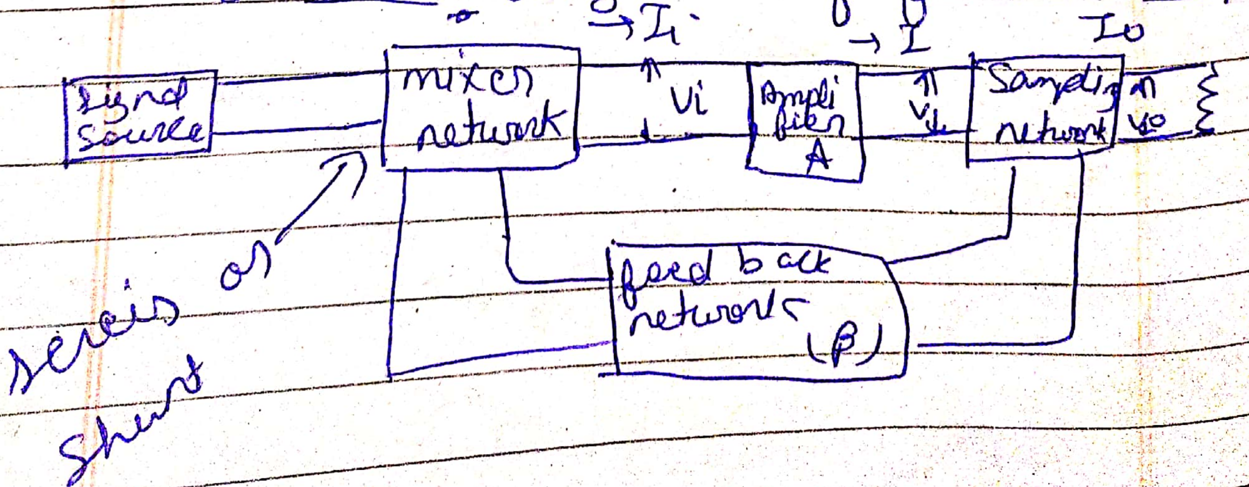
Feedback Amplifiers

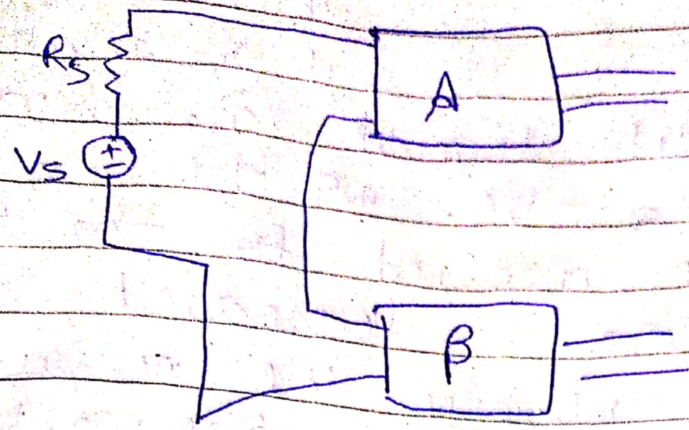
A gain must be independent of external factors such as variation in the voltage of the d.c supply and of the values of the circuit components. All this can be achieved by <u>feedback</u>

Feedback :- Output of feedback network, which has a fraction of the output signal is combined with external source Vs through of a mixer and fed to the basic amplifier. Mixers are also known as comparators, are of two types namely series & shunt

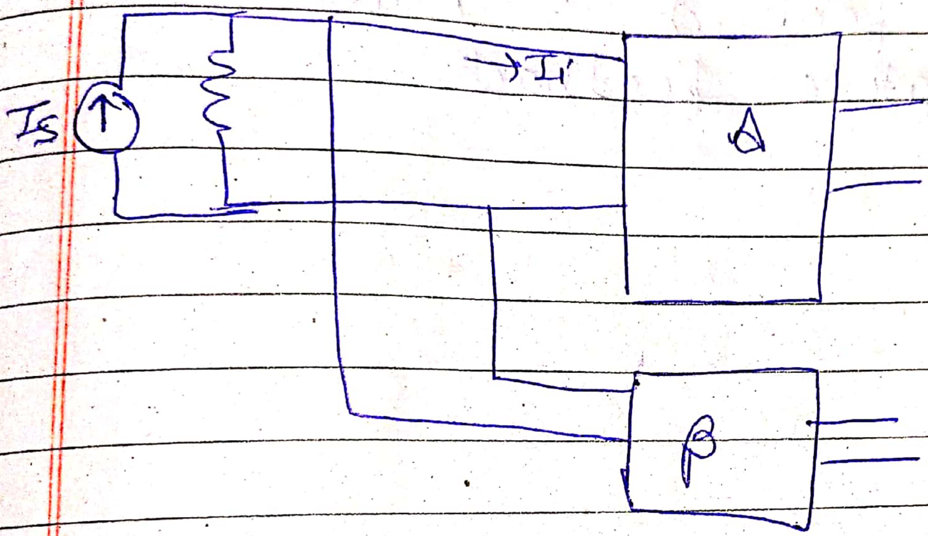
<u>Block diagram of feeback amp.</u>



Series mixer



Shunt mixer



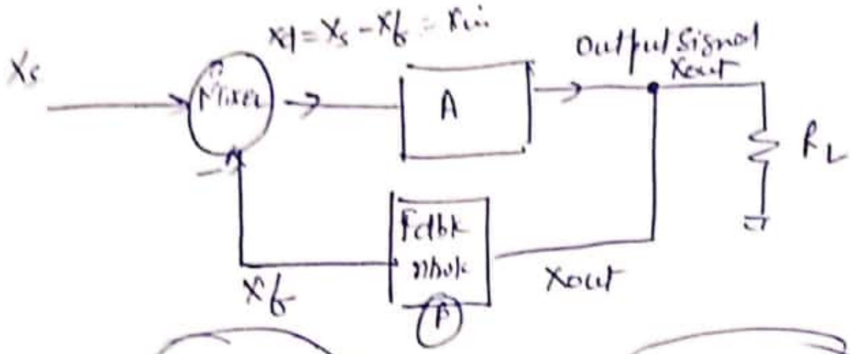
Positive feedback

If the feedback signal V_f is in phase with input signal V_S, then the net input $V_i = V_S + V_f$. Hence, the input voltage applied to the basic amplifier is increased thereby increase V_o exponentially. This type of feedback is called positive feedback.

Negative feedback

If the feedback signal V_f is out of phase with the input signal V_S, then $V_i = V_S - V_f$. So the input voltage applied to the basic amplifier is decreased and correspondingly the output is decreased. Hence the voltage gain is reduced. This type of feedback is known as negative feedback

Schematic Representation of feedback amplifier



We define $\beta = \dfrac{X_f}{X_{out}}$; and $A = \dfrac{X_{out}}{X_{in}}$

$$A_f = \frac{X_{out}}{X_s} = \frac{X_{out}}{X_{in} + X_f} = \frac{\frac{X_{out}}{X_{in}}}{1 + \frac{X_f}{X_{in}}}$$

$$= \frac{\frac{X_{out}}{X_{in}}}{1 + \frac{X_f}{X_{out}} \times \frac{X_{out}}{X_{in}}} = \frac{A}{1 + A\beta}$$

→ * A_f is less than A, in case of negative feedback.

$A_f > A$ ... positive feedback ... regenerative.

Advantages of Negative feedback

(1) Gain stability : as $A_f \propto (A, \beta)$, at if $A\beta >> 1$ then A_f depends on β and β depends on passive elements so A_f is stabilized.

(2) Reduced Non-linear distortion : $D_f = \dfrac{D}{1 + A\beta}$.

(3) Reduced Noise

(4) Increased Bandwidth

(5) Increased Input Impedance.

(6) Reduced output Impedance.

Effect of negative feedback on bandwidth

The effect of negative feedback on lower cut off and upper cut off frequencies of the amplifier is →

(1) lower cut off frequency

~~From the~~

$$\boxed{f_{Lf} = \frac{f_L}{1 + A_{mid}\,\beta}}$$

From the above equation, we can say that lower cut off frequency with feedback is less than the lower cut off frequency without feedback by factor $(1 + A\beta)$.

② Upper cutt off frequency

$$f_{Hf} = (1 + A_{mid}\beta) f_H$$

From the above eqn we can say that upper cutt off frequency with feedback is greater than upper cutt off frequency without feedback by factor $(1 + A_{mid}\beta)$.

Therefore By negative feedback, low ~~freq~~ frequency response and high frequency response is improved.

Bandwidth is given by

$$BW = f_H - f_L$$

$$= (1 + A_{mid}\beta) f_H - \frac{f_L}{(1 + A_{mid}\beta)}$$

It can also written as

$$BW_f = BW(1 + A_{mid}\beta)$$

So the bandwidth is increased.

$$A_f \times BW_f = A \times BW$$

∴ Voltage gain of first stage in dB = (80 − 43.52) dB = 36.48 dB.

Q.3. (b) What are the advantages of negative feedback? How do stabilization of gain take place with negative feedback? (5)

Ans. Negative Feedback

Negative feedback reduces the gain of the amplifier but improves its performance in several aspects and does not effect the current of the circuit.

Advantages:

1. It improves the gain stability.
2. It reduces non-linear distortion and noise.
3. It increases bandwidth or improved frequency response.
4. It increases input impedance.
5. It reduces output impedance.

Stabilization of gain with negative feedback.

The voltage gain of negative feedback.

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

The gain A_f is thus independent of internal gain of the amplifier and depends on passive components such as resistors that remain fairly constant. Thus the gain is stabilized.

Hence while comparing the biasing circuits, we should focus our attention more on the value of S.

Thermal Runaway: The maximum power that a transistor can dissipate without getting damaged depends largely on the maximum temperature that a collector-base junction can withstand. The rise in the collector-base junction takes place due to two reasons:

- Due to increase in the ambient temperature and
- Due to the internal heating.

Out of them the internal heating process is cumulative as explained below:

(*i*) An increase in collector current I_C increases the power dissipated in the collector-base junction of the transistor.

(*ii*) This will increase the temperature of C–B junction.