Series - Series Feedback Amplifier

First term series represent Input

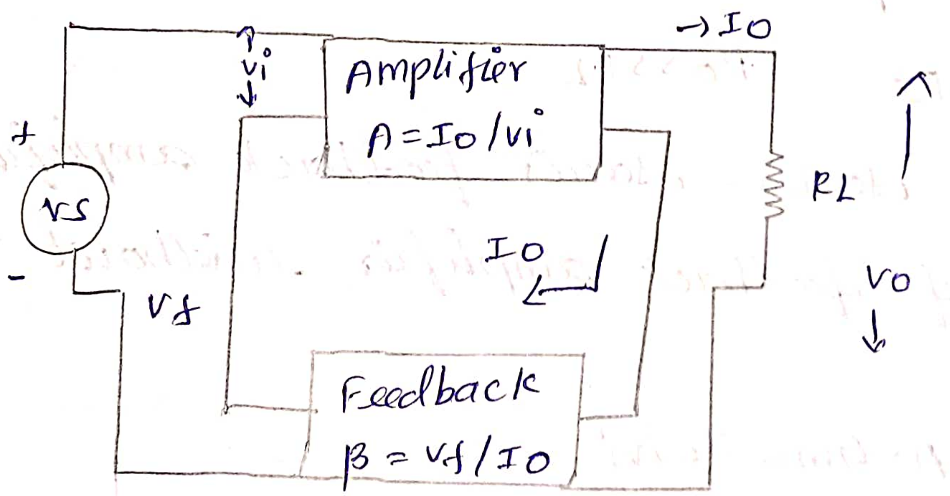
Input is voltage series

second Term series represent output

output is current series

so, It is also known as current - series feedback amplifier

Both the series, the Input and output Impedance are increased



$V_f = \beta I_o$

Amplifier with gain

$$A = \frac{I_o \rightarrow o/p}{V_i \rightarrow I/p}$$

Feedback network with gain

$\beta = V_f / I_o$

$V_f = \beta I_o$

Here, Input is voltage and output is

current, so

$I_o \propto V_i$

$I_o = G_m V_i$

$G_m = I_o V_i$

this ratio of current & voltage act

as Transfer conductance.

So it is also known as Transfer

conductance feedback amplifier.

The Input impedance is high and

output impedance are also high

$R_i >> R_s$ $\quad R_o >> R_L$

gain of series - series feedback amplifier

gain of feedback amplifier without

feedback.

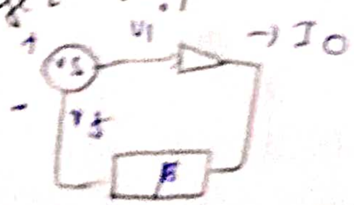
$A = G_m = I_o / V_i$

$I_o = G_m V_i$

gain of feedback amplifier with

feedback $\quad \beta = \frac{V_f}{I_o} \qquad V_f = \beta I_o$

To get input voltage amplifier



v_i = Actual Input voltage

To get a input voltage, subtracting feedback voltage from source voltage.

$$v_i = v_s - v_f$$

$$\because \boxed{v_f = \beta I_o}$$

$$v_i = v_s - \beta I_o$$

$$\because \boxed{I_o = G_m v_i}$$

$$v_i = v_s - \beta G_m v_i$$

$$v_s = v_i + \beta G_m v_i$$

$$v_s = v_i [1 + \beta G_m]$$

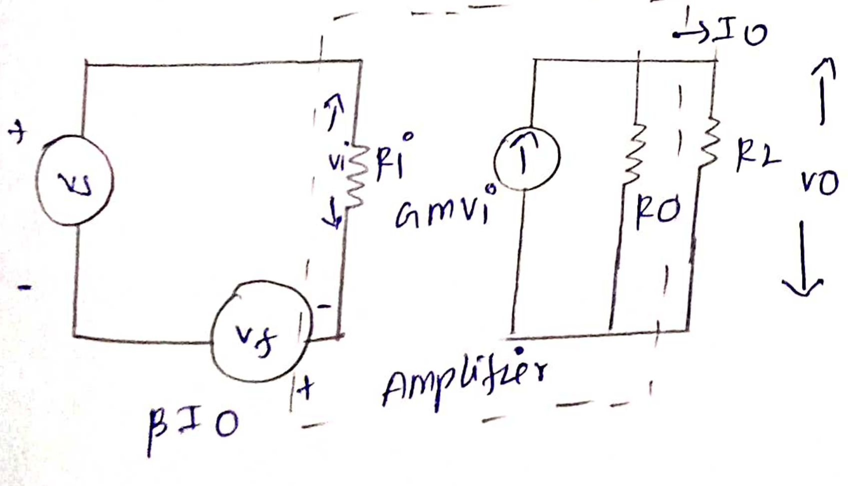
The gain of feedback amplifier

$$A_f = \frac{I_o}{v_s} \qquad \because \boxed{I_o = G_m v_i}$$

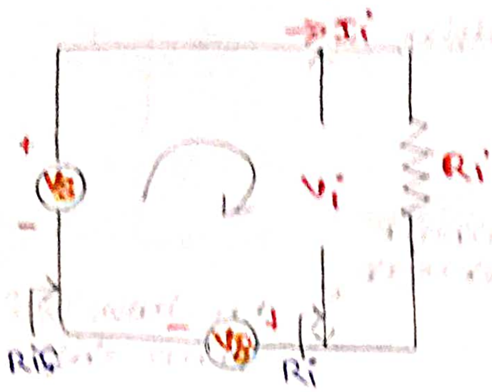
$$= \frac{G_m v_i}{v_i[1 + G_m \beta]} \qquad \boxed{v_s = v_i[1 + G_m \beta]}$$

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

The gain of amplifier decrease $(1 + G_m \beta)$ to improve stability



Input Impedance



The input impedance without feedback

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

The input impedance with feedback is

$$R_{if} = \frac{V_s}{I_i} \begin{array}{l} \rightarrow \text{I/P voltage} \\ \rightarrow \text{I/P current} \end{array}$$

Apply KVL to input circuit

$$V_s = I_i R_i + V_f \qquad [\because V_f = \beta I_o]$$

$$= I_i R_i + \beta I_o \qquad [I_o = G_M V_i]$$

$$= I_i R_i + \beta G_M V_i \qquad [V_i = I_i R_i]$$

$$= I_i R_i + \beta G_M I_i R_i$$

$$V_s = I_i R_i [1 + \beta G_M]$$

$$\frac{V_s}{I_i} = R_i [1 + \beta G_M R_i]$$

$$R_{if} = R_i [1 + G_M \beta]$$

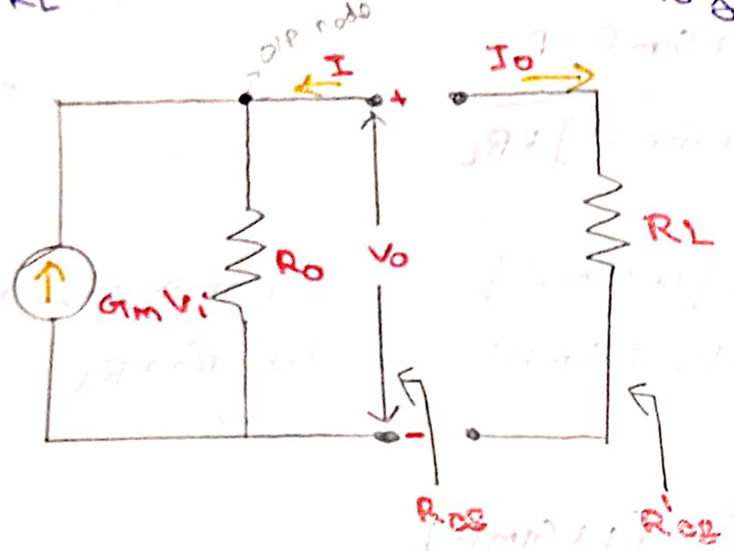
Thus the input impedance of the amplifier is increased by the factor $(1 + G_M \beta)$ using series - series feedback output Impedance

For finding the output impedance we have to make two assumption here

1) output resistance can be measured by shorting the input source $V_s = 0$

2) Looking into the output terminals with R_L disconnected

To find R_{of}



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

Applying KCL to the output Node

$V_s = 0$

$$I_o = \frac{V_o}{R_o} - G_m V_i = \frac{V_o}{R_o} - G_m V_f \quad [\because V_i = V_s - V_f$$
$$V_i = -V_f]$$

$$= \frac{V_o}{R_o} - G_m \beta I_o \quad [\because V_f = \beta I_o]$$

$$\frac{V_o}{R_o} = I_o + G_m \beta I_o$$

$$\frac{V_o}{R_o} = I_o [1 + G_m \beta]$$

$$\frac{V_o}{I_o} = R_o [1 + G_m \beta]$$

$$R_{of} = R_o [1 + G_m \beta]$$

Thus the output impedance is increased by the factor $(1 + G_m \beta)$ using series - series feedback

Output Impedance with 'RL'

Then we can include this RL which is parallel to this Rof to get R'of

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

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

$$= \frac{R_o[1+G_m\beta]R_L}{R_o[1+G_m\beta]+R_L}$$

$$= \frac{R_o R_L[1+G_m\beta]}{R_o+R_L+G_m\beta R_o}$$ ÷ numerator and denominator by R_o+R_L

$$R'_{of} = \frac{\frac{R_o R_L}{R_o+R_L}[1+G_m\beta]}{\frac{R_o+R_L}{R_o+R_L}+\frac{R_o G_m}{R_o+R_L}\beta}$$

where

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

$$G_M = \frac{R_o}{R_o+R_L} G_m$$ → Gain of the amplifier without RL resistor

↓ Gain of the amplifier with RL resistor

$$R'_{of} = \frac{R'_o(1+\beta G_m)}{(1+\beta G_M)}$$