US03CPHY02
UNIT 3 Feedback in Amplifiers
Part- 1 Feedback Concepts

Dr. T. H. Patel
Associate Professor
VP & RPTP Science College
Vallabh Vidyanagar-388120
Gujarat, India.
pateltarunh@yahoo.com

UNIT 3 USO3CPHY02

UNIT-III Feedback in Amplifiers

Concepts of feedback in amplifiers, Types of feedback, Voltage gain of feedback amplifier, Advantages of negative feedback, Stabilization of gain, Reduction in distortion and noise, Increase in input impedance, Decrease in output impedance, Increase in bandwidth, Amplifier circuit with negative feedback, RC coupled amplifier without bypass capacitor, Emitter follower, Related Numericals

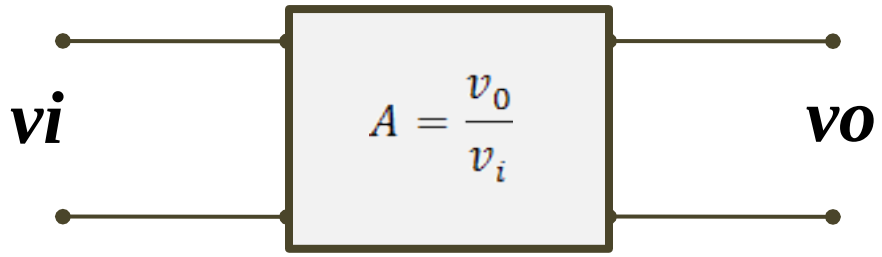
UNIT-IV Oscillators

Need of an oscillator, Classification of oscillators, Tuned circuit for generation of sine waves, Frequency of oscillation in LC circuit, Sustained oscillations, Positive feedback amplifier as an oscillator, The starting voltage, Hartley oscillator, Colpitts oscillator, Basic principles of RC oscillator, Phase shift oscillator, Wien bridge oscillator, Crystal oscillators, Crystal oscillator circuit, Related Numericals

Feedback in Amplifiers.

What is a feedback?

It is the process of taking a part from output signal (current or voltage) and feeding it back (in series or shunt) to the input of the amplifier



Amplifier

v_i = Input voltage to amplifier

v_o = Output voltage of amplifier

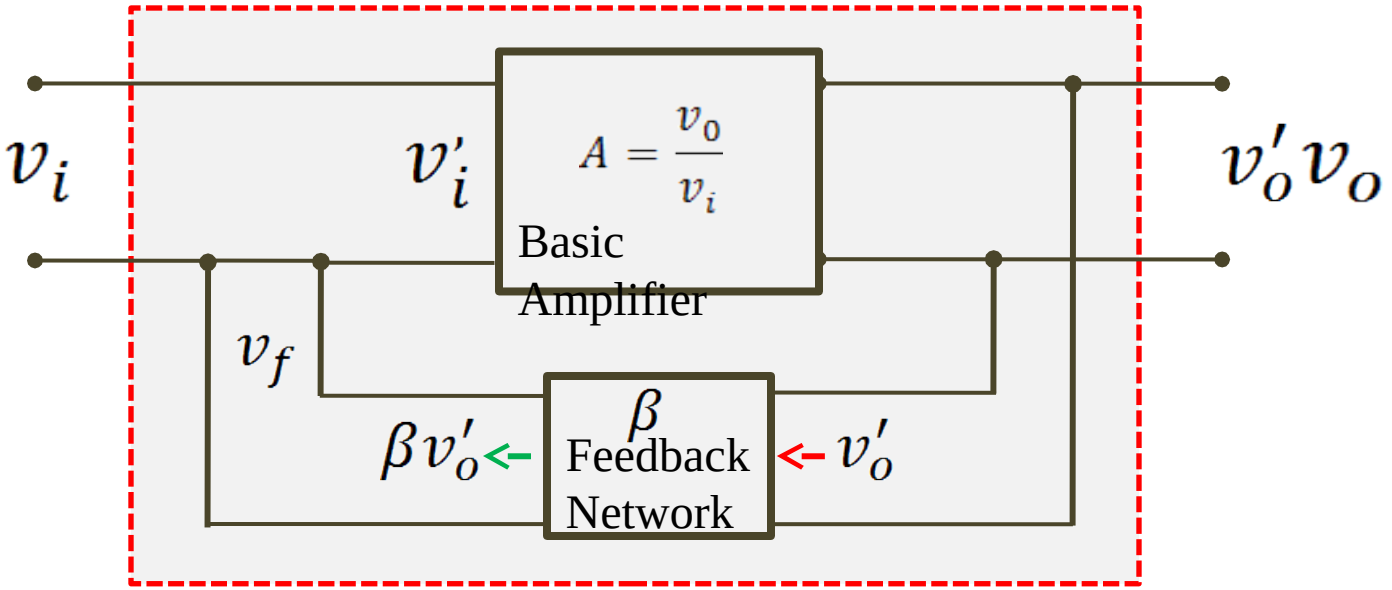
$A = \frac{v_0}{v_i}$ = Gain of amplifier

Input is not affected by Output .

This is a Open loop or non-feedback system.

What is a feedback System?

Feedback Amplifier



This is a closed loop or feedback system.
Input is affected by Output.

v_i = input voltage

v_o = Output voltage of Basic amplifier

v_o' = output voltage

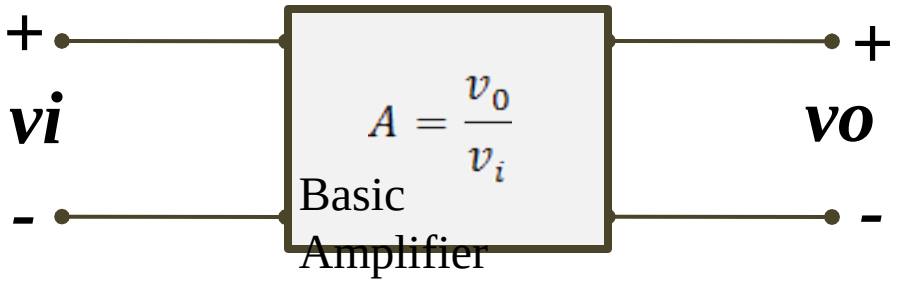
β = Feedback Factor

$v_f = \beta v_o'$ = Feedback Voltage

v_i' = effective input voltage

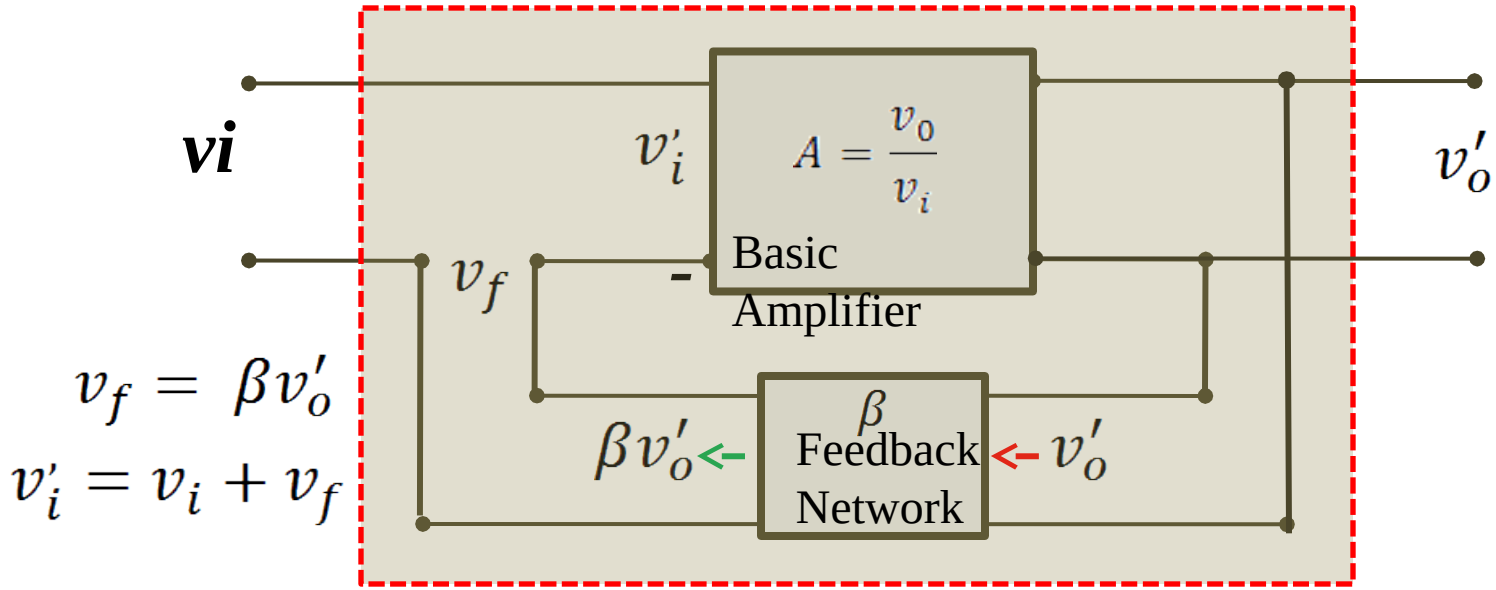
$v_i' = v_i + v_f$

$A_f = \frac{v_o'}{v_i}$ = **Gain of Feedback Amplifier**



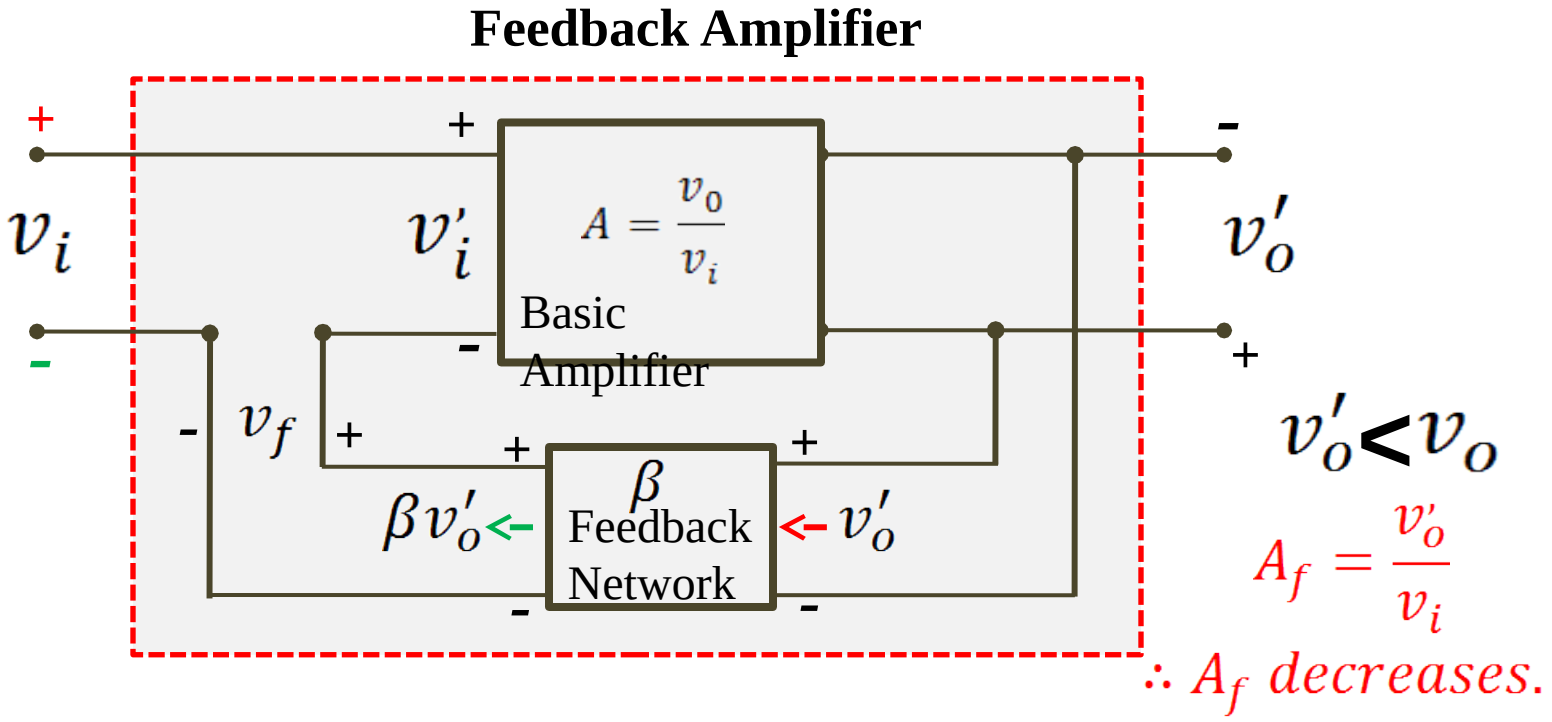
Open loop or non-feedback system.

Feedback Amplifier



closed loop or feedback system

Types of Feedback: Phase Based



v_i = input voltage

v_o' = output voltage

β = Feedback Factor

$v_f = \beta v_o'$ = Feedback Voltage

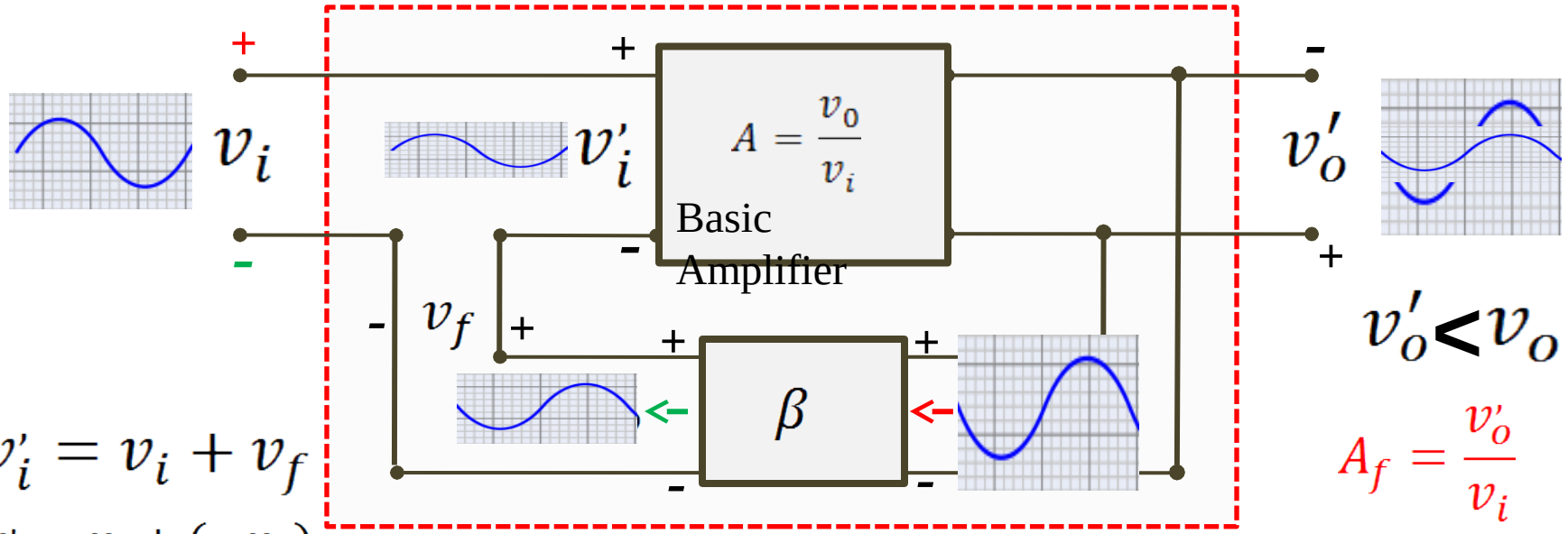
v_i' = effective input voltage

$$v_i' = v_i + v_f$$

$$v_i' = v_i + (-v_f)$$

$$\therefore v_i' = v_i - v_f$$

Types of Feedback: Phase Based



$v_o' < v_o$

$v_i' = v_i + v_f$

$v_i' = v_i + (-v_f)$

$\therefore v_i' = v_i - v_f$

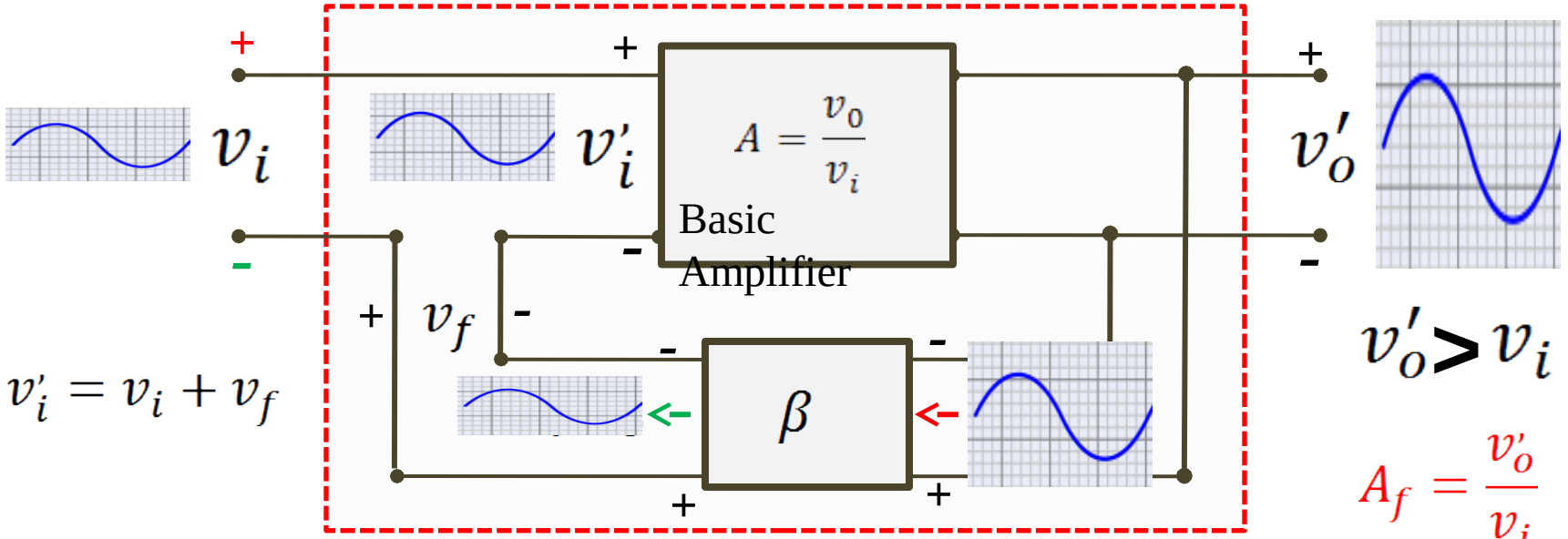
$A_f = \frac{v_o'}{v_i}$

$\therefore A_f$ *decreases.*

Negative Feedback

Also known as de-generative or inverse feedback

Types of Feedback: Phase Based

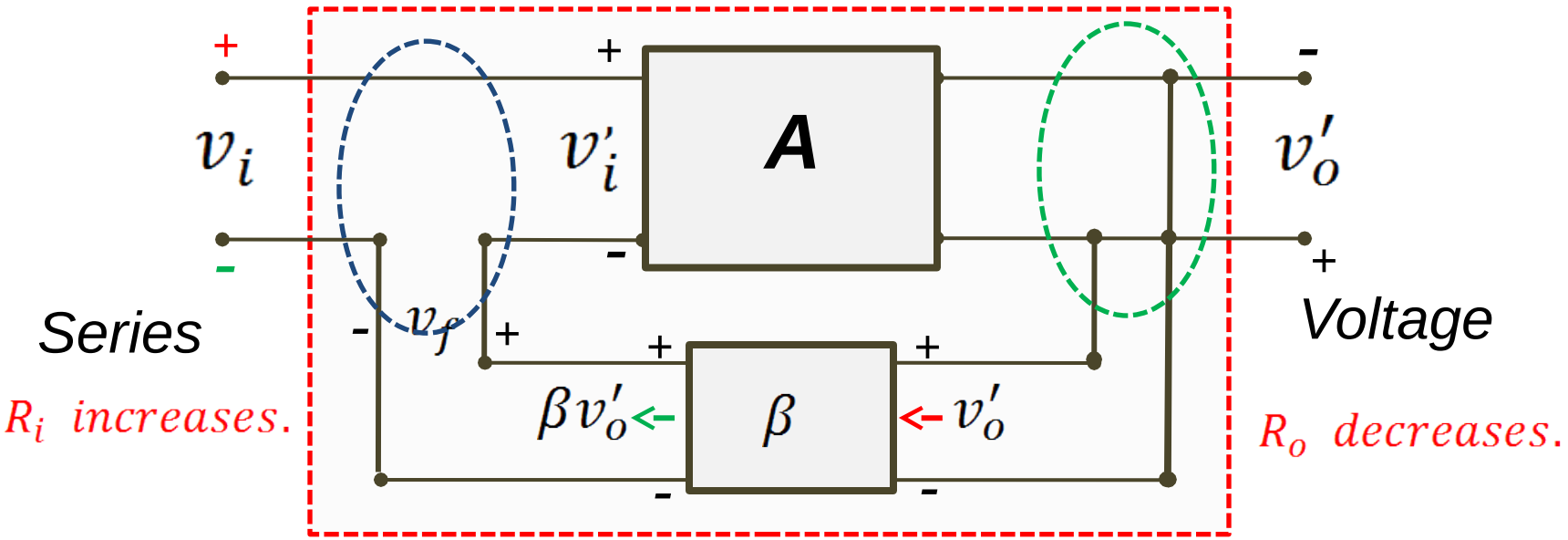


Positive Feedback

Also known as re-generative or direct feedback

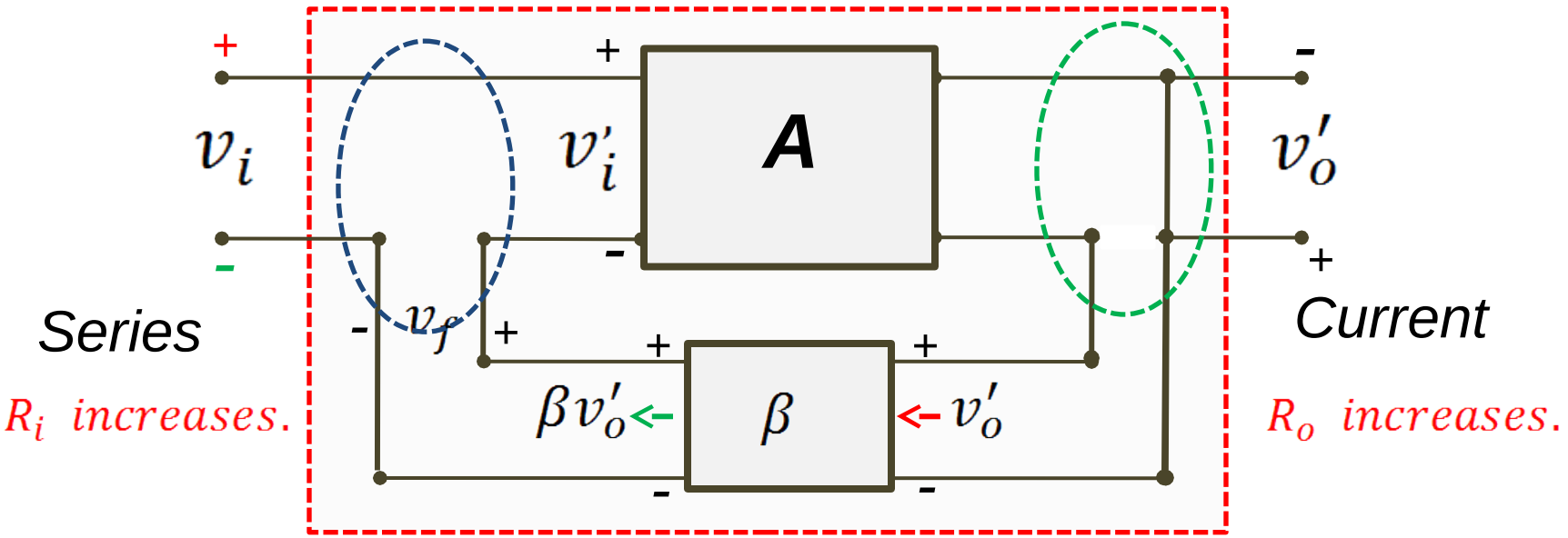
A. Negative Feedback B. Positive Feedback

Types of Feedback: What you Feed? How you feed?



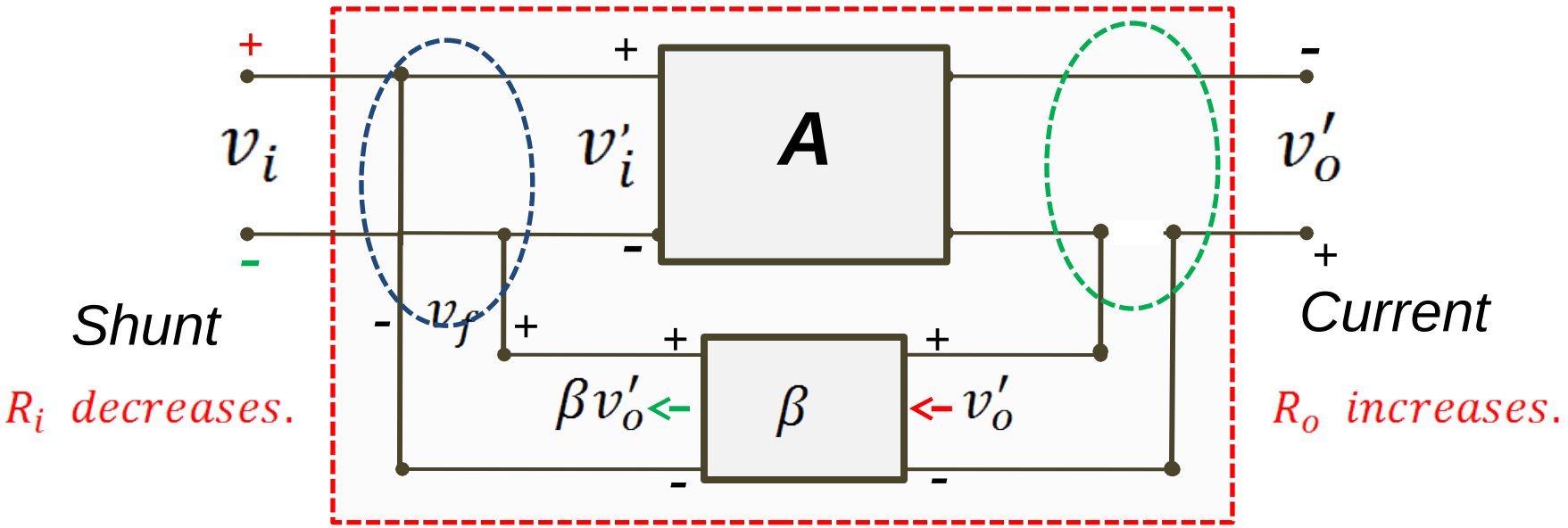
1. Series Voltage feedback

Types of Feedback: What you Feed? How you feed?



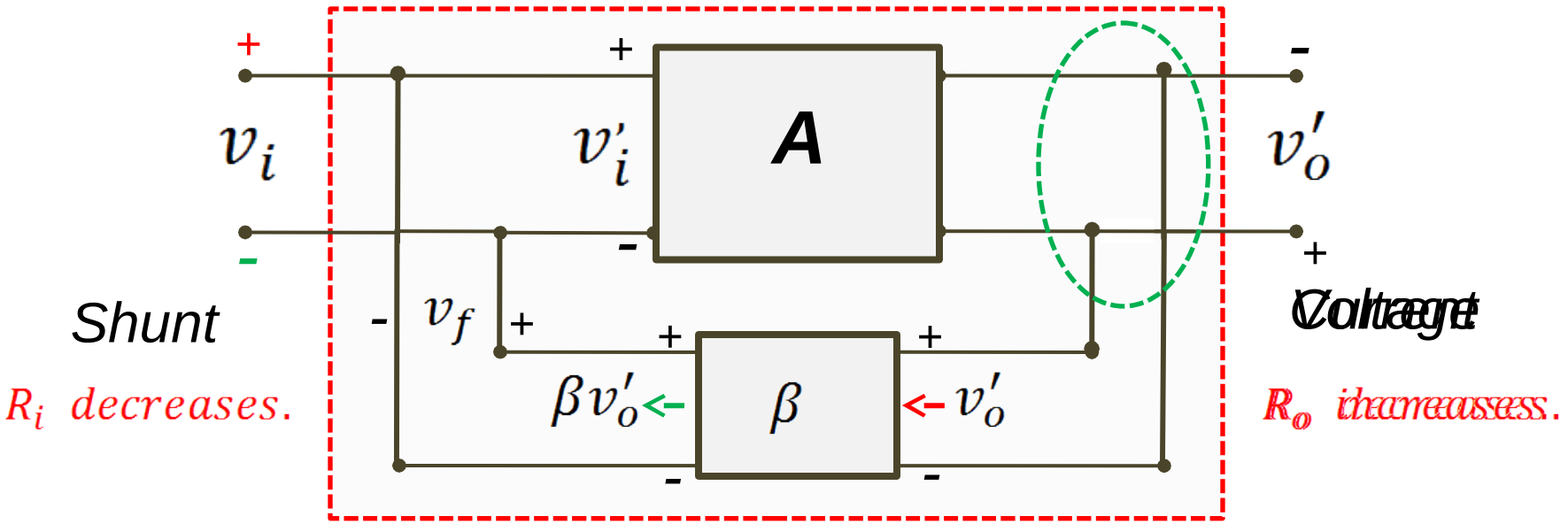
1. Series Voltage feedback

Types of Feedback: What you Feed? How you feed?



3. Shunt Current feedback

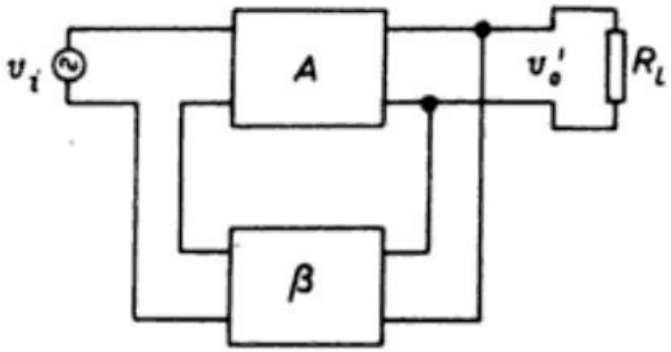
Types of Feedback: What you Feed? How you feed?



4. Shunt Voltage feedback

1. Series Voltage feedback
2. Shunt Current feedback
3. Shunt Voltage feedback
4. Shunt Current feedback

Types of Feedback



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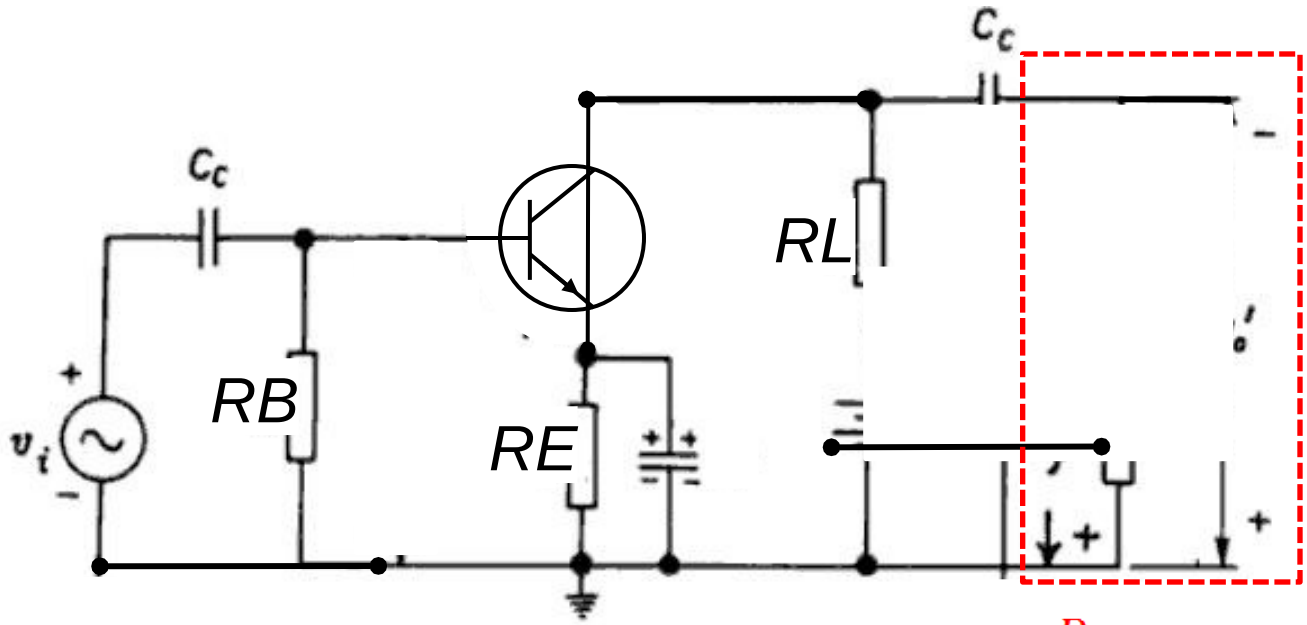
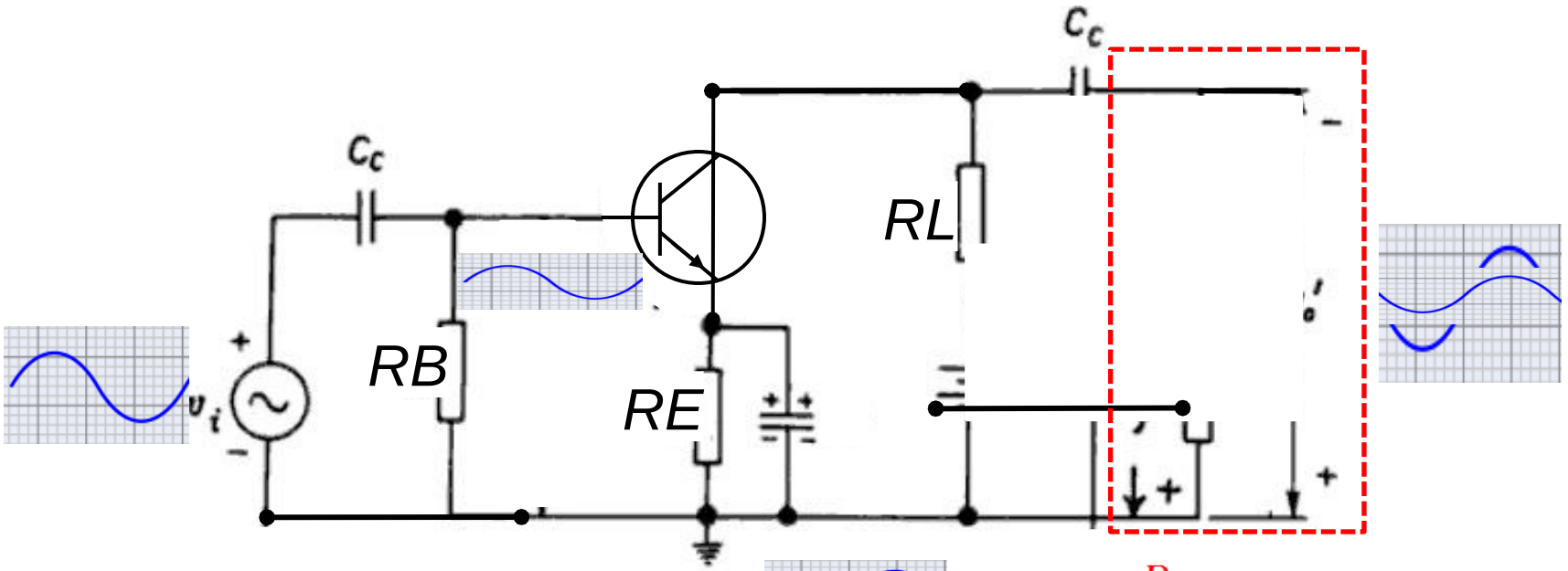
Voltage Gain of Feedback Amplifier



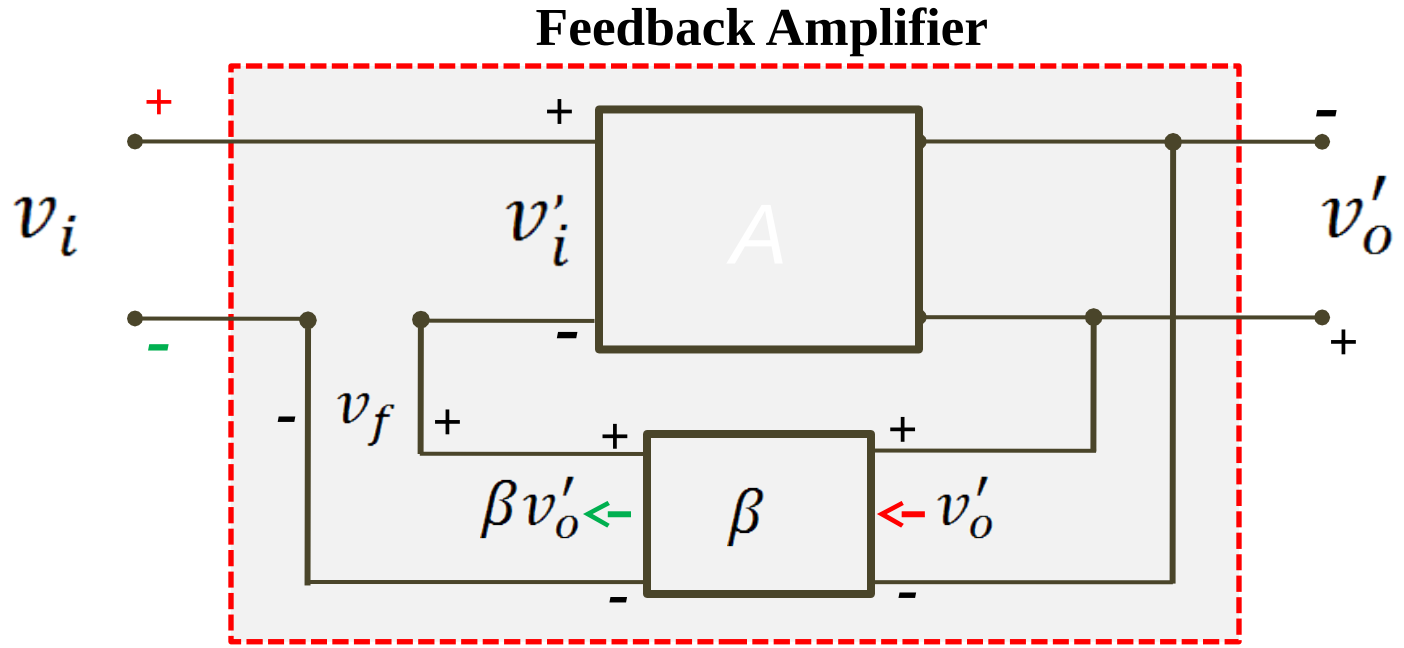
$$v_f = \frac{R_1}{R_1 + R_2} v_o'$$

Voltage Gain of Feedback Amplifier



$$v_f = \frac{R_1}{R_1 + R_2} v_o'$$

Block diagram of Series Voltage feedback



v_i = input voltage

v_o' = output voltage

β = Feedback actor $= \frac{R_1}{R_1 + R_2}$

$v_f = \beta v_o'$ = Feedback Voltage

v_i' = effective input voltage to feedback amplifier

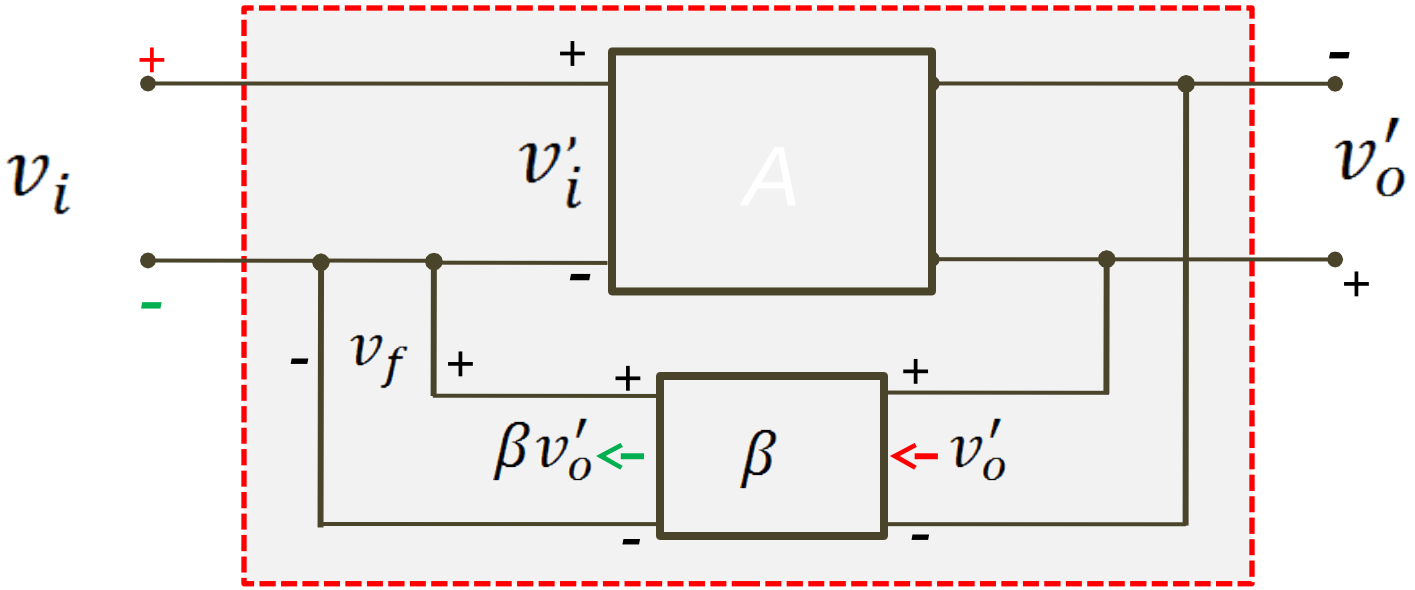
$v_i' = v_i + v_f$

Gain of basic Amplifier = $A = \frac{v_0'}{v_i'}$

Gain of Feedback Amplifier = $A_f = \frac{v_o'}{v_i}$

Af in terms of *A for series voltage negative feedback*

Feedback Amplifier



For negative feedback:

$$v_i' = v_i - v_f$$

$$Since\ v_f = \beta v_o',$$

$$v_i' = v_i - \beta v_o'$$

$$\therefore\ Av_i' = Av_i - A\beta v_o'$$

$$Since\ Av_i' = v_o',$$

$$v_o' = Av_i - A\beta v_o'$$

$$\therefore\ v_o'(1 + A\beta) = Av_i$$

$$\therefore\ \frac{v_0'}{v_i} = \frac{A}{(1 + A\beta)}$$

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

For positive feedback:

$$v_i' = v_i + v_f$$

$$v_i' = v_i + \beta v_o'$$

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

Af in terms of A

Example 12.1 Calculate the gain of a negative-feedback amplifier with an internal gain, $A = 100$, and feedback factor $\beta = 1/10$.

Solution: The gain of the feedback amplifier is given by

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

Af in terms of A

Example 12.2 An amplifier with negative feedback has a voltage gain of 100. It is found that without feedback, an input signal of 50 mV is required to produce a given output; whereas with feedback, the input signal must be 0.6 V for the same output. Calculate the value of A and β.

Solution: The gain A_f of the feedback amplifier is 100. The input voltage required to produce the same output voltage as for the amplifier without feedback, is 0.6 V. Thus, the output will be

$$v_o' = A_f V_i = 100 \times 0.6 = 60 \text{ V}$$

If no feedback is employed, the required input to produce 60 V output is 50 mV = 0.05 V. Hence, the internal gain of the amplifier is

$$A = \frac{V_o}{V_i} = \frac{60}{0.05} = 1200$$

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

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

or $$1 + 1200 \times \beta = \frac{1200}{100}$$

or $$\beta = \frac{12 - 1}{1200} = \frac{11}{1200} = \frac{11}{12}\ \%$$

Positive versus Negative feedback

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

i.e. Af increases.

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

i.e. Af decreases.

Although Negative feedback is more preferred! Why? Because it offers following advantages.

1. Improves stability of amplifier gain (*Af*).
2. Reduces Distortion and Noise.
3. Increases the input impedance of the amplifier.
4. Decreases the output impedance of the amplifier.
5. Increses the Bandwidth.

- Also, gain can be increased in other way. i.e. by using the multi-stage amplifier.

Advantages of Negative feedback