Basic Concept of Feedback

A block diagram of an amplifier with feedback is shown in the figure below. The output quantity (either voltage or current) is sampled by a suitable sampler, which is of two types, namely, voltage sampler and current sampler, and fed back to the feedback network. The fraction of the output signal is combined with external source signal V_s through of a mixer and fed to the basic amplifier. Mixers, also known as comparators, are of two types, namely, series mixer and shunt mixer.

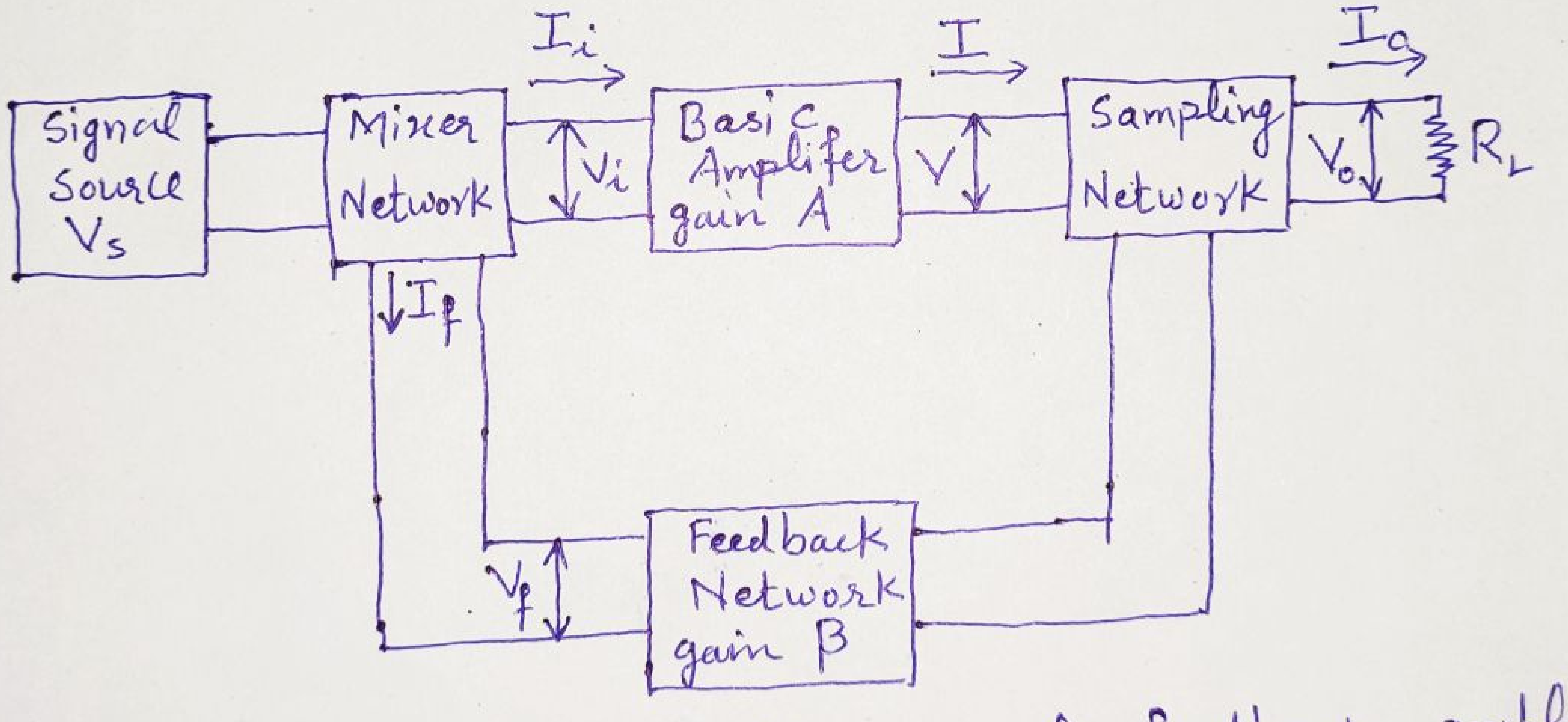

Fig. Block diagram of feedback amplifier

Note: A = gain of the basic amplifier = $\frac{V_o}{V_i}$

β = feedback ratio = $\frac{V_f}{V_o}$

A_f = gain of the feedback amplifier = $\frac{V_o}{V_s}$

V_f = feedback signal (voltage or current)

Feedback Network

This is usually a passive two-port network and may be formed of resistors, capacitors and inductors. However, more often it is simply formed of resistors.

Sampling Network

There are two ways of sampling the signal at the output which is shown in Figure (a) and (b) below. In Figure (a), the output voltage is sampled by connecting the feedback network in shunt across the output. This type of connection at the output is referred to as voltage or node sampling. Another feedback connection which samples the output current is shown in Figure (b), where the feedback network is connected in series with the output. This type of connection is referred to as current or loop sampling.

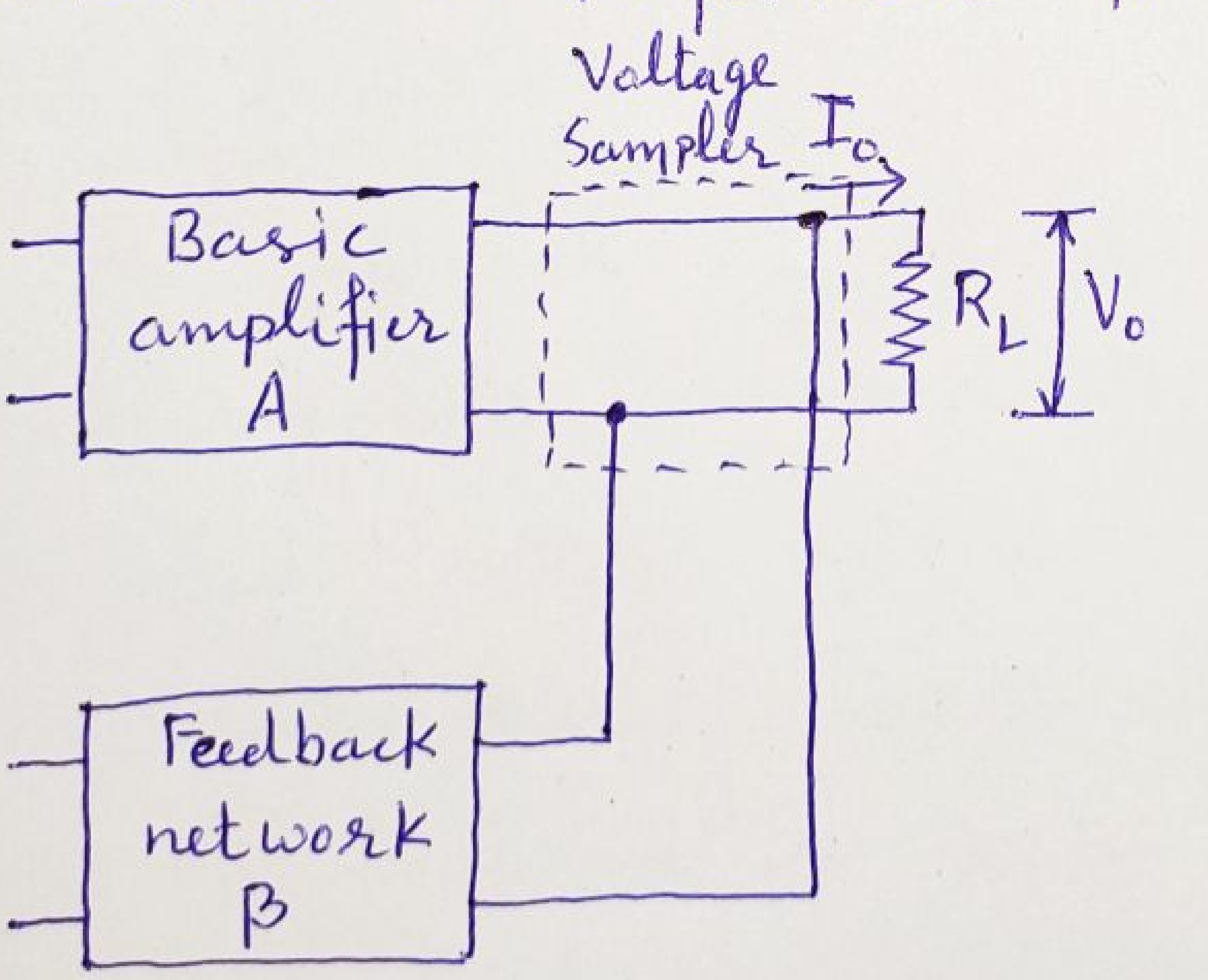

Figure. (a). Voltage or node Sampling

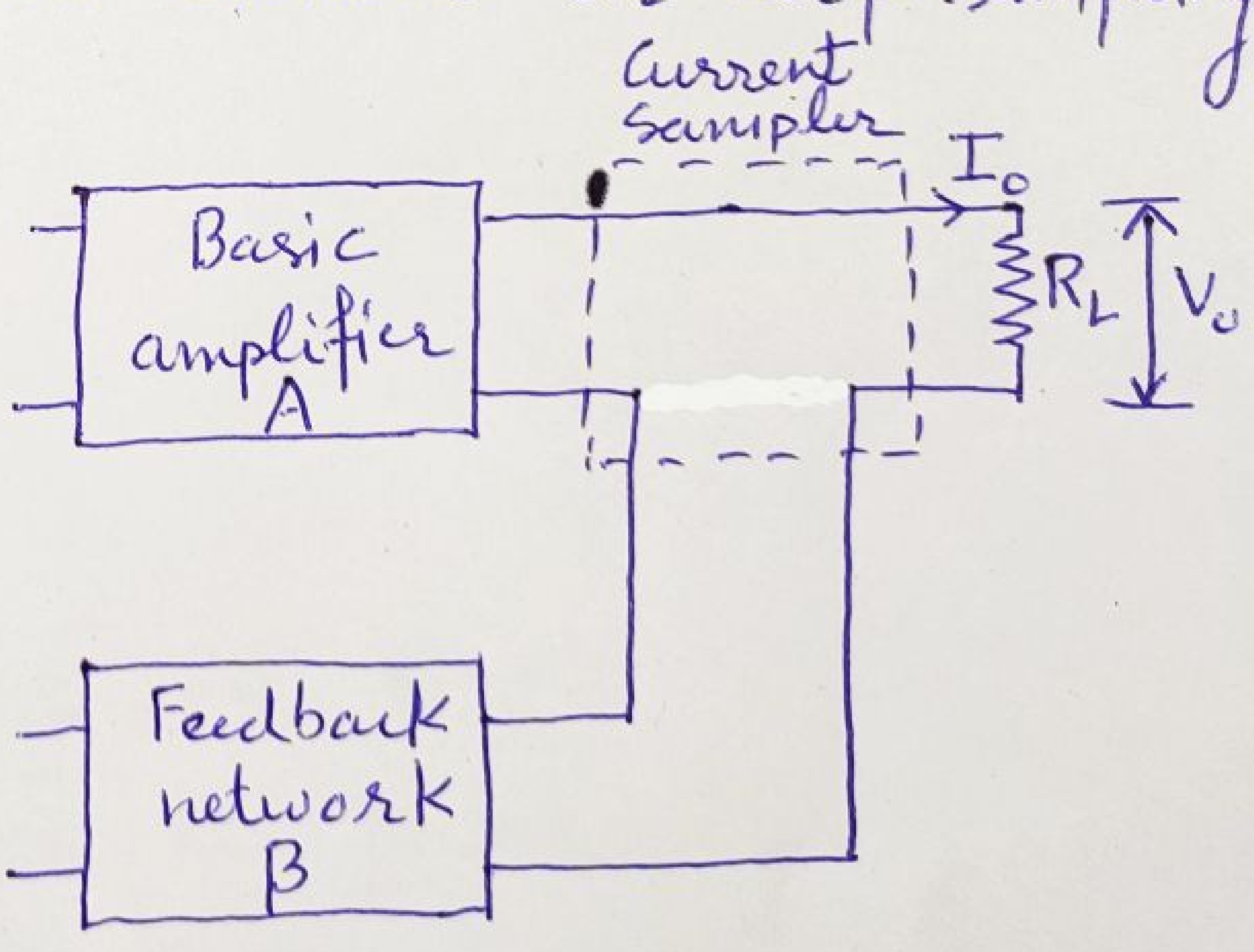

Figure. (b). Current or loop Sampling

Mixer Network

The feedback voltage may be mixed with single voltage in two basic ways : (a) series input and (b) shunt input. Figure (i) shows the series (loop) connection and Figure (ii) shows the shunt (node) connection at the input.

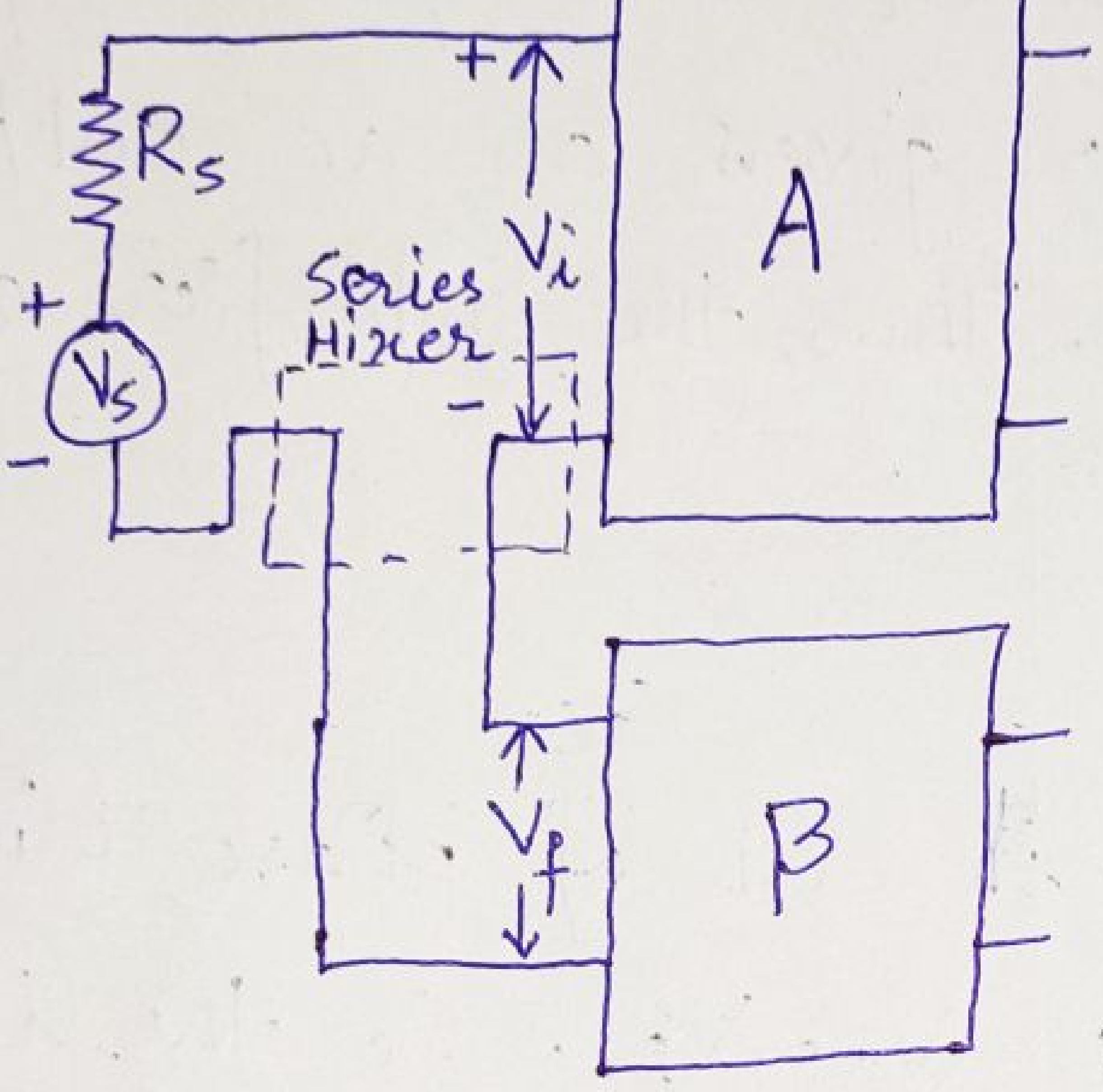

Figure (i) Series input Connection

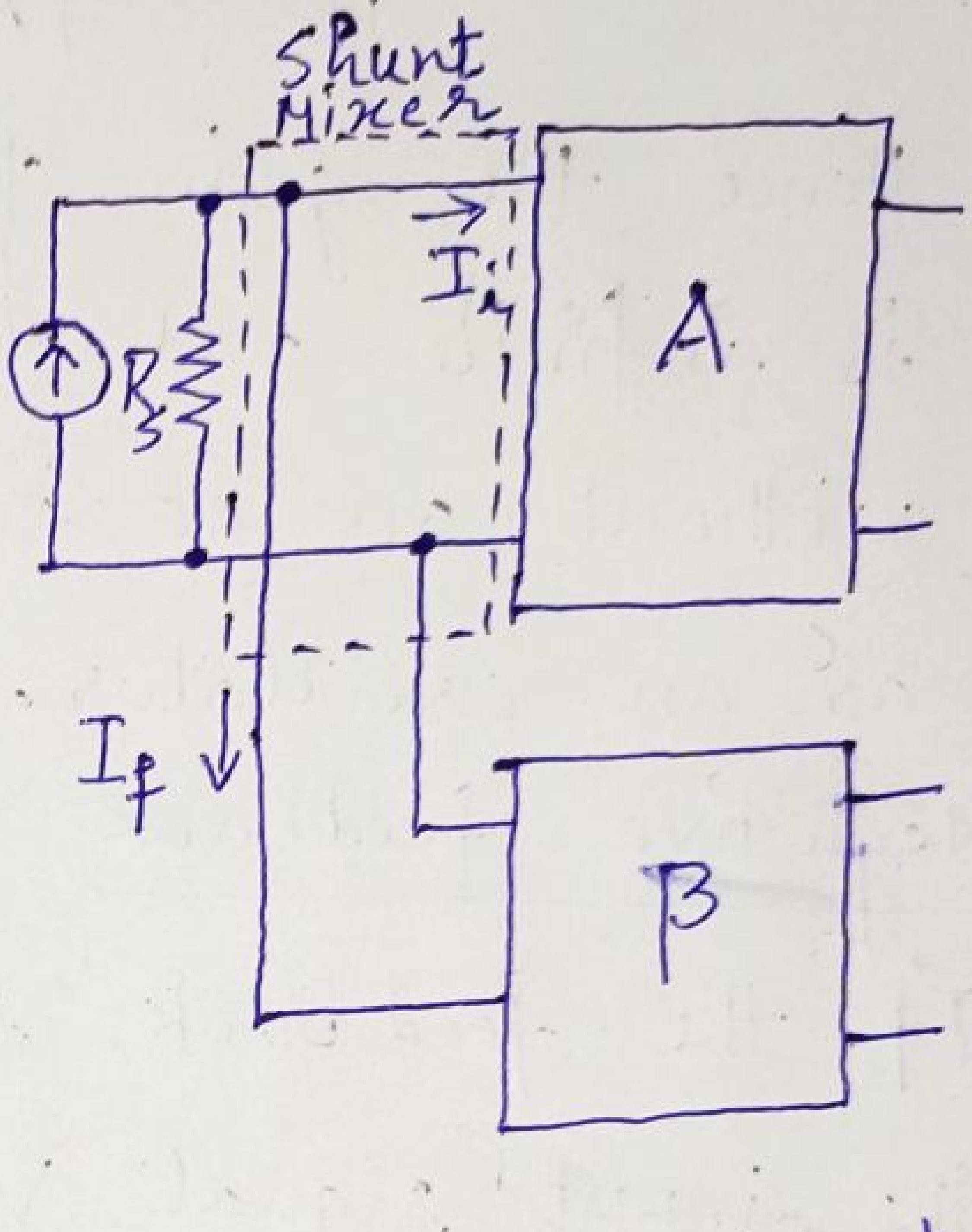

Figure (ii). Shunt input connection

Positive and Negative Feedback

Positive feedback

If the feedback signal V_f is in phase with the input signal V_s, then the net $V_i = V_s + V_f$. Hence the input voltage applied to the basic amplifier is increased, thereby increasing V_o exponentially. This type of feedback is said to be positive or regenerative feedback. Gain of the amplifier with positive feedback is

$$A_f = \frac{V_o}{V_s} = \frac{V_o}{V_i - V_f} = \frac{1}{\frac{V_i}{V_o} - \frac{V_f}{V_o}}$$

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

Here $|A_f| > |A|$. The product of the open gain and the feedback factor is called the loop gain.

i.e loop gain = $A\beta$

if $|A\beta| = 1$, then $A_f = \infty$

Hence the gain of the amplifier with positive feedback is infinite and the amplifier gives an ac output without an ac input signal. Thus, the amplifier acts as an oscillator.

Negative feedback

If the feed back signal V_f is out of phase with the input signal V_s, then $V_i = V_s - V_f$. So the input voltage applied to the basic amplifier is decreased and correspondingly the output is decreased. Hence, the voltage gain is reduced. This type of feedback is known as negative or degenerative feedback. Gain of the amplifier with negative feedback is,

$$A_f = \frac{V_o}{V_s} = \frac{V_o}{V_i + V_f} = \frac{1}{\frac{V_i}{V_o} + \frac{V_f}{V_o}}$$

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

Here $|A_f| < |A|$. If $|A\beta| \gg 1$, then $A_f = \frac{1}{\beta}$, where β is a feedback ratio. So, the gain will depend upon the feedback network only.