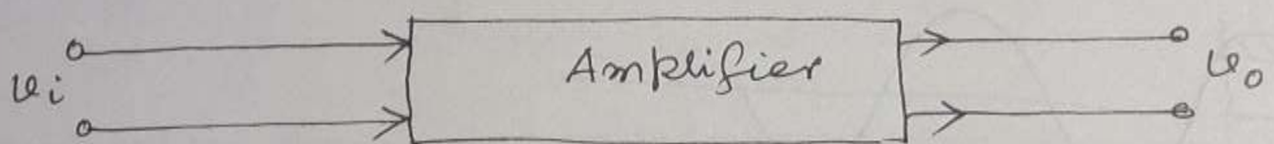
Feedback Amplifier

Background

Feedback Amplifiers

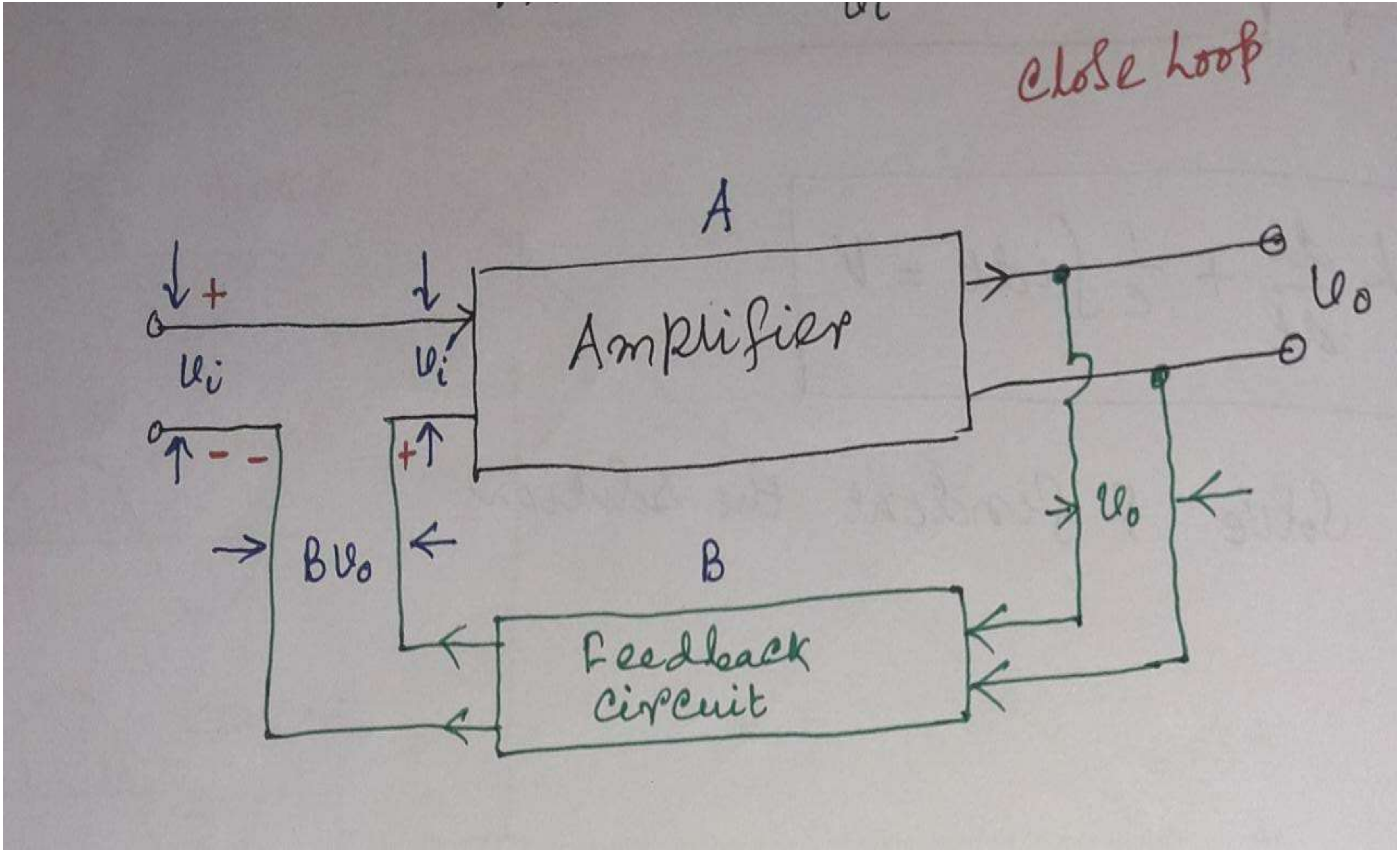
open loop amplifiers has some typical limitations
- ① Gain is dependent on gain of the transistor
- so not controllable ② Gain is changing with temperature ③ sometimes having nonlinear response.

So closed loop amplifiers are introduced in order to mitigate the limitations.



$$A = \text{Gain} = \frac{v_o}{v_i}$$

Feedback Amplifiers



Feedback Amplifiers

$$v_i' = v_i - B v_o$$

$$= v_i - B(A v_i)$$

$$= v_i(1 - AB)$$

$$A_f = \text{Closed Loop Gain} = \frac{v_o}{v_i'} = \frac{A v_i}{v_i(1-AB)}$$

$$\boxed{A_f = \frac{A}{1-AB}}$$

B = Gain of the feedback

Feedback Amplifiers

Analysis of the result.

① $(1 - AB) < 1$, $B \to +Ve$, $A_f > A$

Positive feedback or Regenerative Feedback.

Unstable

② $(1 - AB) > 1$, $B \to -Ve$, $A_f < A$

Negative feedback or Degenerative feedback

Stable

③ $1 - AB = 0$, $AB = 1$, $A_f \to \infty$

No i/p, but o/p

OSCILLATOR

Feedback Amplifiers

Topologies of Feedback Amplifier

(I) Voltage - Series feedback

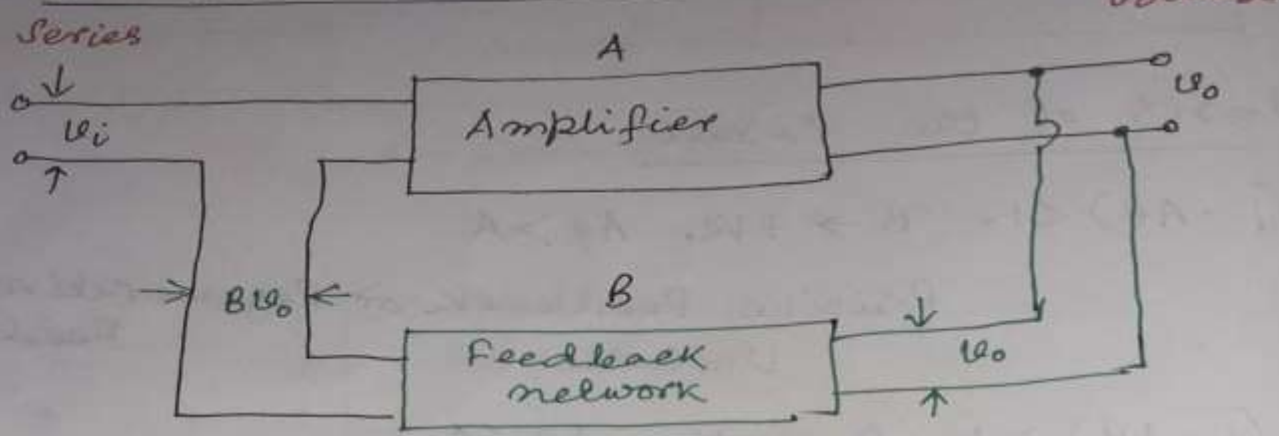
(II) Voltage - Shunt feedback

(III) Current - Series feedback

(IV) Current - Shunt feedback.

Feedback Amplifiers

Voltage - Series feedback

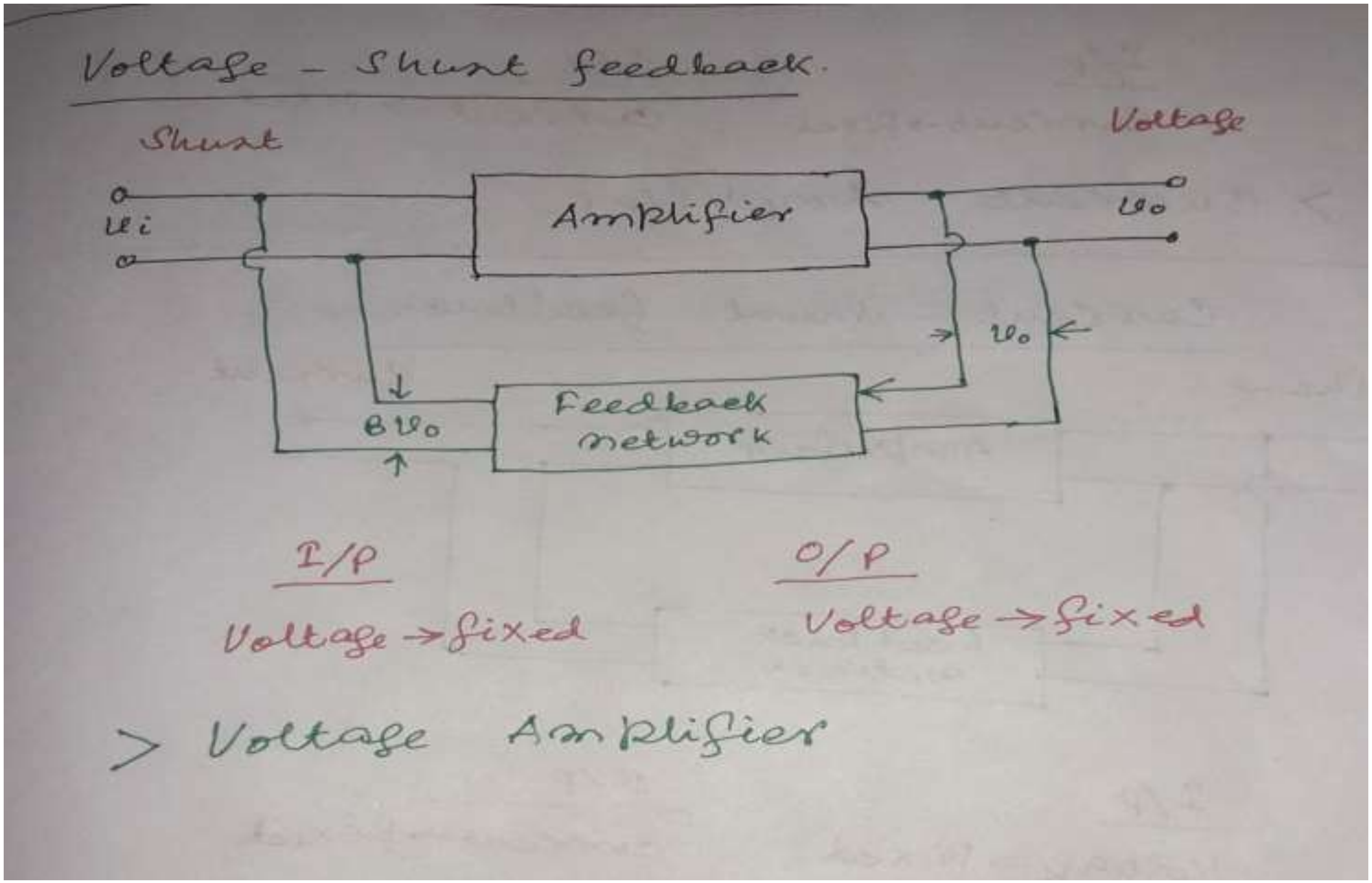


I/P	O/P
Current → fixed	voltage → fixed.

> Transresistance Amplifier

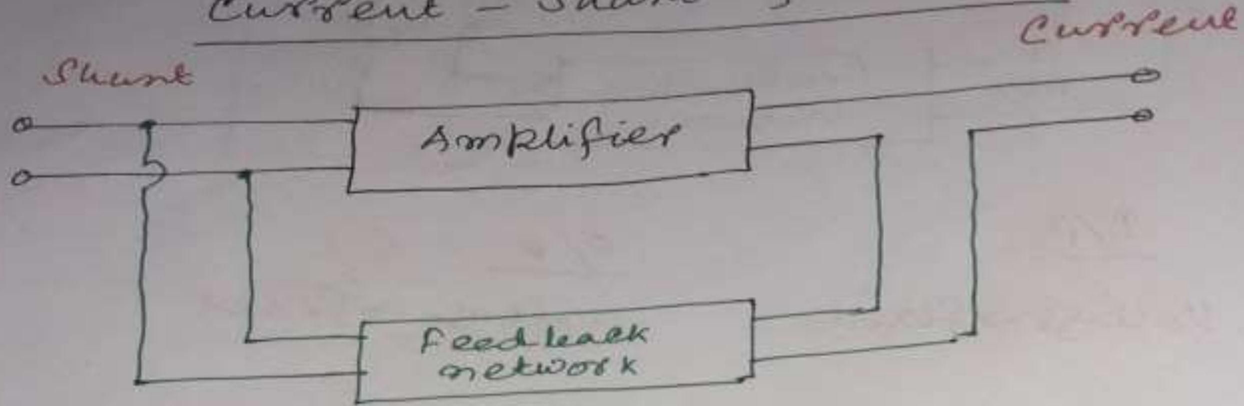
> I to V converter.

Feedback Amplifiers



Feedback Amplifiers

Current - Shunt feedback.

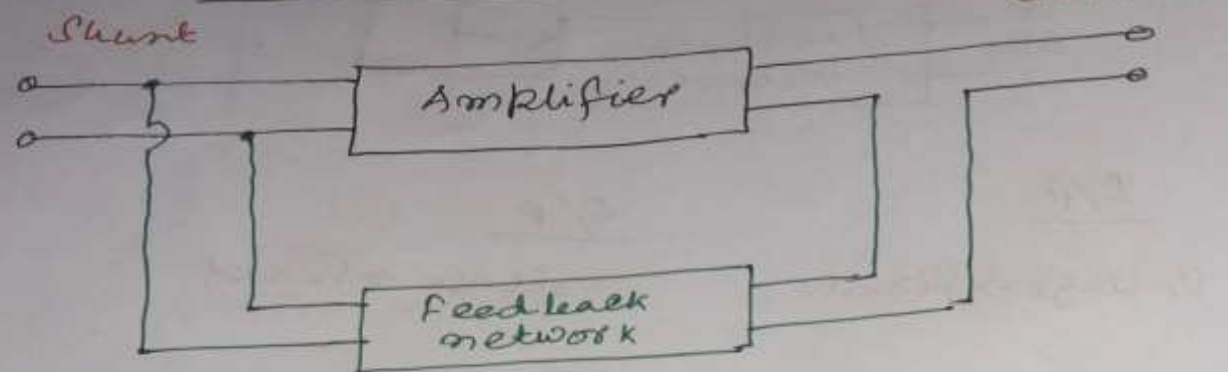


I/P	O/P
Voltage → fixed	Current → fixed

> Transconductance Amplifier
> V to I Converter.

Feedback Amplifiers

Current – Shunt feedback.



I/P	O/P
Voltage → fixed	Current → fixed

> Transconductance Amplifier

> V to I Converter.

Feedback Amplifiers

Effects of negative feedback.

(i) The stability of the amplifier is improved.

(ii) Input impedance can be varied.

(iii) Output impedance can be varied.

(iv) Nonlinear distortion is reduced

(v) Noise is reduced

(vi) Bandwidth of the amplifier increases.

Feedback Amplifiers

(i) Improvement of Stability

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

$\therefore$ $(1+AB) > 1$, $A_f < A$

So stability is improved.

(ii) For negative feedback .... i/p impedance.

$$V_i' = V_i(1+AB)$$

$$\therefore \quad Z_{if} = \frac{V_i'}{I_i} = \frac{V_i}{I_i}(1+AB) = Z_i(1+AB)$$

(iii) O/P impedance.

$$Z_{of} = \frac{V_o}{I_o}, \qquad Z_o = \frac{V_o}{I_o'}$$

$$I_o = \frac{V_o - AV_i}{Z_o} = \frac{V_o + ABV_o}{Z_o} = \frac{V_o(1+AB)}{Z_o}$$

$$Z_{of} = \frac{V_o}{\frac{V_o(1+AB)}{Z_o}} = \frac{Z_o}{1+AB}$$

Feedback Amplifiers

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Feedback Amplifiers

(iv) Reduction of noise.

$$V_n$$

$$V_{nf} = A_f \cdot V_n = \frac{A V_n}{1+AB} = \frac{V_{on}}{1+AB}.$$

$(1+AB) > 1, \quad V_{nf} < V_{on}$

(v) Enhancement of Bandwidth.

BW = Frequency range for which gain remains constant.

Frequency at which gain is one.

$$\text{Constant} = UGB = A f_o$$

$$\text{Constant} = UGB = A_f \cdot f_F$$

$$A f_o = A_f f_F$$

$$\therefore f_F = \frac{A f_o}{A_f} = \frac{A f_o}{A/1+AB}.$$

$$\therefore \boxed{f_F = f_o (1 + AB)}$$

Feedback Amplifiers

Condition of Oscillation.

$AB = 1$

- $|AB| = 1$ CRITERION I
- $\angle AB = 0$ or 360° CRITERION II

BARKHAUSEN CRITERIA

Oscillator