1

# positive feedback: when the feedback is so applied that voltag (or current) it increase the input voltage (or current) it is in phase with the input it is called as positive feedback.

negative feedback: when the feedback is so applied that voltage (or current) it decreases the input voltage (or current) it is out of phase with the input it is called as negative feedback.

# what are the effect / ~~advantage~~ of negative feedback.

Increased stability:

The gain of the amplifier with negative feedback is given by $A' = \frac{A}{1+AB}$

In negative feedback amplifiers, the designer deliberatly makes the product BA much greater than unity so that I may be neglected in comparision to it, Hence

$$A' = \frac{A}{BA} = \frac{1}{B}$$

Thus $A'$ depends only on B (feedback ratio) characteristics of feedback circuit. As feedback circuit is usually a voltage devider and resistor can be selected very precisely with almost zero temperature coefficient of resistance, therefore the gain is unaffected by changes in temperature variations in transistor parameters and frequency. Hence the gain of the ampuifier is extremely stable.

(ii) Reduction in non-liniear destortion:

A large signal stage has non linear distortion beacuage its voltage gain changes at various points in the cycle. the use of negative feedback in large signal product BA much greater than unity so that 1 may be neglacted in comparision to it, Hence

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(ii) Reduction in non-linear destortion:

A large signal stage has non linear distortion beacuage its voltage gain change at various points in the cycle. the use of negative feedback in large signal amplifiers reduces the non-linear distortion.

Let $D$ = Distortion voltage generated in amplifier without feedback.

$D'$ = Distortion voltage generated in amplifier with feedback.

suppose $D' = xD$

now fraction of output distorted voltage feedback to input $= BD' = BxD$ --- (1)

This voltage is amplified by the amplifier The amplified distorted voltage will be $BxDA$. This is in antiphase with the original distorted voltage $D$ so the new distorted voltage $D'$ which apear in the output is,

$D' = D - BxDA$ --- (11)

From eq (1) and (2)

we get,

$$xD = D - BxDA$$

$$\therefore x(1+BA) = 1$$

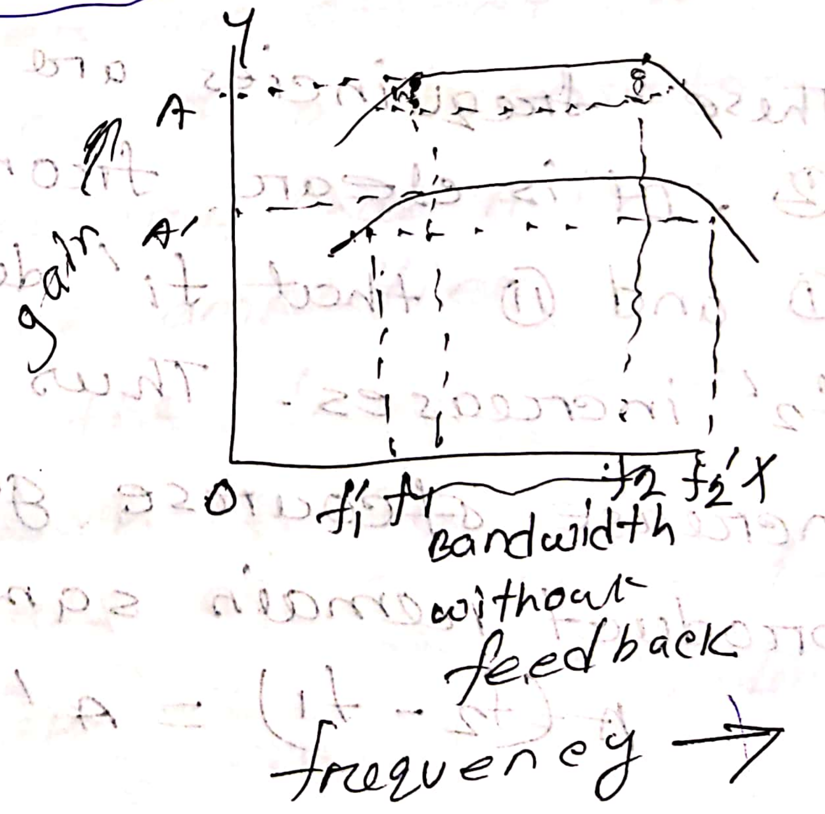
$$\Rightarrow x = \frac{1}{1+BA}$$

substitiviting this value in equation ①

we get $D' = \frac{D}{1+BA}$.

so the negative feedback reduces the amplifier distoration by a factor $(1+BA)$.

(1) Increased bandwidth :



When a feedback is applied, the gain of the amplifier is decreased but gain bandwidth remains the same. This indicates that the bandwidth must increased to compensate the decrease in gain. It can be shown that with negative feedback, the lower and upper frequencies are expressed as.

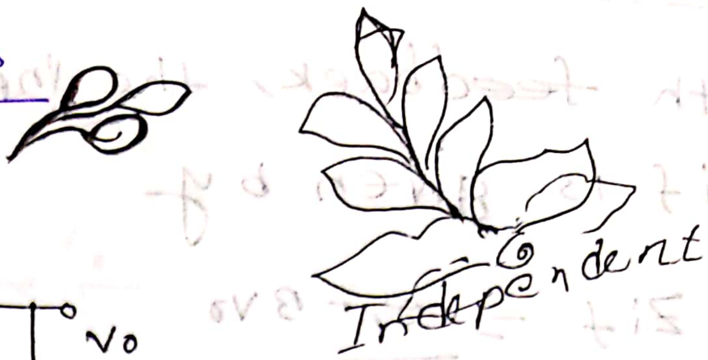
$$f_1' = \frac{f_1}{1+BA} \quad --- (I)$$

$$f_2' = f_2(1+BA) \quad --- (II)$$

These frequencies are shown in figure (2). It is clear from expressions (I) and (II) that $f_1'$ decrease while $f_2'$ increases. Thus the bandwidth increase, of course gain bandwidth product remain same.

$$A(f_2 - f_1) = A'(f_2' - f_1')$$

## (IV) Input Impedences:



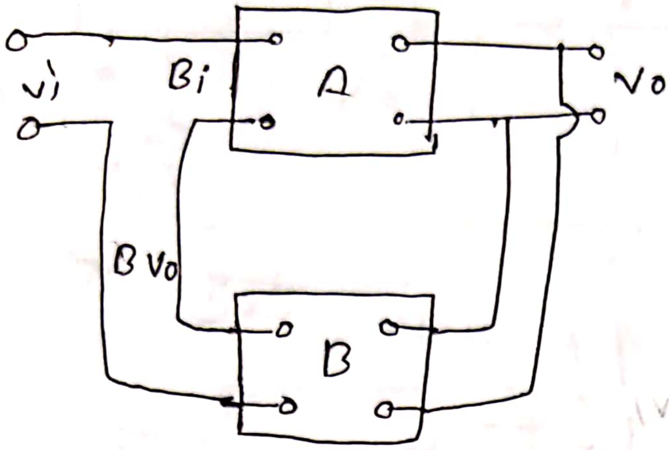
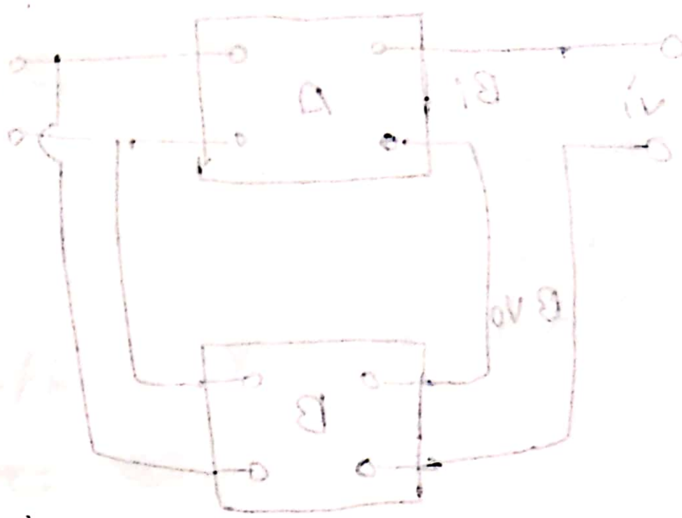




Fig: Input impedence increases due to negative feedback.

In order to consider the effect of feedback on input impedence of a transistor amplifier, we assume that A is the normal gain of the amplifier without feedback. BVo is the fraction of the output voltage which is feedback to the input terminals as shown in figure without feedback the input imedence is

$$z_i = \frac{e_1}{i_1} = \frac{v_1}{i_1} \quad (\text{since } v_1 = e_1)$$

with feedback, the Input impedence $z_{if}$ is given by




$$z_{if} = \frac{e_1 - B V_o}{i_1}$$

$$= \frac{V_1 - B V_o}{I_1}$$

$$= \frac{V_1 - B A V_1}{I_1}$$

$$\Rightarrow \frac{e_1 - B \times A e_1}{i_1}$$

$$\therefore (V_o = A e_1) = \frac{e_1}{i_1} [1 - B A]$$

$$\therefore z_i (1 - AB)$$

In negative feedback, $(1 - AB)$ is greater than unity and consquiently $z_{if}$ is greater thn $z_i$ that is due to negative feedback input impedence of a transiston amplifier increase.

output

Fig

In ordere to
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circuit the
a voltage sou
terminal as
has been

## Output Impedence:

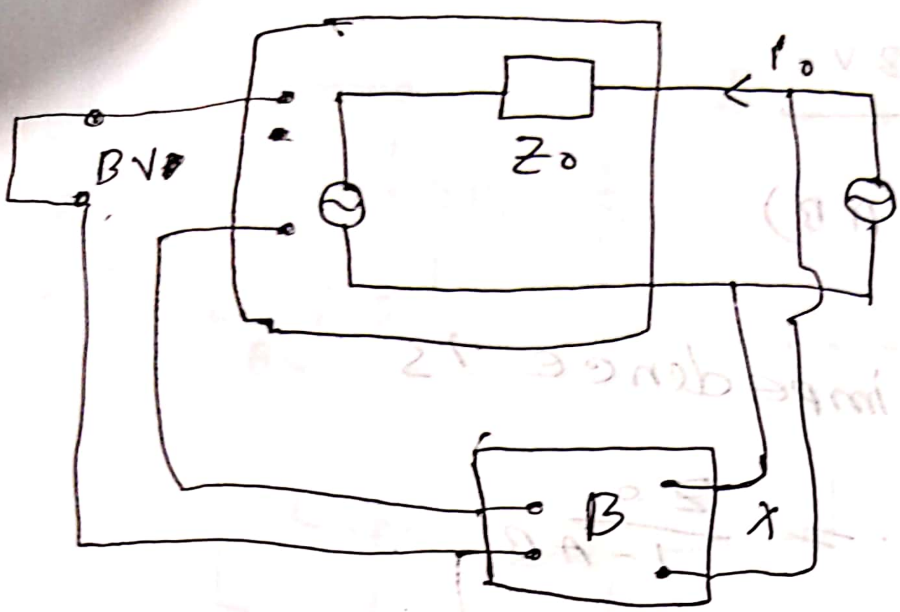


Fig-4

In order to find the output impedence of the amplifier with feedback, we short circuit the input source and connect a voltage source $V_o$ at the output terminal as shown in figure. The output has been replaced by an equivalent voltage source $A B V_o$. Let i be the current with feedback.

from figure,

$$Z_o i_o' = V_o - ABV_o$$

$$\Rightarrow i_o' = \frac{V_o - ABV_o}{Z_o}$$

$$= \frac{V_o}{Z_o}(1-AB)$$

so the output impedence is

$$Z_{of} = \frac{V_o}{i_o'} = \boxed{\frac{Z_o}{1-AB}}$$

since the negative feed back $(1-AB) > 1$, $Z_{of}$ is less that $Z_o$. that is output impedence deacrease due to negative feedback.

# voltage series feedback:

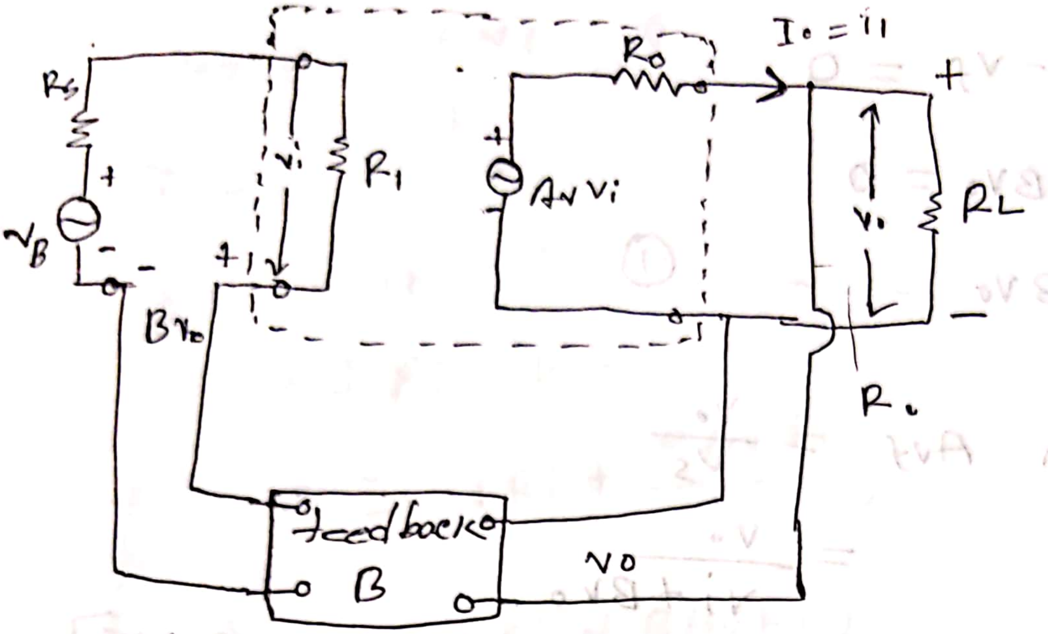


Figure: voltage amplifier with voltage series feedback

Figure shows the schematic circuit of a voltage amplifier with voltage series feedback. Here the following two assumptions are made:

(i) The feedback network does not load the output circuit of the amplifier.

(ii) There are no forward transmision through the feedback network. now we shall calculate voltage gain, output resistance and input resistance, voltage gain from the figure we have, from the input circuit,

$$V_s - V_i - V_f = 0$$

$$\Rightarrow V_s - V_i - BV_o = 0$$

$$\Rightarrow V_s = V_i + BV_o \quad \text{--- (1)}$$

voltage gain $A_{vf} = \dfrac{V_o}{V_s}$

$$= \frac{V_o}{V_i + BV_o}$$

$$= \frac{A_v V_i}{V_i + BV_o} \qquad [V_o = A_v V_i]$$

~~voltage gain $A_{vf}$~~ $= \dfrac{V_o}{V_s}$

$$= \frac{A_v V_i}{V_i + A B V_i}$$

$$= \frac{A_v}{1 + A_v B}$$

Input impedence $R_{if} = \dfrac{V_s}{I_i} = R_i (1 + BA_v)$

without feedback the input resistance $R_i$ is given by $\dfrac{V_i}{I_i}$ with feedback.

Input impedence, $R_{if} = \frac{V_s}{I_i} = R_i(1+BA_v)$

we have, $V_s - V_i - V_f = 0$

$\Rightarrow V_s = V_i + V_f$

$= I_i R_i + BV_o$

$= I_i R_i + BA_v V_i$

$= I_i \left(R_i + \frac{BA_v B_i}{I_i}\right)$

$\Rightarrow \frac{V_s}{I_i} = (R_i + BA_v R_i)$

$\Rightarrow \frac{V_s}{I_i} = R_i(1 + BA_v)$

$\Rightarrow R_{if} = R_i(1+BA_v)$

The output impedence

output impedence:

with feedback $R_{of} = \frac{V_o}{I_o} = \frac{R_o}{1+BA_v}$

Now, $V_o - I_o R_o - A_v V_i = 0$

$\Rightarrow V_o = I_o R_o + A_v V_i$

$\Rightarrow V_o(1+BA_v) = I_o R_o$

$\Rightarrow \frac{V_o}{I_o} = \frac{R_o}{1+BA_v}$

$V_s - V_i - BV_o = 0$

$V_s = 0$

$\Rightarrow -V_i = BV_o$

$\Rightarrow V_i = -BV_o$

# Define feedback ~~to~~ the example :

# feedback is a process in which a fraction of the ~~energy~~ output energy is combined to the input.

Depending upon whether the feedback energy aids or oposes the input ~~energy~~ signal.

# Advantage of negative feedback :

(i) Highly stabilized gain

(ii) Reduction in non-linear distortion.

(iii) Increased bandwidth ie. improved frequency respons.

(iv) Increased circuit stability

(v) Less amplitude destortion.

(vi) Less frequency destortion.

(viii) Less phase distortion

(ix) Reduce noise

(x) Increased input impedence and decrease output impedence. i.e. input and output impedence can be modified as desired.

Example: 3 a transistor amplifier has a voltage gain of 50. The input resistance of the amplifier is 1 kΩ and the output resistance is 40 kΩ. The amplifier is now provided with 10% negative voltage feedback in series with the input. Calculate the voltage gain, input and output resistance with feedback.

In this problem 10% negative voltage feedback has been provided ie $\beta = \frac{-10}{100}$

$= -0.1$

(i) $A' = \frac{A}{1-BA}$

$= \frac{50}{1-(-0.1 \times 50)}$

$= \frac{50}{6}$

$= 8.33.$

(ii) $Z_{if} = Z_i (1-BA)$

$= 1K(1-(-0.1 \times 50)) = 6K\Omega$

(iii) $Z_{of} = \frac{Z_o}{1-BA}$

$= \frac{40K}{1-(-0.1 \times 50)}$

$= \frac{40}{6}$

$= 6.66 K\Omega.$

# differance between positive and negative feedback:

| Basic for comparision | positive feedback | negative feedback |
|---|---|---|
| (i) Also called as | Regenerative feedback | Degenerative feedback |
| (ii) The ralation between input and output | Input signal and output signal are in the same phase | Input signal and output signals are in opposite phase w.r. to each other |
| (iii) Final output | final output is grater that the gain of the signal | smaller than the gain of the syte |
| (iv) Transfer function of system with. respetive feedback | $\frac{G}{1-GH}$ | $\frac{G}{1+GH}$ |
| stability | Less | comparatively more |
| Phase shift | $0^\circ$ or $360^\circ$ | $180^\circ$ |

| | | |
|---|---|---|
| feedback is taken from | non inverting terminal of op-amp | Inverting terminal of op-amp |
| use | in oscillators | in amplifier |