Effect of positive feedback

(1)

(i) Gain with +ve feedback $A_f = \frac{A}{1-A\beta}$.

$\therefore A_f \gg A$.

So overall gain of the +ve feedback amplifier increases.

(2) As. $A_f \gg A$.

$\therefore$ Sensitivity $= \frac{\frac{dA_f}{A_f}}{\frac{dA}{A}}$ is high.

So change ~~in~~ of overall gain of the amplifier ckt is large w.r to change of open loop gain of the amplifier ckt. Thus due to ~~any~~ any change in basic amplifier paramiters A_f changes heavily. So instability arises.

(3) Input impedance with +ve feedback $R_{if} = \frac{R_i}{(1-A\beta)}$ so ~~on~~ input impedance decreases by a factor $(1-A\beta)$.

(4) Output impedance. $R_{of} = R_o(1-A\beta)$

$\therefore$ Output impedance increases by a factor $(1-A\beta)$.

(5) As overall gain of the amplifier for +ve feedback increases thus noise and distortion at the o/p of the +ve feedback amplifier will increase.

(6) Due to +ve feedback overall bandwidth will be decreased.

Concept of oscillation

For +ve feedback $A_f = \frac{A}{1-A\beta}$.

If loop gain $A\beta = 1$.

$\therefore A_f = \infty$.

~~As~~ As, $A_f = \frac{V_o}{V_s} = \infty$ refers to if $V_s \to 0$

$\therefore V_o \to \infty$.

So without any ~~i~~ external i/p we are getting the o/p signal V_o.

Oscillator :- The device consisting of active and passive elements to produce a sinusoidal or other repetative ~~waf~~ waveform at its o/p without the application of any i/p signal.

For +ve feedback $A\beta = 1$.

(i) $\therefore$ Loop gain of feedback amplifier is unity $A\beta = 1$.

(ii) Loop gain phase shift is zero or $360°$.

These condition of unity loop gain $A\beta = 1$ is called Barkhausen Criterion.

So basic condition for oscillation

(i) Feedback must be positive or regenerative

(ii) Loop gain must be 1. $(A\beta = 1)$.

$V_c = V_i + V_f = V_i + \beta V_o$

Increase of Bandwidth :-

The bandwidth of an amplifier without feedback is equal to the seperation b/w the 3dB frequencies f_1 and f_2

$$\therefore BW = f_2 - f_1$$

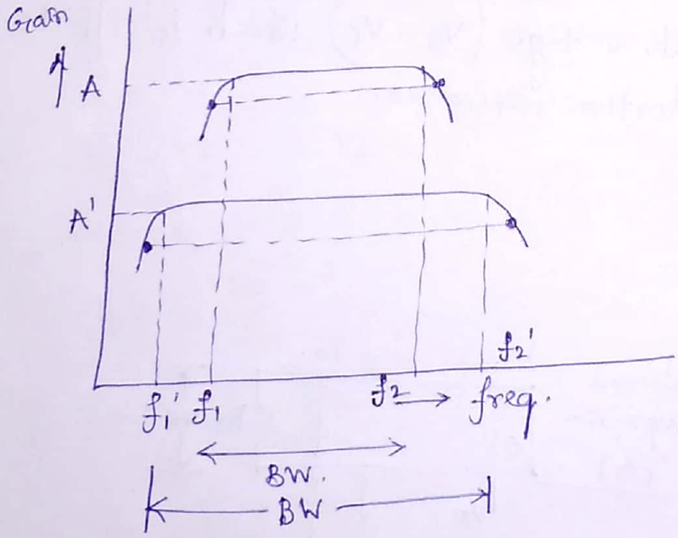
f_1 = lower 3dB freq.

f_2 = ~~hi~~ upper 3dB freq.

If gain = A.

$\therefore$ Gain bandwidth product = $A \times BW$.

For -ve feedback gain of amplifier is reduced. Since the gain BW product has to remain the same in both cases, so the bandwidth must increase to compensate for the decrease in gain.



f_1' has decreased whereas f_2' has increased.

$$f_1' = \frac{f_1}{1 + A\beta}$$

$$f_2' = f_2 (1 + A\beta)$$

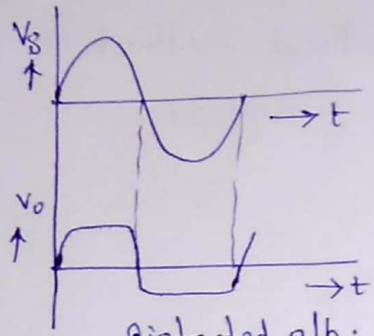
$$\therefore A_f \times BW_f' = A \times BW.$$

or, $$\frac{A}{(1 + A\beta)} BW_f' = A \times BW.$$

or, $$\boxed{BW_f' = BW(1 + A\beta)}.$$

$$\boxed{BW_f > BW.}$$

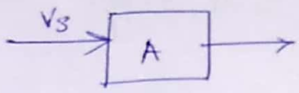
Reduction of signal distortion



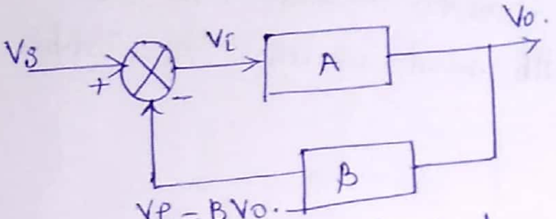
Distorted o/p.

V_s supply voltage at the i/p of the amplifier

V_o = distorted o/p from the amplifier without −ve feedback.



Now we introduce feedback

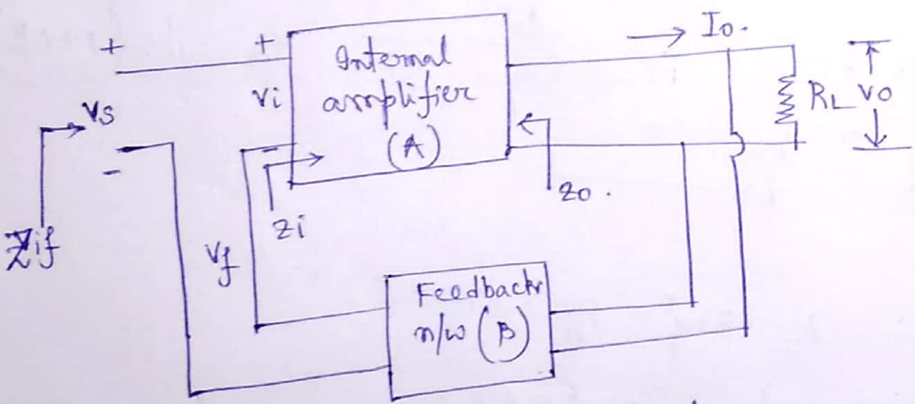


$V_f = \beta V_o$.

Due to −ve feedback $V_i = V_s - V_f$.

So maximum peak voltage $(V_s - V_f)$ which is i/p to the amplifier. So distortion minimizes.

Input impedance



I/p impedance of internal amplifier

$$Z_i = \frac{V_i}{I_i} \quad \text{———} (i)$$

Input impedance of the feedback amplifier

$$Z_{if} = \frac{V_s}{I_i} \quad \text{———} (ii)$$

Input signal voltage,

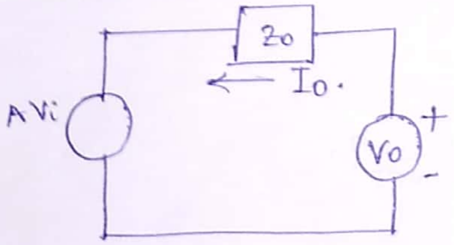
$$V_s = V_i + V_f = V_i + \beta V_o$$
$$= V_i + A\beta V_i \quad [V_o = AV_i]$$
$$\therefore V_s = V_i(1+A\beta)$$

From eq^n (2) we get,

$$Z_{if} = \frac{V_i(1+A\beta)}{I_i} \quad [\text{From (i)}]$$

$$\boxed{Z_{if} = Z_i(1+A\beta)} \Rightarrow \boxed{Z_{if} > Z_i}$$

Output impedance



We put i/p signal voltage $V_s = 0$., disconnect load resistance R_L and put voltage source Vo at the load terminal.

$$V_s = 0.$$
$$V_i = V_s - V_f = -V_f = -\beta V_o.$$

O/p impedance with feedback.

$$Z_{of} = \frac{V_o}{I_o}$$

$$\therefore I_o = \frac{V_o - AV_i}{Z_o} \quad [\text{from ckt}]$$

$$= \frac{V_o + A\beta V_o}{Z_o} = \frac{V_o(1+A\beta)}{Z_o}$$

$$\therefore Z_{of} = \frac{V_o \cdot Z_o}{V_o(1+A\beta)}$$

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

$$\therefore \boxed{Z_{of} < Z_o}$$

1 Voltage gain of an amplifier without feedback 60 db. It decreases to 40 dB with feedback. Calculate feedback factor.

$A = 60$ dB. $\qquad A_f = 40$ dB.

$20 \log A = \cancel{40}\ 60$. $\qquad \therefore 20 \log A_f = 40$.

$\therefore A = 1000$. $\qquad$ or, $A_f = 100$. $\quad$ (antilog $\frac{40}{20}$)

Gain with feedback

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

$\therefore$

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

$$= \frac{1000}{100} - 1 = 9.$$

2 Amplifier has a voltage gain of -100. The feedback ratio is -0.04.

Find (i) voltage gain with feedback

(ii) the amount of feedback in dB.

(iii) the o/p voltage of the feedback amp. for an i/p voltage 40 mV.

(iv) feedback factor.

(v) feedback voltage.

Solⁿ (i) $A_f = \frac{A}{1+A\beta} = \frac{-100}{1+(-100)(-0.04)} = -20$

(ii) $F = 20 \log_{10} \left| \frac{A_f}{A} \right| = 20 \log_{10} \left(\frac{1}{5}\right) = -13.98$ dB.

(iii) output voltage with feedback

$V_o = A_f V_s$

$= -20 \times 40 \times 10^{-3} = -0.8V.$

(iv) feedback factor

$-A\beta = (-100) \times (-0.04) = -1.$

(v) feedback voltage

$V_f = \beta V_o = -0.04 \times -0.8$

$= 32 mV.$