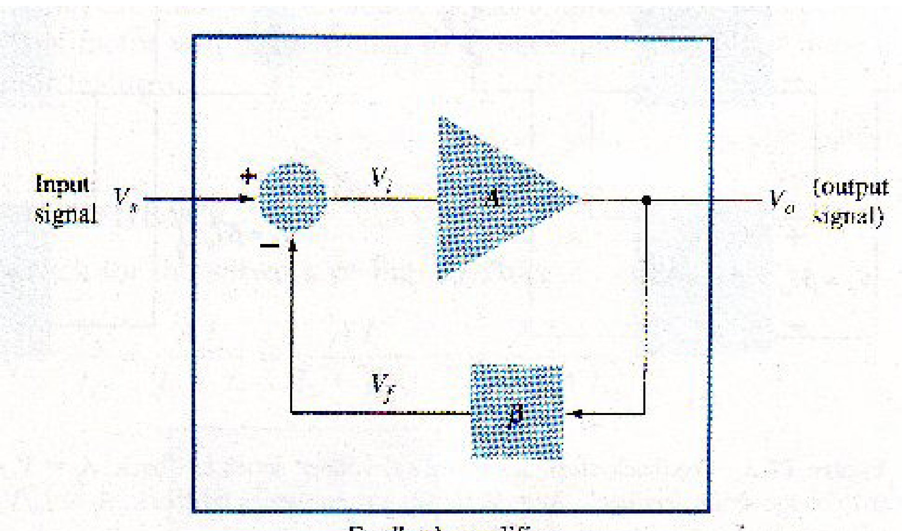
Feedback Amplifier

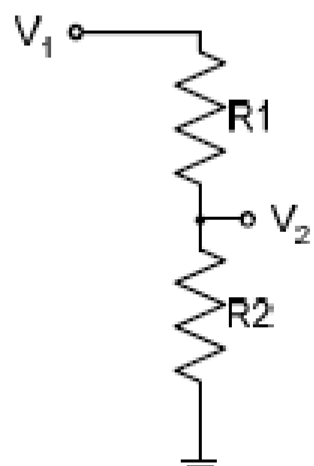
➢ Feedback amplifier contains two component namely feedback circuit and amplifier circuit.

➢ Feedback circuit is essentially a potential divider consisting of resistances R_1 & R_2

➢ The purpose of feedback circuit is to return a fraction of the output voltage to the input of the amplifier circuit.



Feedback amplifier



feedback fraction β

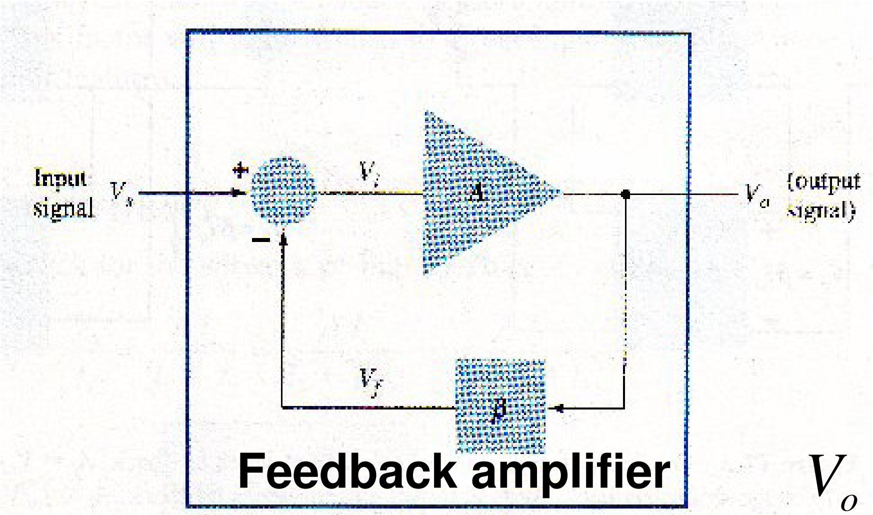
$$\beta = \frac{V_2}{V_1} = \frac{R_2}{R_1 + R_2}$$

Feedback circuit

Feedback

- Both negative feedback and positive feedback are used in amplifier circuits.

- Negative feedback returns part of the output to oppose the input, whereas in positive feedback the feedback signal aids the input signal.



Feedback amplifier

If $V_f = 0$ (there is no feedback)

$$A = \frac{V_o}{V_S} = \frac{V_o}{V_i}$$

If feedback signal V_f is connected in series with the input, then $V_i = V_S - V_f$

$$V_o = AV_i = A(V_s - V_f) \quad \text{But} \quad V_f = \beta V_o$$

$$V_o = A(V_s - \beta V_o) \qquad V_o(1+\beta A) = AV_s$$

A_f : closed-loop gain of the amplifier
A: Open-loop gain of the amplifier gain

$$A_f = \frac{V_o}{V_s} = \frac{A}{(1+\beta A)}$$

Feedback

For negative feedback: *$\beta A > 0$;* For positive feedback: *$\beta A < 0$*

Advantages of Negative feedback

➢ **Negative feedback can reduce the gain of the amplifier, but it has many advantages, such as gain stabilization, reduction of nonlinear distortion and noise, control of input and output impedances, and extension of bandwidth.**

❑ Gain stabilization

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

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

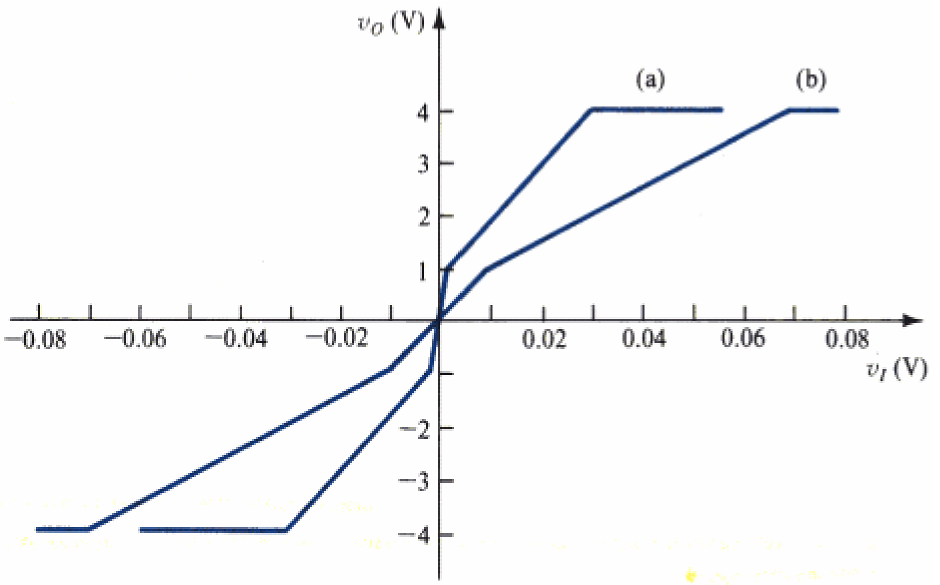
$$\frac{dA_f}{A_f} = \frac{1}{(1+\beta A)}\frac{dA}{A}$$

Therefore percentage change in A_f *(due to variations in some* circuit parameter) is reduced by (1+βA) times compared to without feedback.

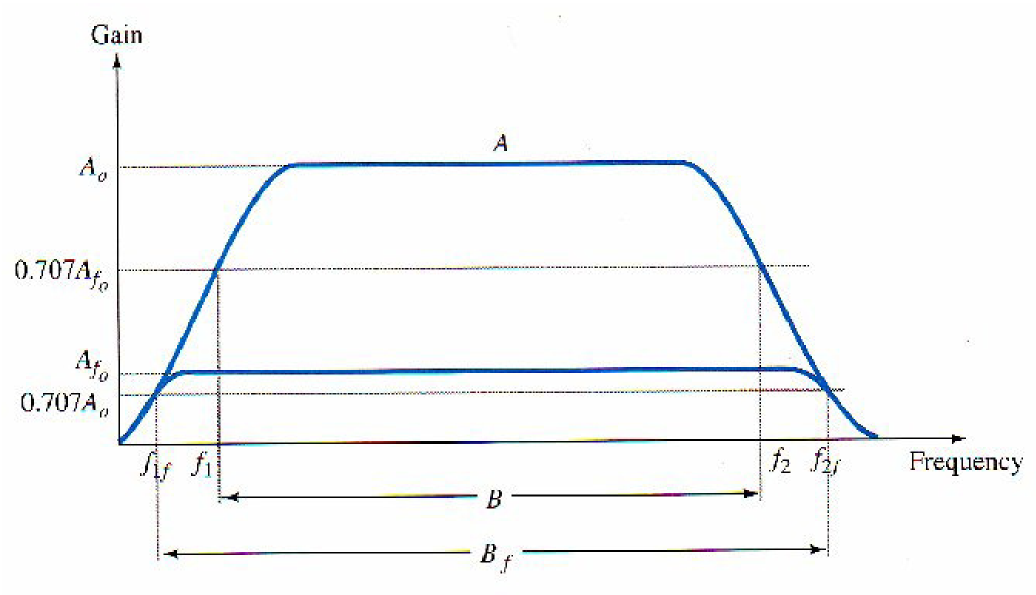
Advantages of Negative feedback

❑ Reduction of nonlinear distortion

(a) Open loop gain
(b) Closed loop gain



❑ Bandwidth extension



Basic Feedback Topologies

➢ **Depending on the input signal (voltage or current) to be amplified and form of the output (voltage or current), amplifiers can be classified into four categories. Depending on the amplifier category, one of four types of feedback structures should be used.**

❖ **Voltage series feedback (**$A_f = V_o/V_s$) – *Voltage amplifier*

❖ **Voltage shunt feedback (**$A_f = V_o/I_s$) – *Trans-resistance amplifier*

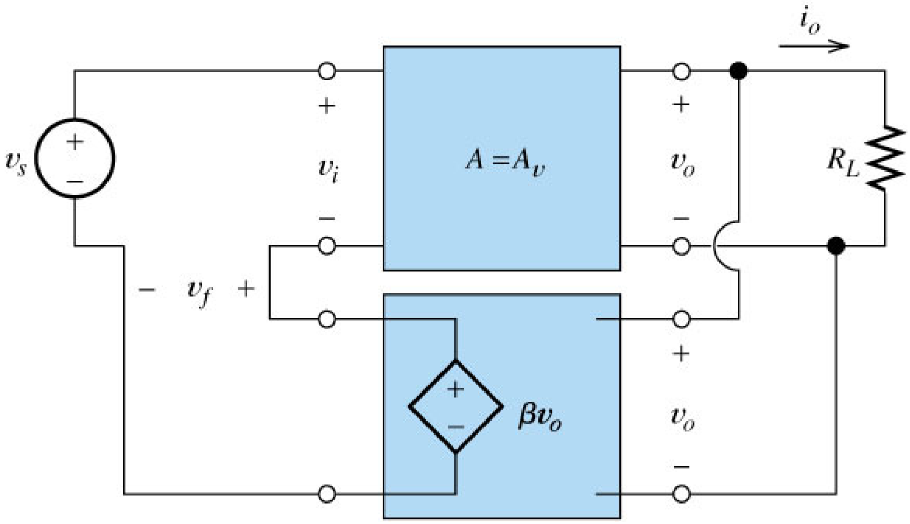
❖ **Current series feedback (**$A_f = I_o/V_s$) **-** *Trans-conductance amplifier*

❖ **Current shunt feedback (**$A_f = I_o/I_s$) - Current amplifier

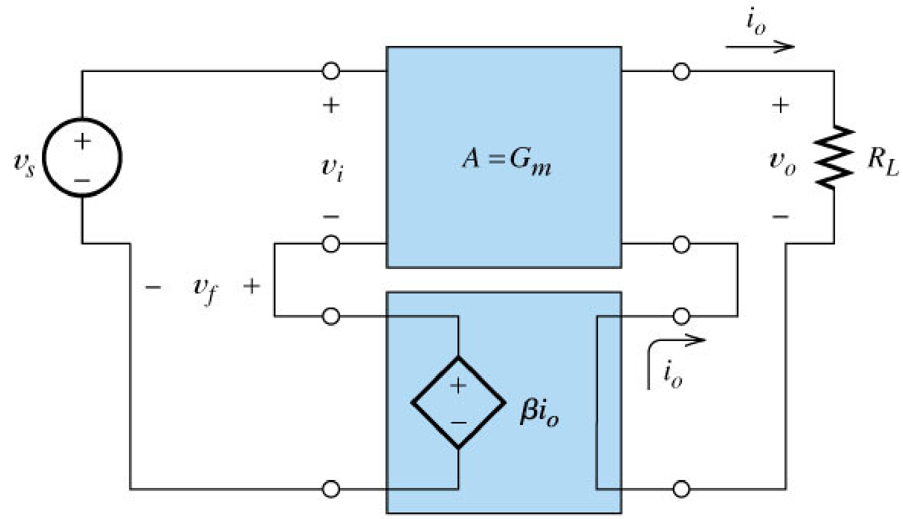
➢ **Here voltage refers to connecting the output voltage as input to the feedback network. Similarly current refers to connecting the output current as input to the feedback network.**

➢**Series refers to connecting the feedback signal in series with the input voltage; Shunt refers to connecting the feedback signal in shunt (parallel) with an input current source.**

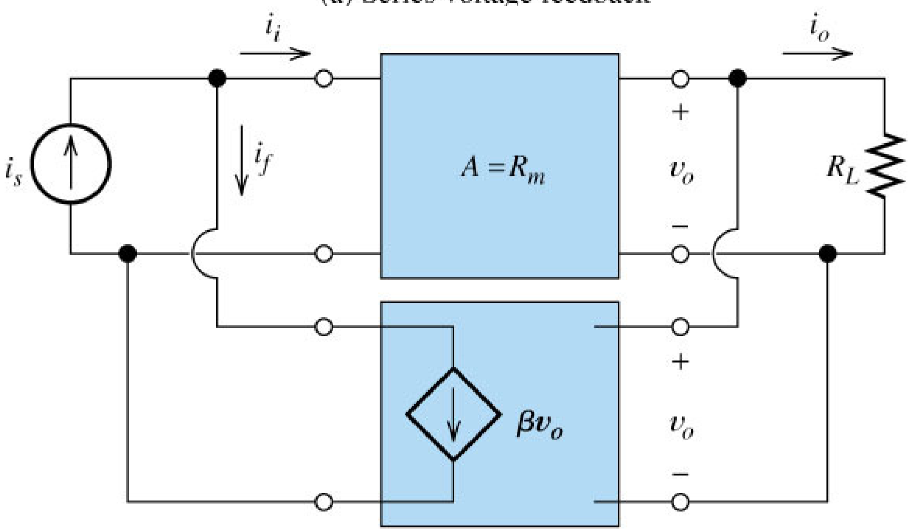
Feedback topologies



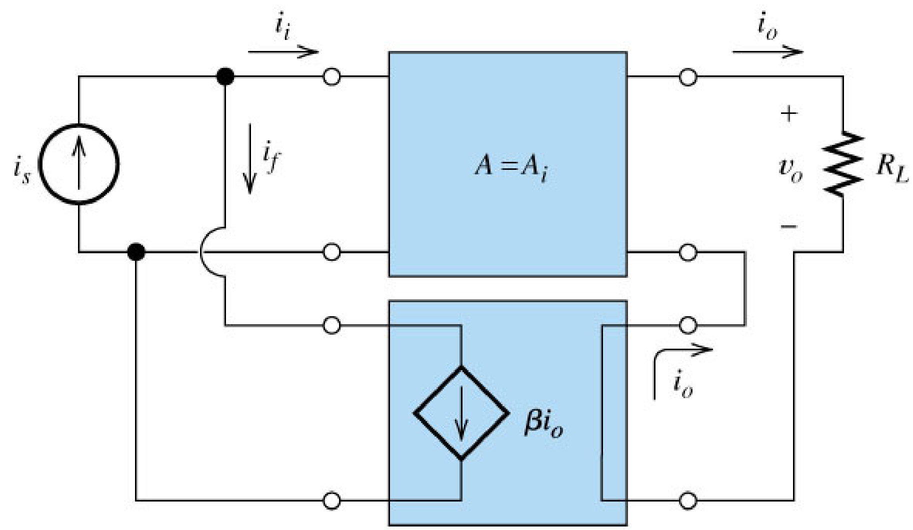
(a) Series voltage feedback



(b) Series current feedback



(c) Parallel voltage feedback



(d) Parallel current feedback