = \frac{A}{1+A\beta}$ Given $A_f = 25$, $A = 50$

then $\beta = 0.02$

(i) without feedback % reduction in gain $= \frac{50-40}{50} \times 100$

$= 20\%$

when the gain without feedback was 50, the gain with feedback, was 50. Now the gain without feedback falls to 40

then $A_f = \frac{A}{1+A\beta} = \frac{40}{1+0.02\times 40} = 22.2$ | % reduction in gain $= \frac{25-22.2}{25} \times 100 = 11.2\%$

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