SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Course Name: **23BMB101-Electron Devices and Circuits**

I Year : II Semester

Unit V –Feedback Amplifiers and Oscillators

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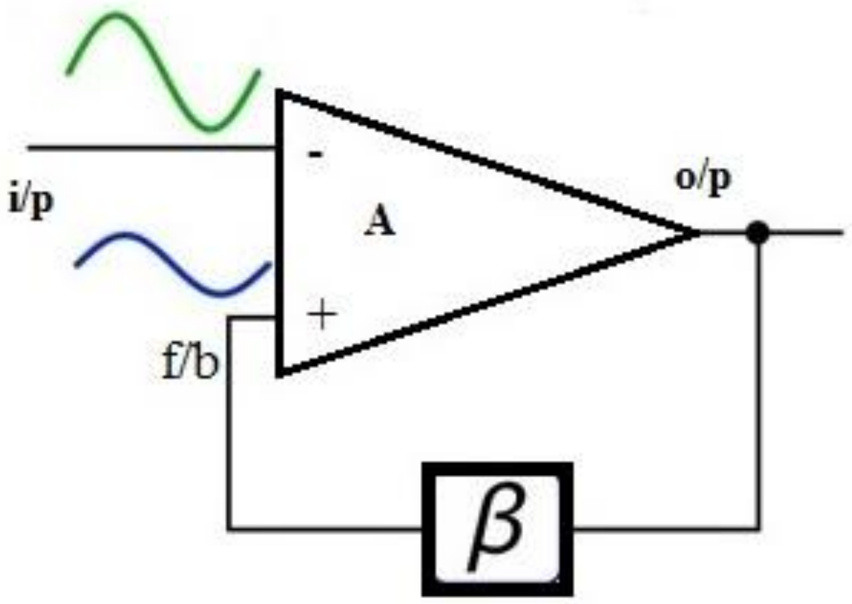
Topic : Negative Feedback Amplifiers

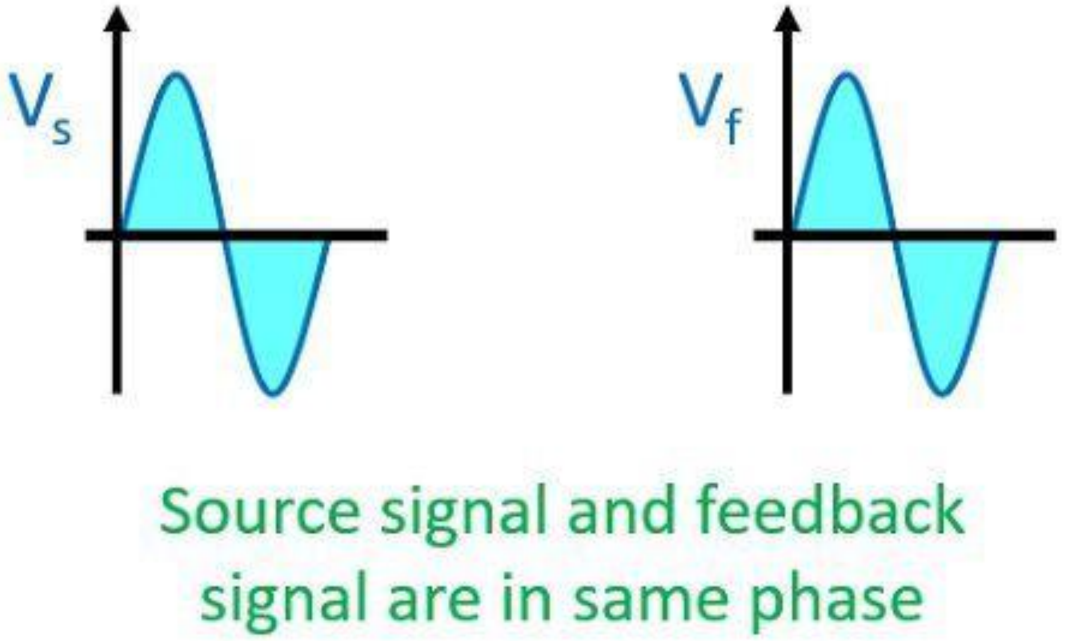
INTRODUCTION

- The phenomenon of feeding a portion of the output signal back to the input circuit is known as feedback. The effect results in a dependence between the output and the input and an effective control can be obtained in the working of the circuit. Feedback is of two types.
  - Positive Feedback
  - Negative Feedback

Positive or regenerate feedback

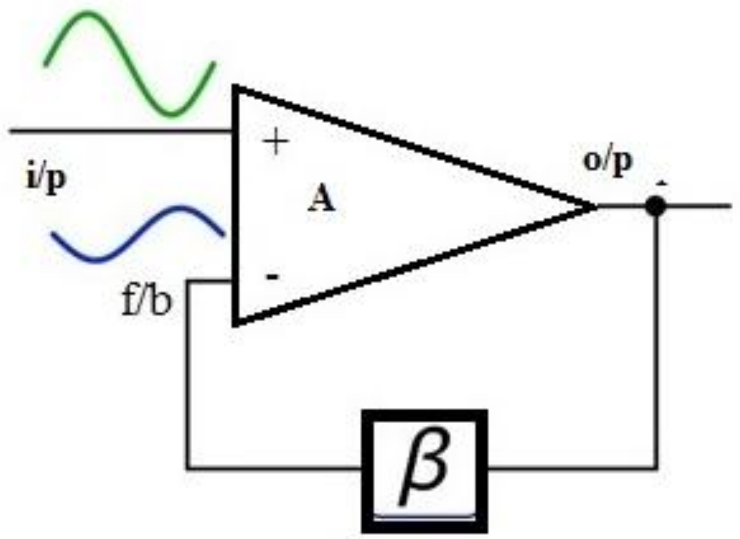
- In positive feedback, the feedback energy (voltage or currents), is in phase with the input signal and thus aids it. Positive feedback increases gain of the amplifier also increases distortion, noise and instability.
- Because of these disadvantages, positive feedback is seldom employed in amplifiers. But the positive feedback is used in oscillators.





Negative or Degenerate feedback

- In negative feedback, the feedback energy (voltage or current), is out of phase with the input signal and thus opposes it.
- Negative feedback reduces gain of the amplifier. It also reduce distortion, noise and instability.
- This feedback increases bandwidth and improves input and output impedances.
- Due to these advantages, the negative feedback is frequently used in amplifiers.



Source signal and feedback signal are out of phase

Negative Feedback

- Feedback energy is out phase with their input signal
- Gain of the amplifier decreases
- Gain stability increases
- Noise and distortion decreases
- Increase the band width
- Used in amplifiers

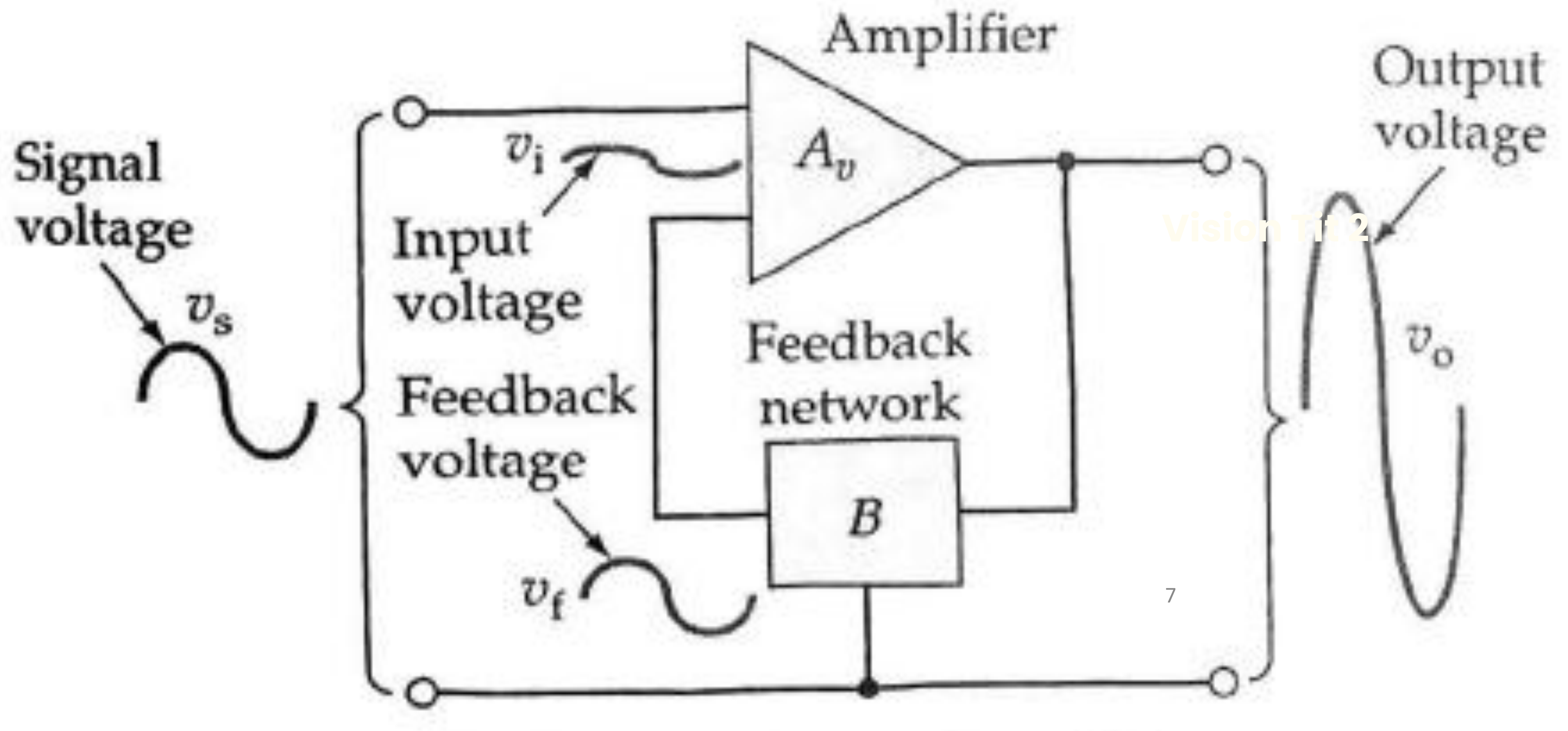
Positive Feedback

- Feedback energy is in phase with the input signal
- Gain of the amplifier increases
- Gain stability decreases
- Noise and distribution increases
- Decreases bandwidth
- Used in Oscillators

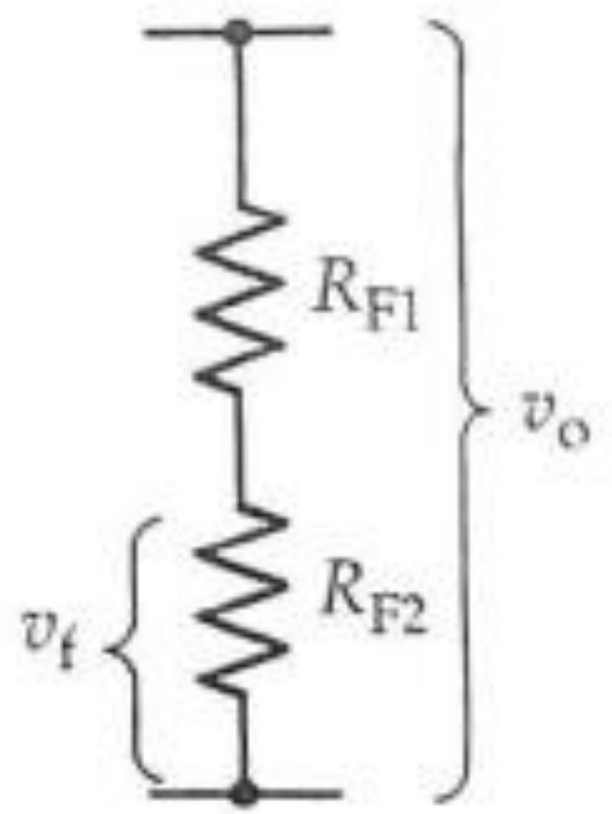
Classification of Feedback Amplifiers

- Feedback Amplifiers
  - Voltage series feedback
  - Voltage shunt feedback
  - Current shunt feedback
  - Current series feedback

SERIES VOLTAGE NEGATIVE FEEDBACK



(a) Negative feedback amplifier

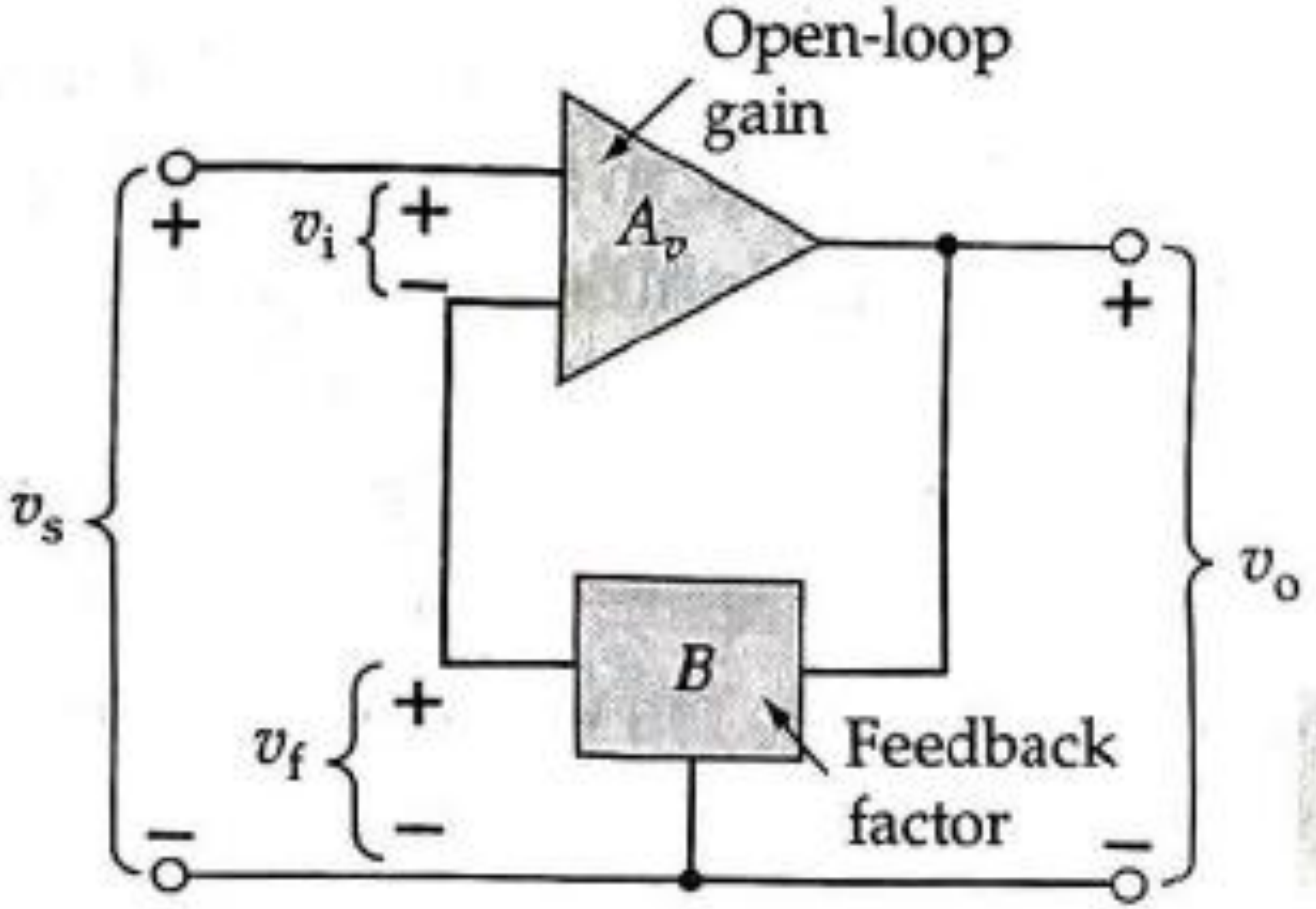


(b) Feedback network

$$V_i = V_s - V_f = V_s - \beta V_o$$

SERIES VOLTAGE NEGATIVE FEEDBACK

VOLTAGE GAIN



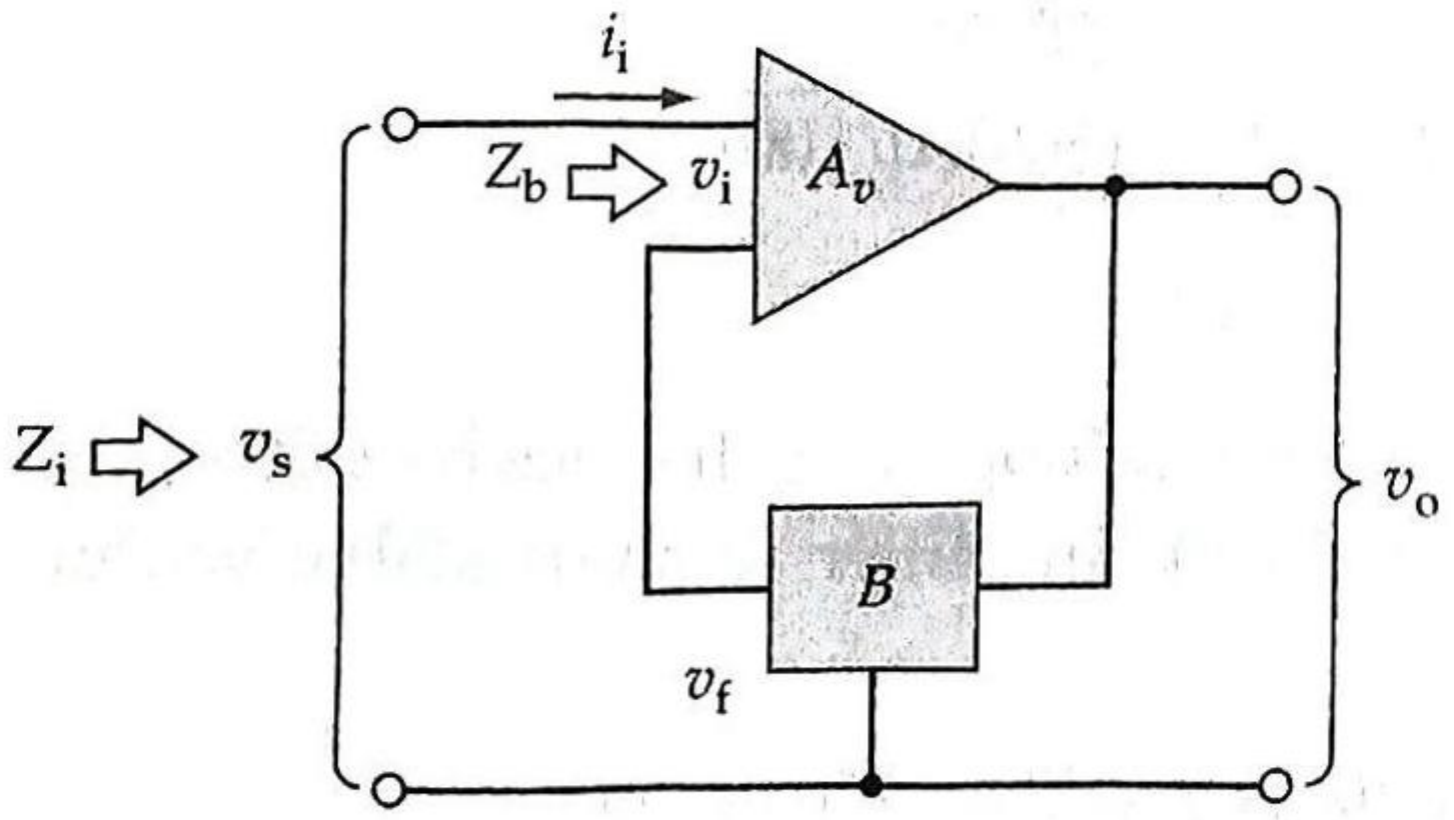
Open-loop gain $A_v = \frac{v_o}{v_i}$

Feedback factor $B = \frac{v_f}{v_o}$

Closed-loop gain $A_{CL} = \frac{A_v}{1 + A_v B}$

SERIES VOLTAGE NEGATIVE FEEDBACK

INPUT IMPEDANCE



•If no negative feedback is present in the amplifier, the input impedance is given by

$$Z_b = \frac{v_i}{i_i}$$

$$i_i = \frac{v_i}{Z_b}$$

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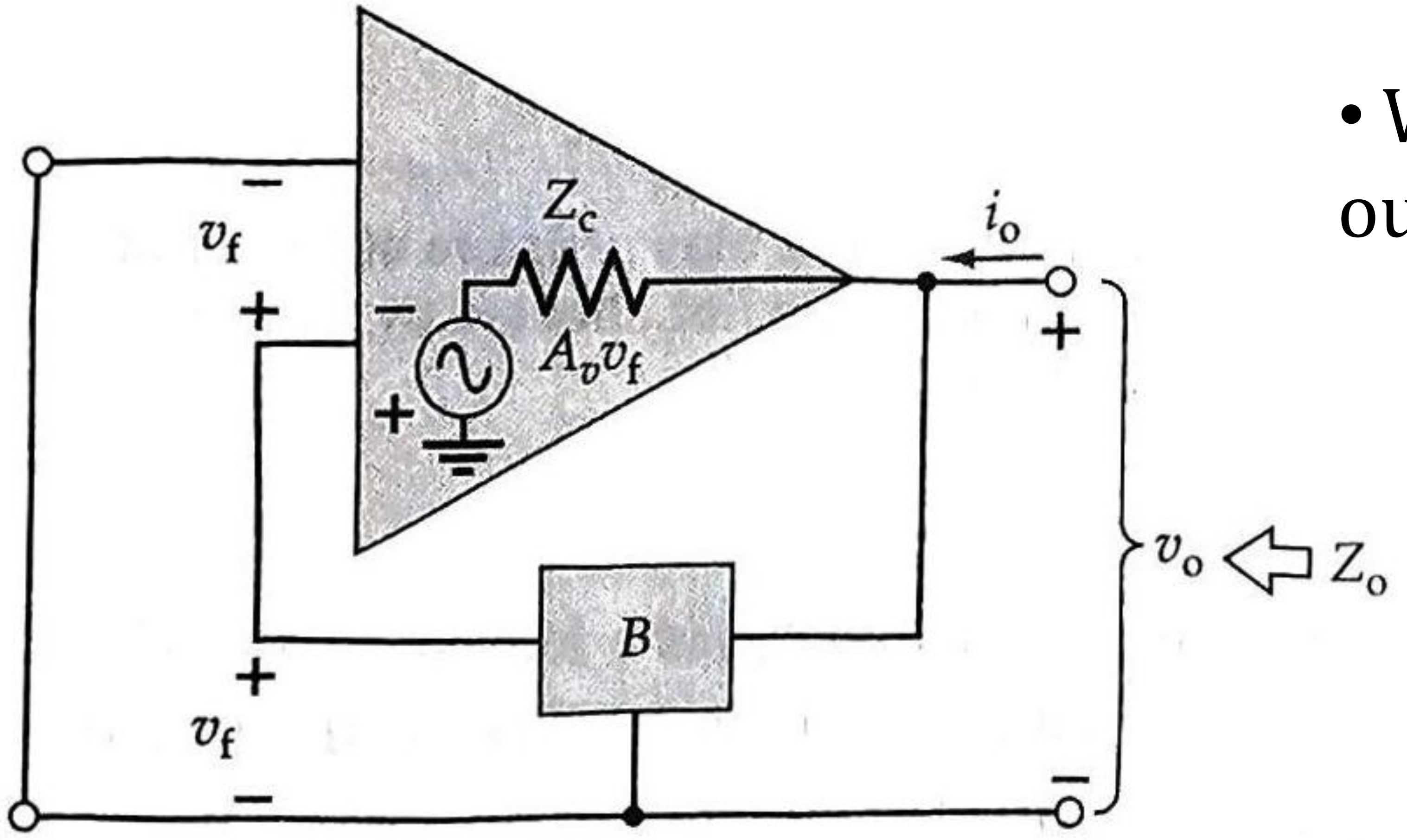
•With negative feedback, the input impedance is

$$Z_i = \frac{v_s}{i_i} = \frac{v_s \times Z_b}{v_i}$$

$$Z_i = (1 + A_v B) Z_b$$

SERIES VOLTAGE NEGATIVE FEEDBACK

OUTPUT IMPEDANCE



- Writing an equation for the voltage drops around the output circuit of the negative feedback amplifier gives

$$v_o = i_o Z_c - A_v v_f$$

$$i_o Z_c = v_o + A_v v_f$$

$$= v_o + A_v B v_o$$

$$= v_o(1 + A_v B)$$

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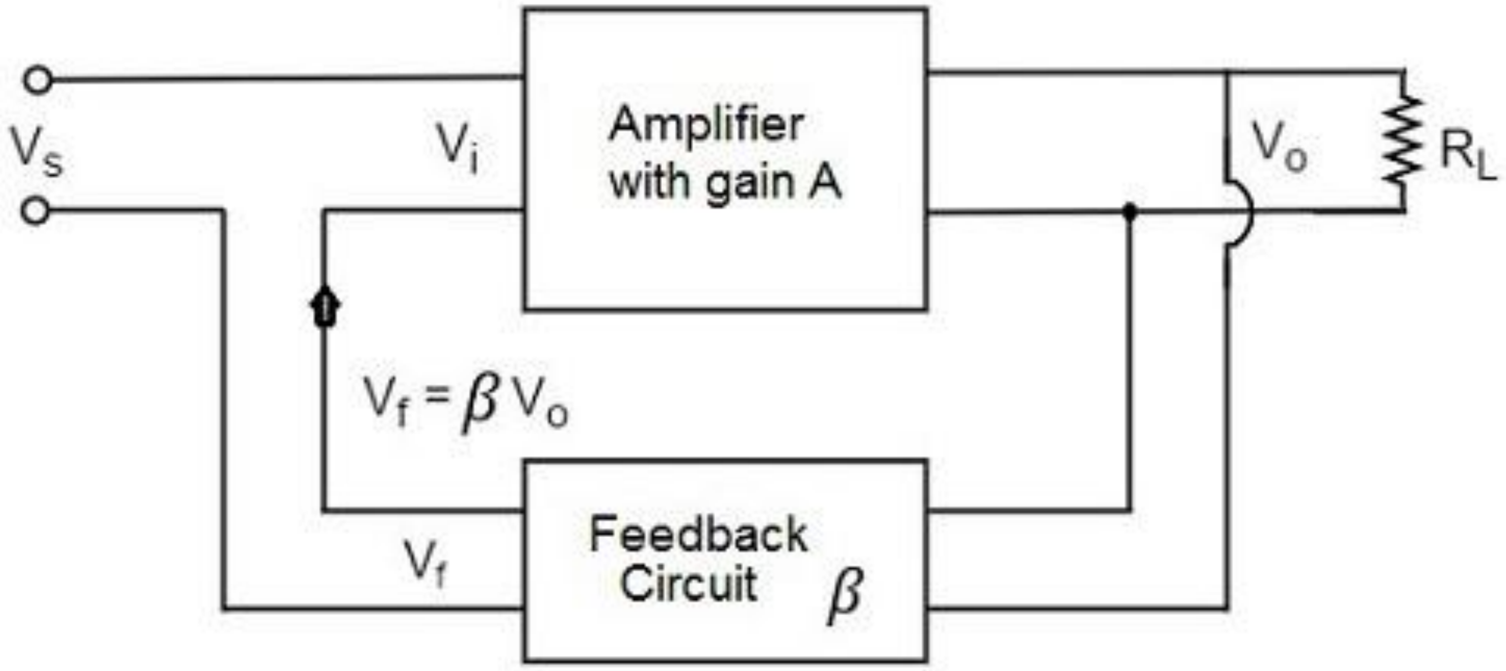
$$Z_o = \frac{v_o}{i_o} \qquad Z_o = \frac{Z_c}{1 + A_v B}$$

FEEDBACK TOPOLOGIES

Voltage-Series Feedback



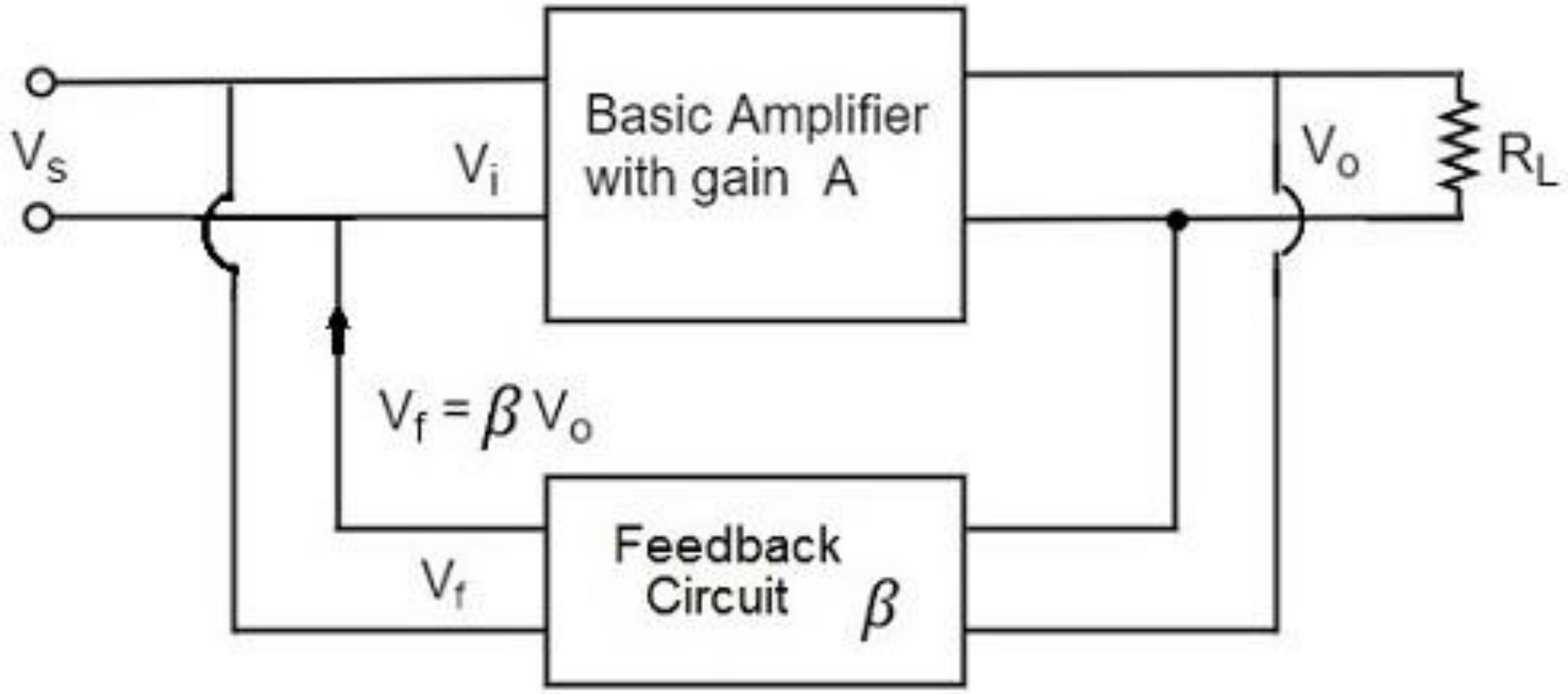
$$R_{if} = R_i\,(1+A\beta)$$

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

- In the voltage series feedback circuit, a fraction of the output voltage is applied in series with the input voltage through the feedback circuit.
- As the feedback circuit is connected in shunt with the output, the output impedance is decreased and due to the series connection with the input, the input impedance is increased

FEEDBACK TOPOLOGIES

Voltage-Shunt Feedback



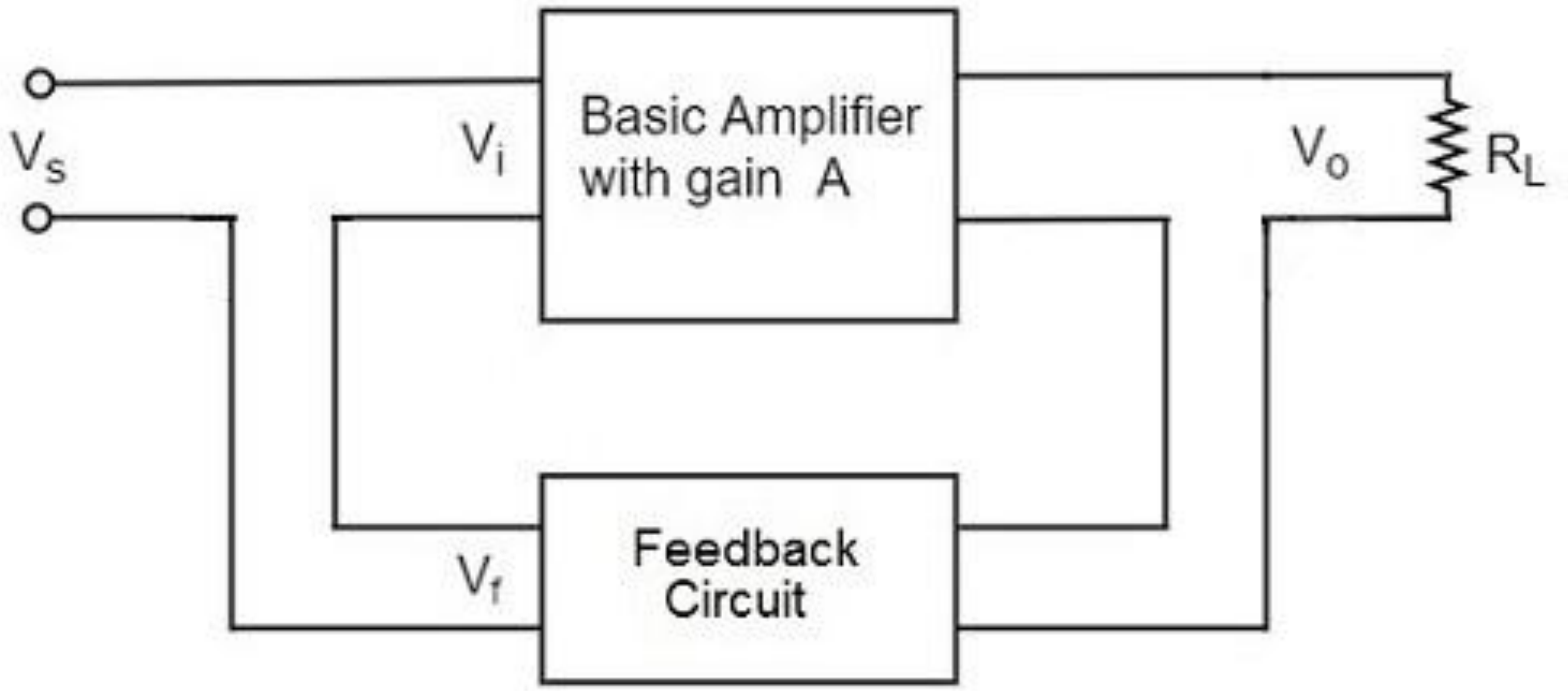
$R_{if} = R_i / (1+A\beta)$

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

- In the voltage shunt feedback circuit, a fraction of the output voltage is applied in parallel with the input voltage through the feedback network.
- As the feedback circuit is connected in shunt with the output and the input as well, both the output impedance and the input impedance are decreased.

FEEDBACK TOPOLOGIES

Current-Series Feedback



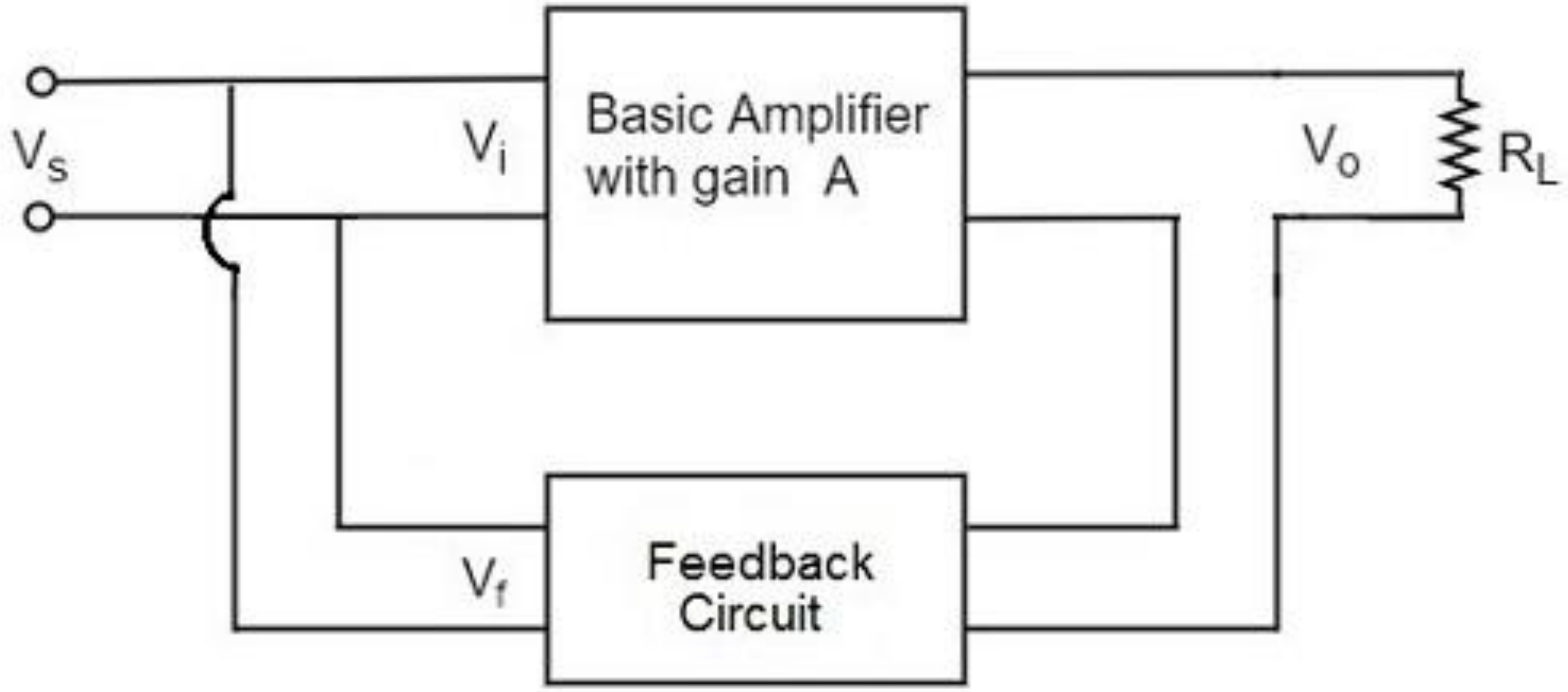
$R_{if} = R_i\,(1+A\beta)$

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

- In the current series feedback circuit, a fraction of the output voltage is applied in series with the input voltage through the feedback circuit.
- As the feedback circuit is connected in series with the output and the input as well, both the output impedance and the input impedance are increased.

FEEDBACK TOPOLOGIES

Current-Shunt Feedback



$$R_{if} = R_i / (1+A\beta)$$

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

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- In the current shunt feedback circuit, a fraction of the output voltage is applied in series with the input voltage through the feedback circuit.
- As the feedback circuit is connected in series with the output, the output impedance is increased and due to the parallel connection with the input, the input impedance is decreased.

FEEDBACK TOPOLOGIES

Characteristics	Types of Feedback			
	Voltage-Series	**Voltage-Shunt**	**Current-Series**	**Current-Shunt**
Voltage Gain	Decreases	Decreases	Decreases	Decreases
Bandwidth	Increases	Increases	Increases	Increases
Input resistance	Increases	Decreases	Increases	Decreases
Output resistance	Decreases	15 Decreases	Increases	Increases
Harmonic distortion	Decreases	Decreases	Decreases	Decreases
Noise	Decreases	Decreases	Decreases	Decreases

Negative Feedback Amplifier Circuit