US03CPHY02
UNIT 3
Feedback in Amplifiers Part-2

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Advantages of Negative feedback

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

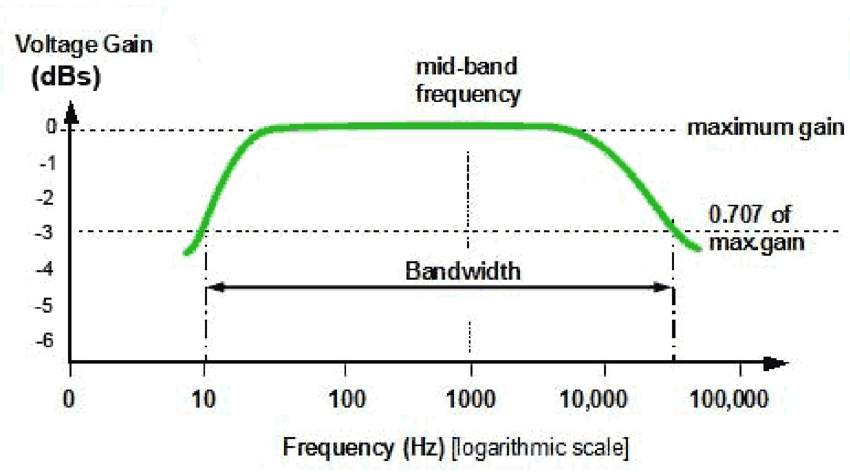
Need of an oscillator, Classification of oscillators, Tuned circuit for generation of sine waves, Frequency of oscillation in LC circuit, Sustained oscillations, Positive feedback amplifier as an oscillator, The starting voltage, Hartley oscillator, Colpitts oscillator, Basic principles of RC oscillator,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

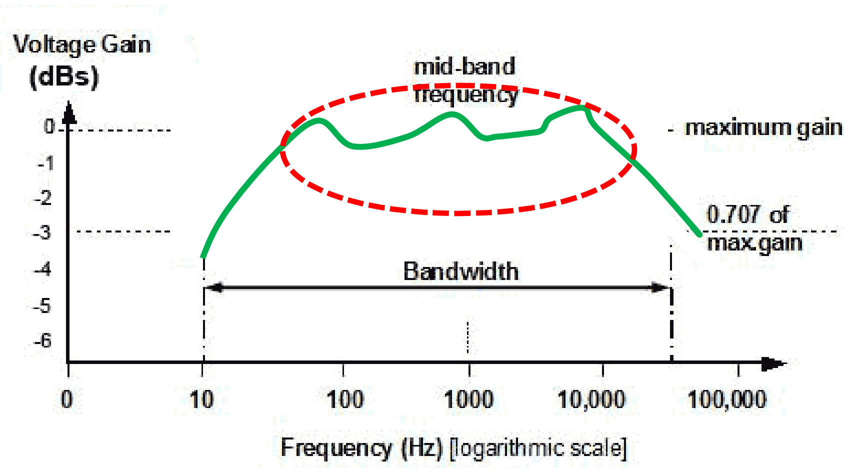
1. Stabilization of Gain. Why?

The gain of the amplifier may changes due to;

1. Change in power supply voltage
2. Change in parameters of the active device like transistor

The change in gain may drive the performance of the amplifier to undesired conditions. So stability of the gain is necessary for smooth functioning of the amplifier.





1. Stabilization of Gain. How?

For a negative feedback amplifier, we have, $A_f = \dfrac{A}{(1 + A\beta)}$ ….. (1)

If we make, $A\beta \gg 1,\ A_f = \dfrac{A}{(1 + A\beta)} = \dfrac{A}{A\beta} = \dfrac{1}{\beta}$

Since $\beta = \dfrac{R_1}{R_1 + R_2}$ = constant.

Af can be made independent of A (gain of internal amplifier).

Now, even if A changes , we can calculate % change in *Af* .

From equation (1)

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

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

$$\therefore dA_f = \frac{dA}{(1 + A\beta)^2} \quad \text{…..(2)}$$

Dividing (2) by (1)

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

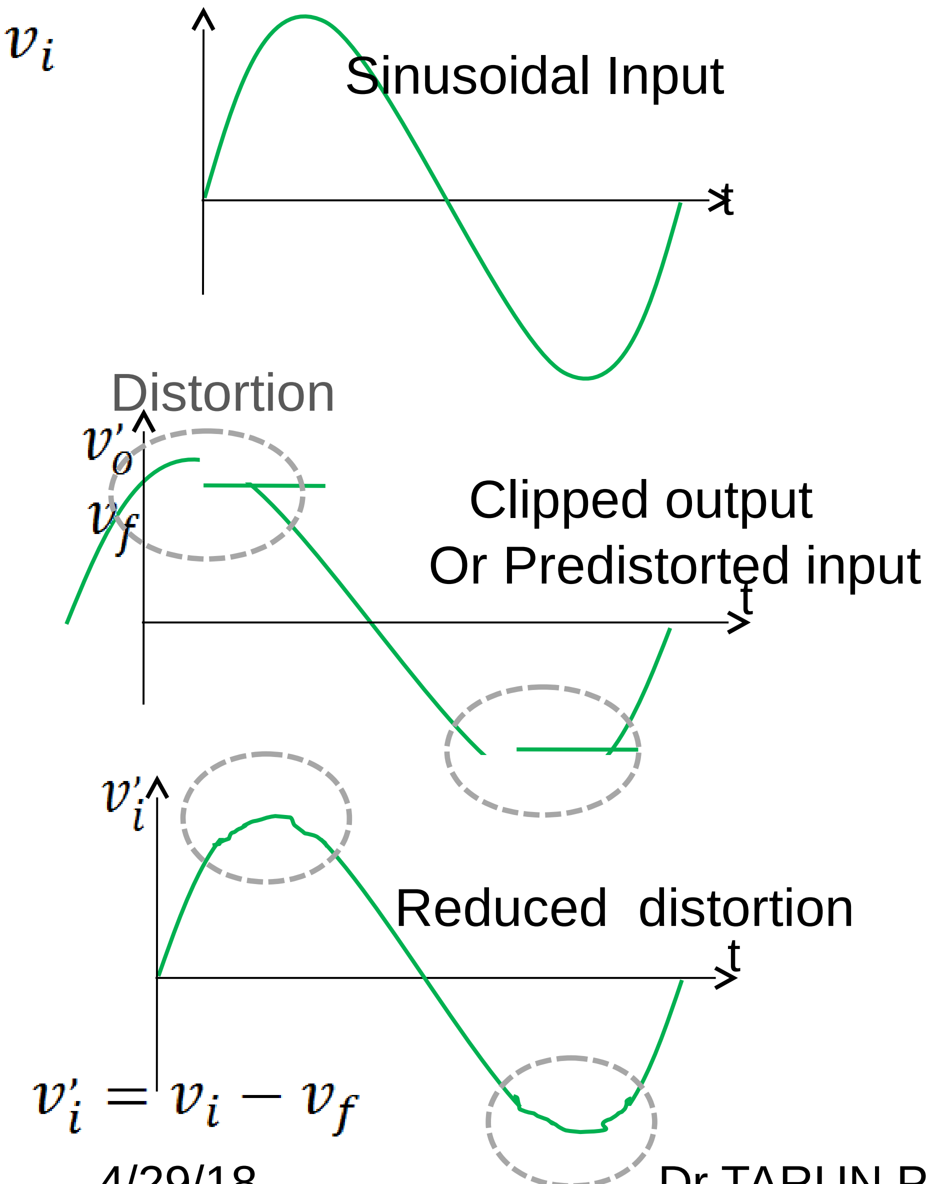
$$\therefore \frac{dA_f}{A_f} = \frac{1}{(1 + A\beta)} \frac{dA}{A}$$

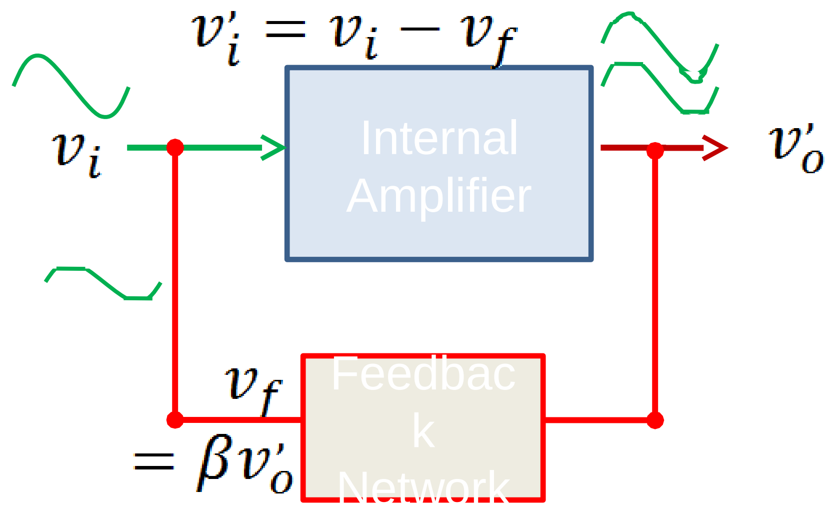
$Since\ (1 + A\beta) > 1,$

(% change in *Af*) is << (% change in A)

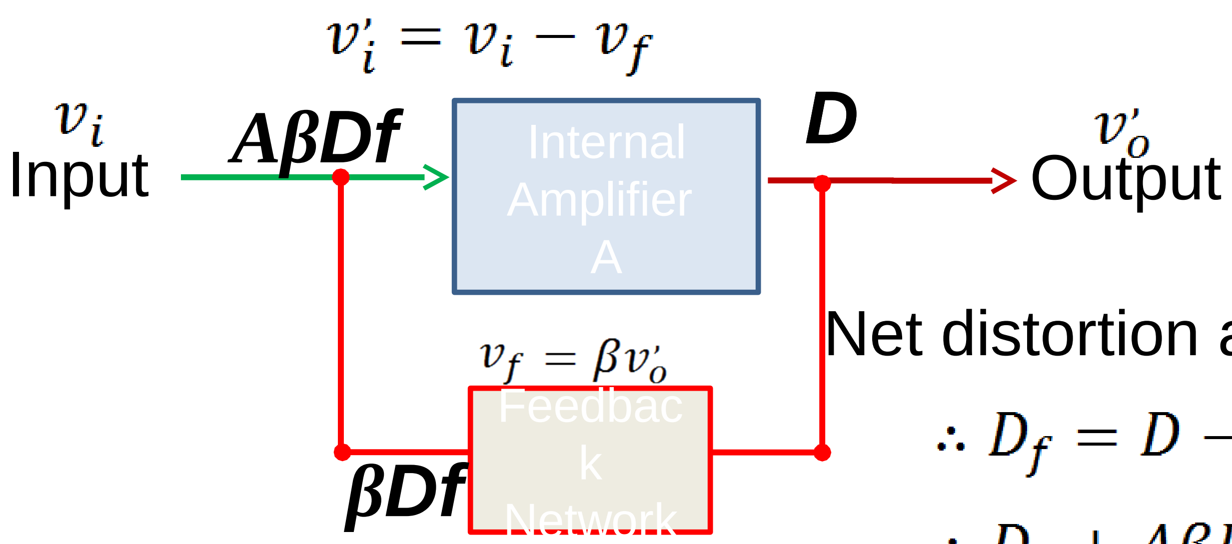
i.e. *Af* is much more stable than A.

2. Reduction in Harmonic Distortion. How?





2.Reduction in Harmonic Distortion. Quantitative



Net distortion after feedback,

$$\therefore D_f = D - A\beta D_f$$

$$\therefore D_f + A\beta D_f = D$$

$$\therefore D_f(1 + A\beta) = D$$

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

$$Since\ (1 + A\beta) > 1$$

$$\therefore \boldsymbol{D_f < D}$$

D = distortion without feedback

Df = distortion AFTER feedback

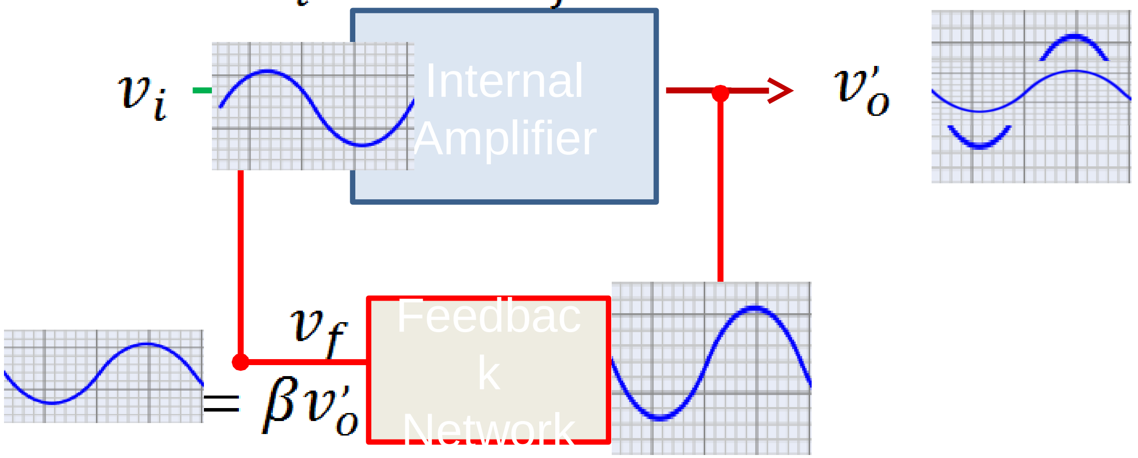
A = Gain of Internal amplifier

Af = Gain of feedback amplifier

2. Reduction in *Noise*

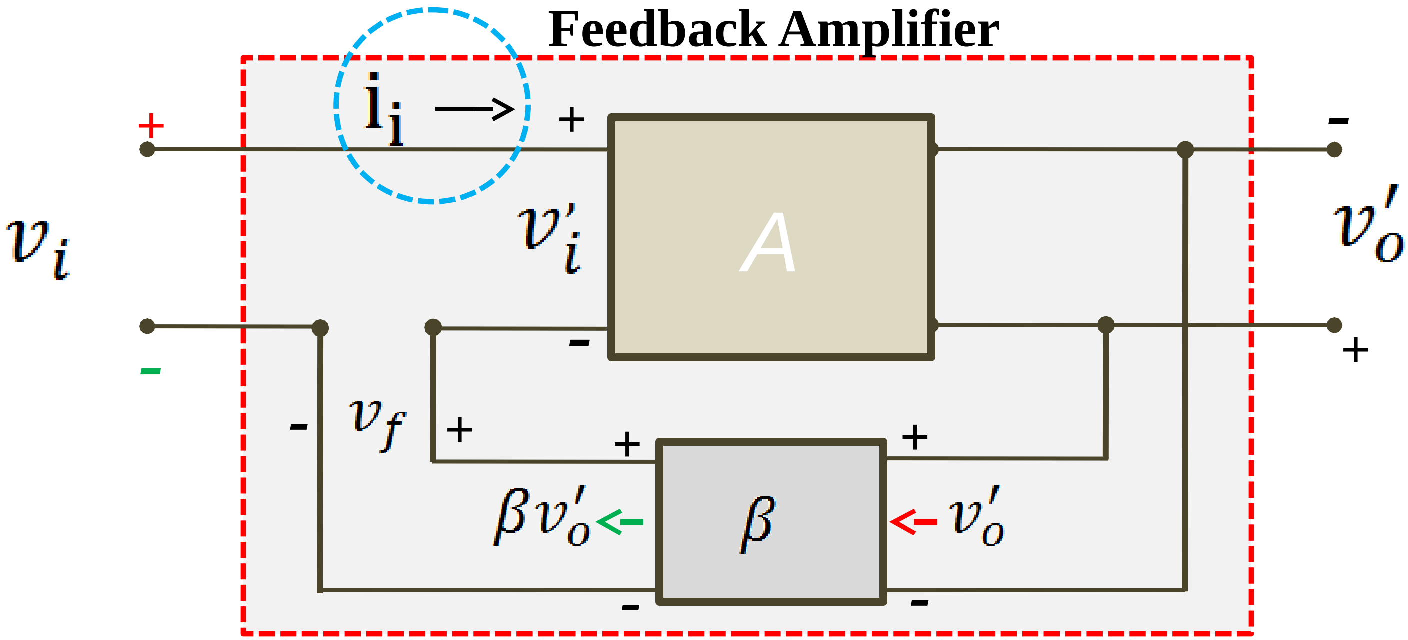
$$v_i' = v_i - v_f$$

$$v_f = \frac{R_2}{R_1 + R_2} v_0'$$



1. Electrical noises are generated due to many reasons.
2. Such noises gives noise voltage signals.
3. These noise voltage signals are amplified and feed backed to basic amplifier.
4. Due to negative feedback net noise signal voltage at the output decreases.
5. Hence the net noise level decreases.

3. Increase in *Input impedance*



$$v'_i = v_i - \beta v'_o$$

$$Since\ A = \frac{v'_o}{v'_i} \qquad v'_o = A v'_i$$

$$\therefore\ v'_i = v_i - A\beta v'_i$$

$$\therefore\ v_i = v'_i + A\beta v'_i$$

$$\therefore\ v_i = v'_i(1 + A\beta)$$

$$\therefore\ \frac{v_i}{i_i} = \frac{v'_i}{i_i}(1 + A\beta)$$

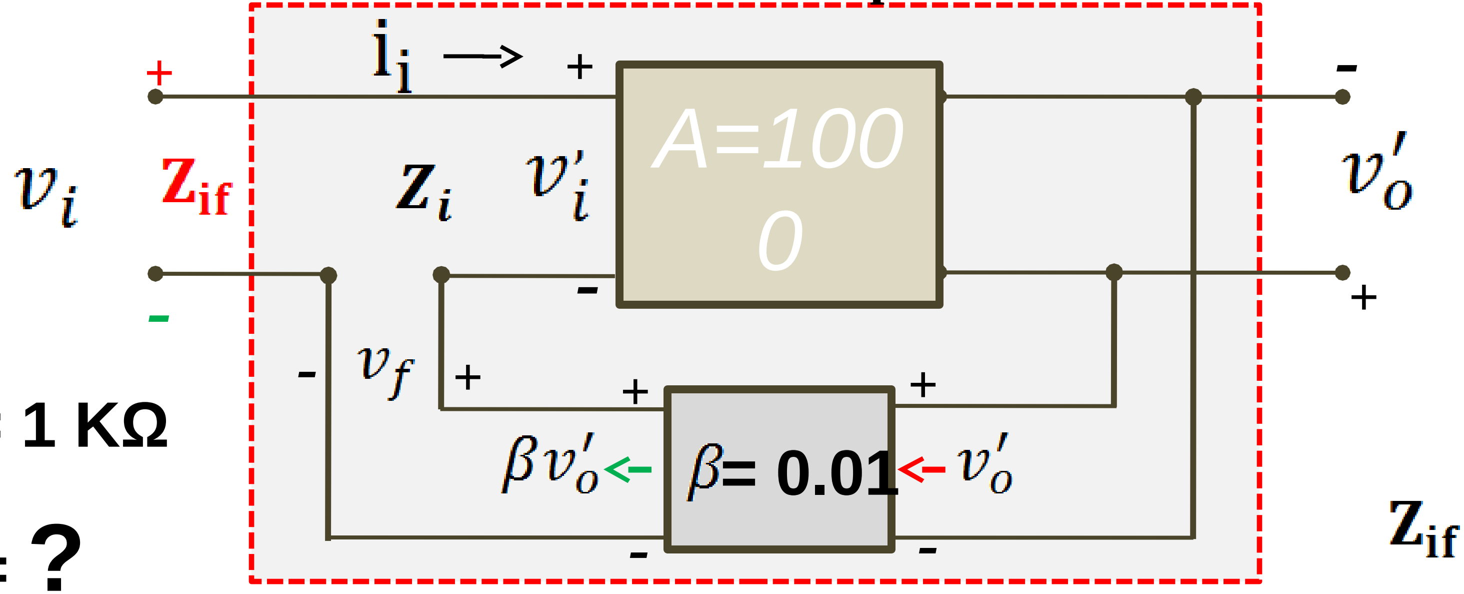
$$\therefore\ z_{if} = z_i(1 + A\beta)$$

$$\therefore\ z_{if} > z_i$$

An amplifier requires higher input impedance.

3. Increase in *Input impedance:* Example

Feedback Amplifier



Z_i = 1 KΩ

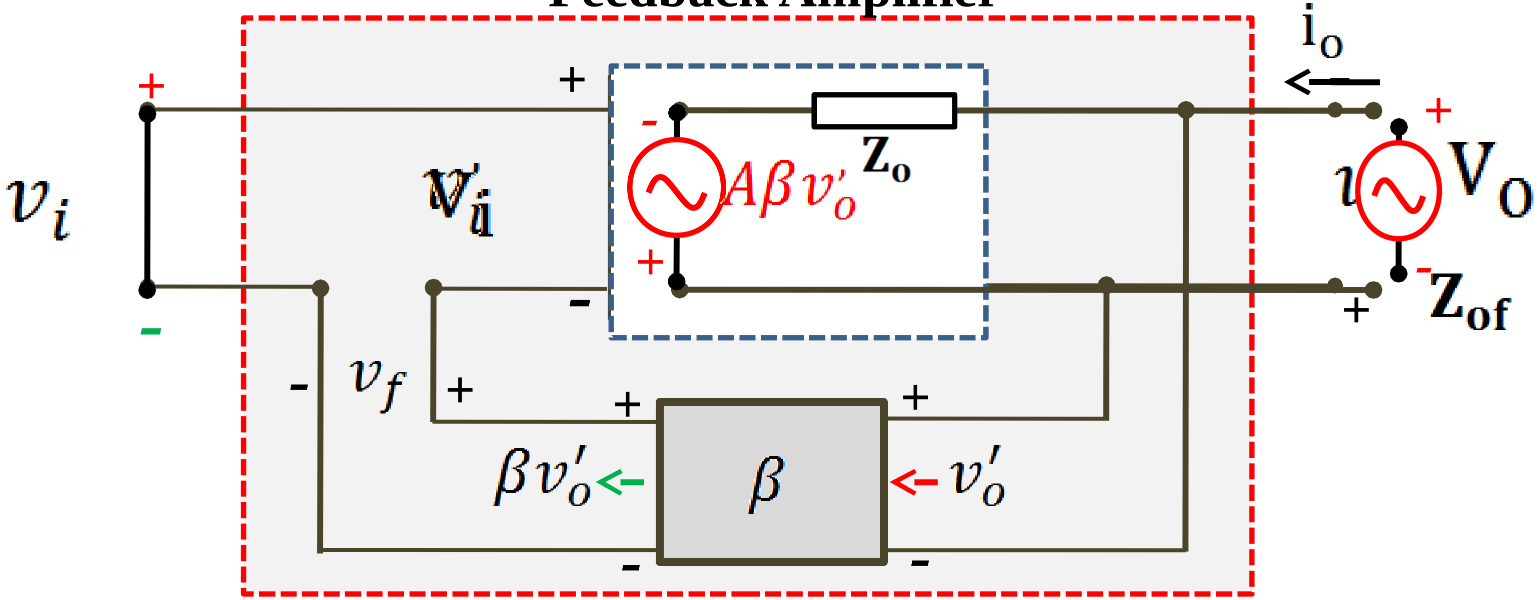
Z_{if} = ?

$$\therefore Z_{if} = Z_i(1 + A\beta)$$

Z_{if} = 11 KΩ

4. Decrease in *Output impedance:*

Feedback Amplifier



1. Output replaced by voltage source.
2. Input terminals shorted.
3. Connect voltage source at output

If input impedance of β network is very high, KVL gives.

$$V_O + A\beta V_0 = I_O Z_0$$

$$\therefore V_O(1 + A\beta) = I_O Z_0$$

$$\therefore \frac{V_O}{I_O} = \frac{Z_0}{(1 + A\beta)}$$

$$\therefore Z_{of} = \frac{Z_0}{(1 + A\beta)}$$

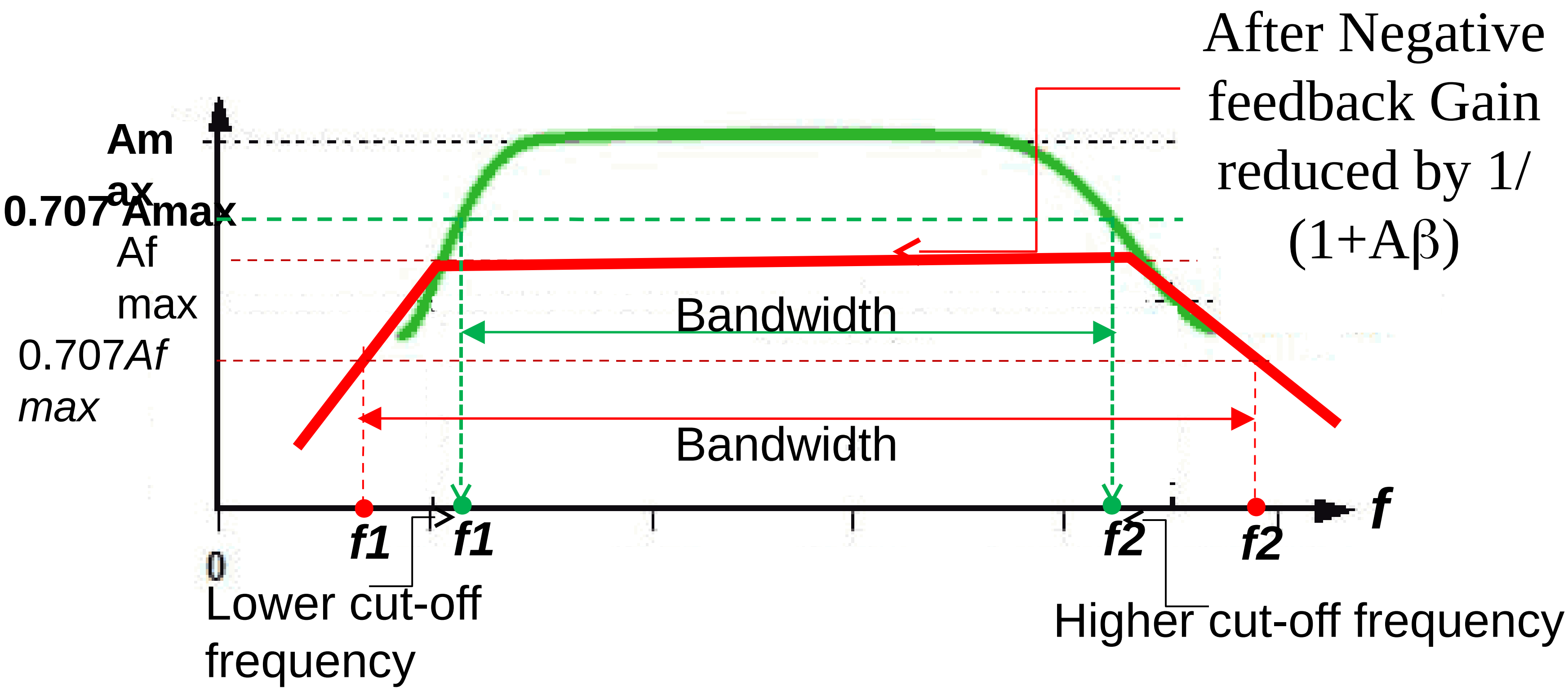
$$\therefore Z_{of} < Z_0$$

An amplifier requires lower output impedance.

5. Increase in *Bandwidth*

Bandwidth:

"band of frequencies where the Gain is ≥ 0.707 of its maximum".

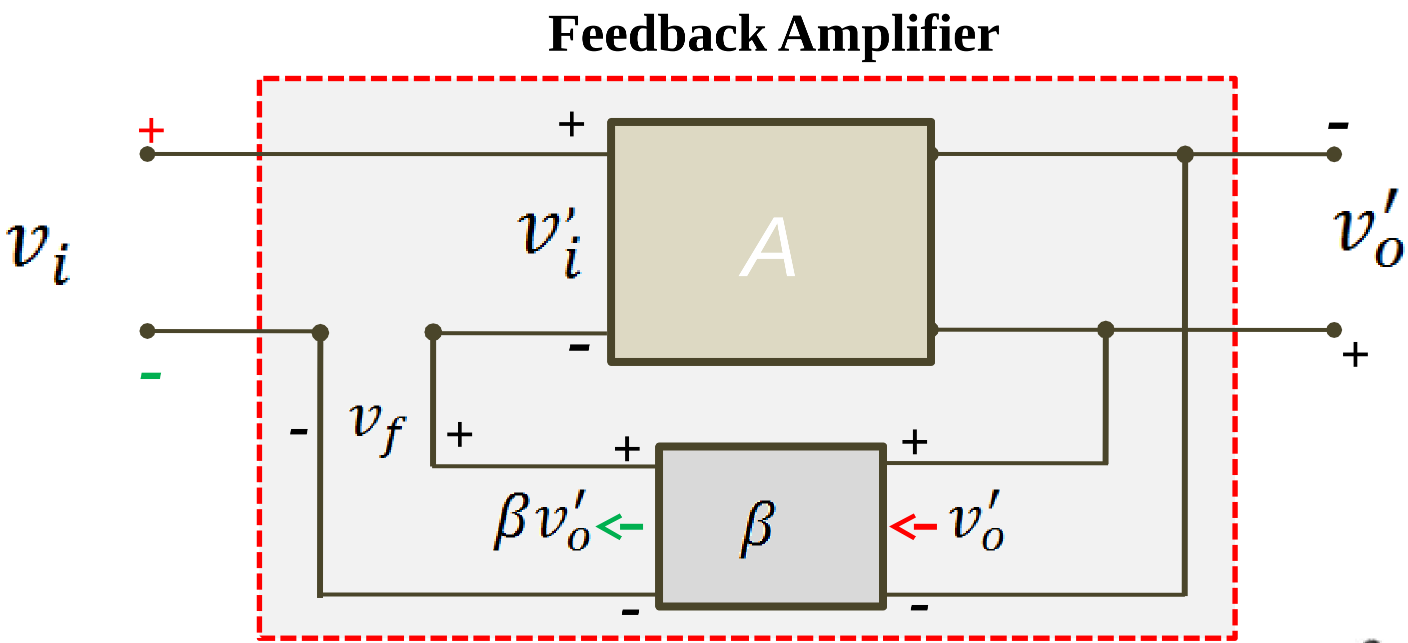


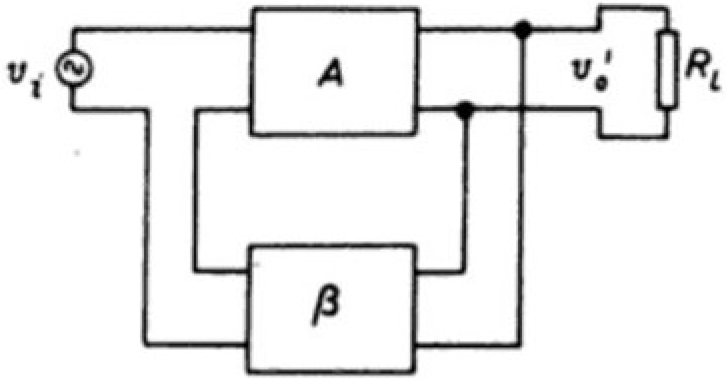
Bandwidth = (*f2 - f1*)*Hz* **>** Bandwidth = (*f2 - f1*)*Hz*

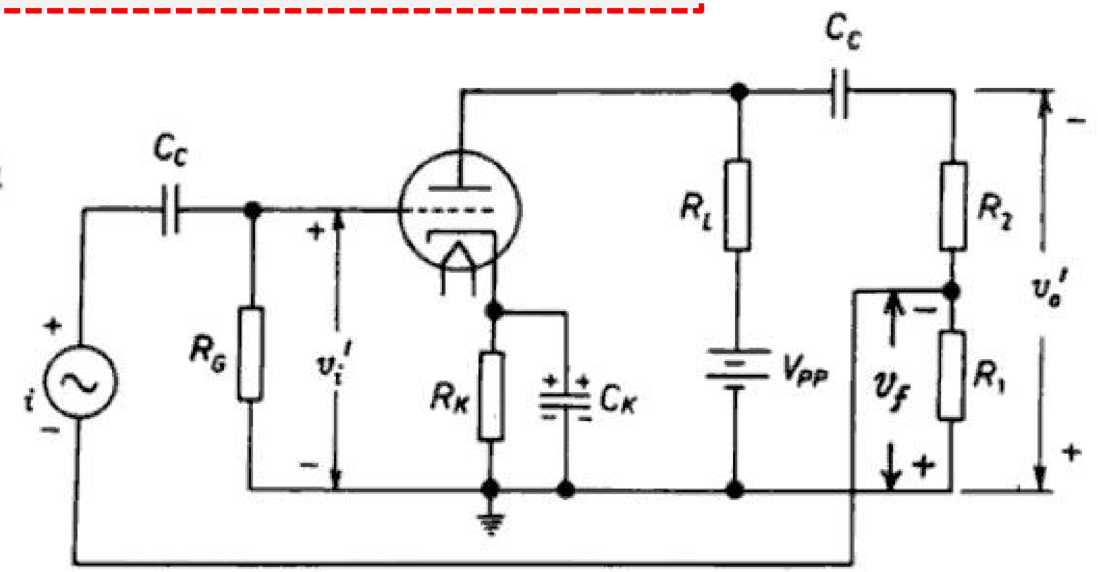
(Gain x Bandwidth) = *Constant*

Amplifiers with Negative Feedback

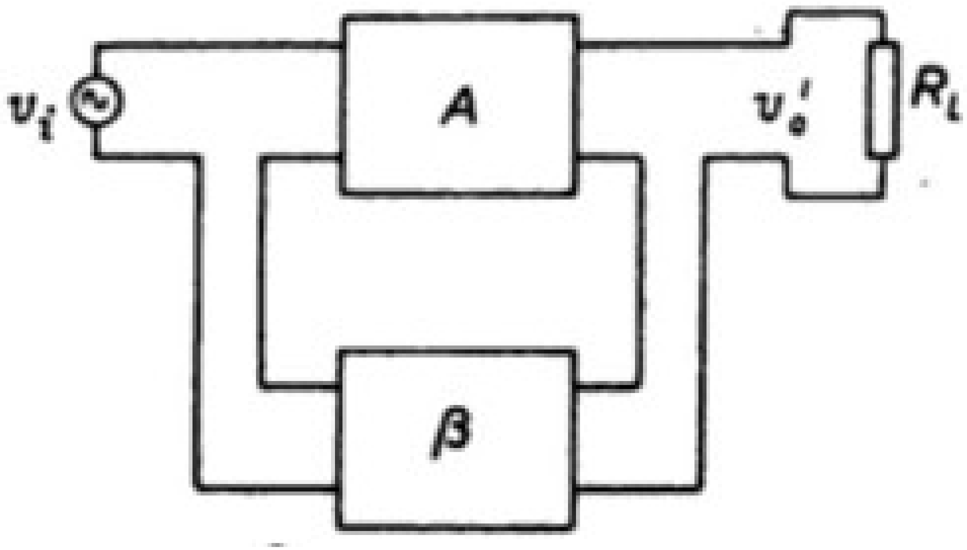
Amplifier with *Series Voltage Negative Feedback*



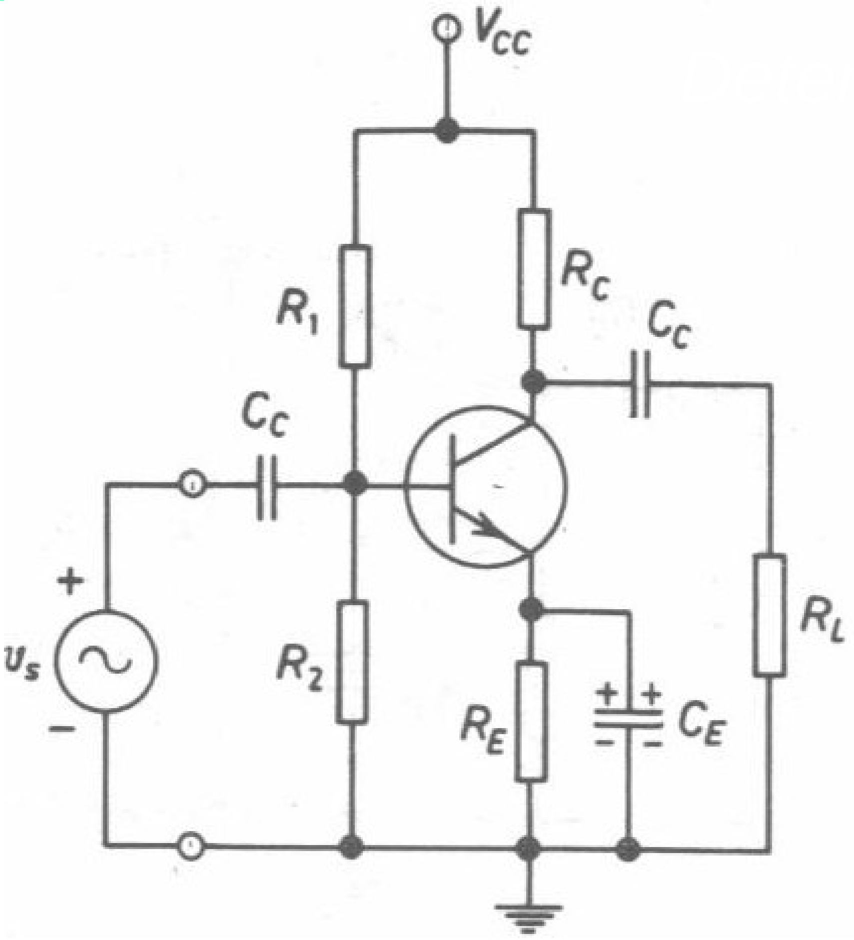




Amplifier Circuits with Negative Feedback



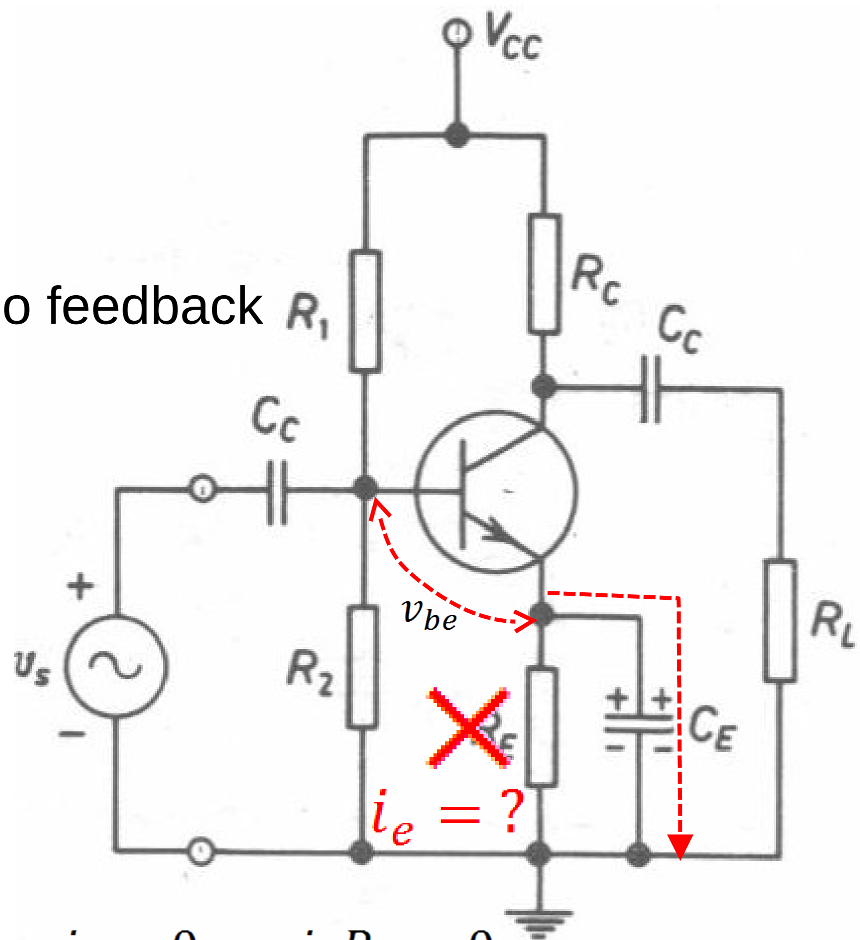
RC Coupled Amplifier



RC Coupled Amplifier

So, this is a Series Current Negative Feedback

No feedback



$i_e = 0 \quad \therefore i_e R_E = 0$

The effective input volage is v_{be}.

$\therefore v_{be} = v_s$

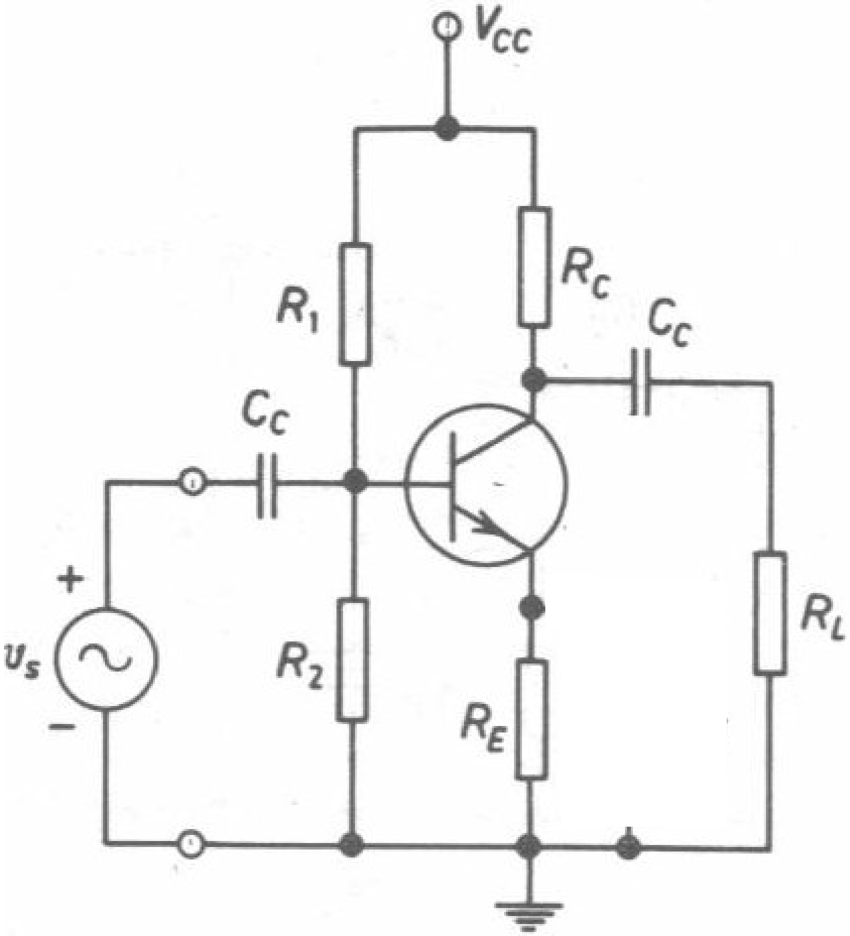
$i_e R_E$ *appears in series with* v_s

$i_e R_E = i_e R_E = v_e =$ *feedback voltage*

$\therefore v_s = i_e R_E + v_{be} \quad v_{be} = v_s - i_e R_E$

Since $i_e \propto i_c, v_e \propto i_c \therefore v_{be} \propto i_c$

RC Coupled Amplifier WITHOUT BYPASS CAPACITOR



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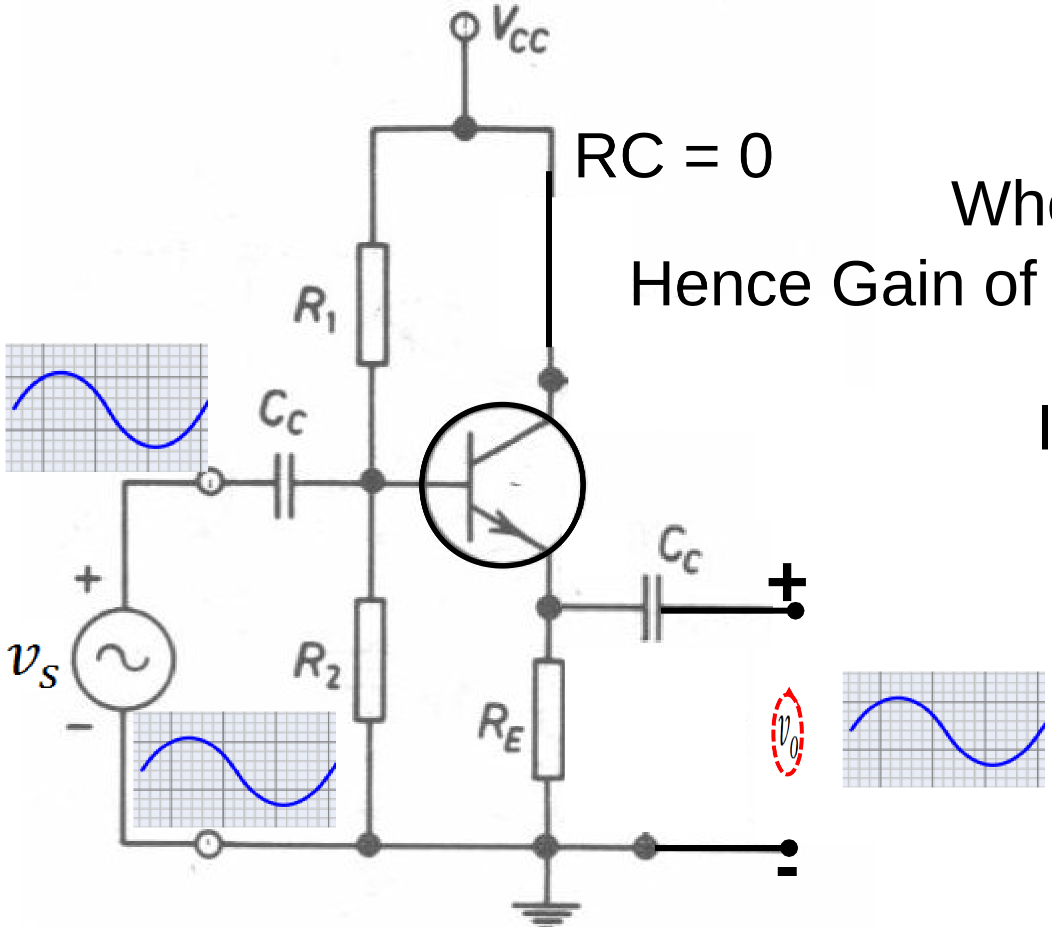
Emitter Follower



The effective input is ,

$$v_{be} = (v_s - v_o)$$

Whole v_o is fed back to the input

Hence Gain of the circuit reduces drastically

$$Here\ v_o < v_s$$

In fact, Gain is less than Unity

$Here\ v_o and\ v_s\ are\ in\ phase.$

$$Also\ v_o \cong v_s$$

$$(v_0\ slightly\ less\ than\ v_s)$$

It can be seen that,

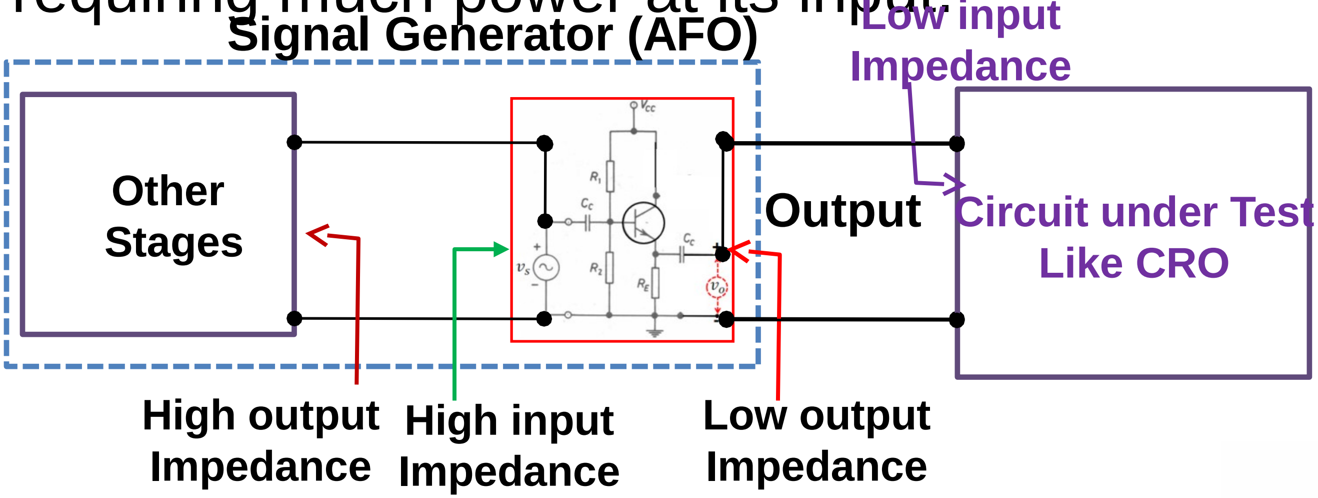
emitter voltage i.e. v_o *simply follows the input voltage* v_s.

What is usefulness of such circuit ?

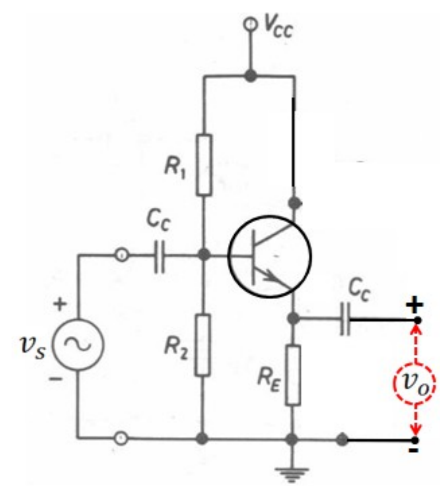
Emitter Follower: What is usefulness of such circuit?

The circuit offers high input impedance and low output impedance.

- Hence it is capable of giving power to a load connected to its output
  without requiring much power at its input.



- This is called as *Impedance matching*
  - Here the emitter follower is acting *as Buffer amplifier.*



UNIT-3 Completes……

Thank you for watching.

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