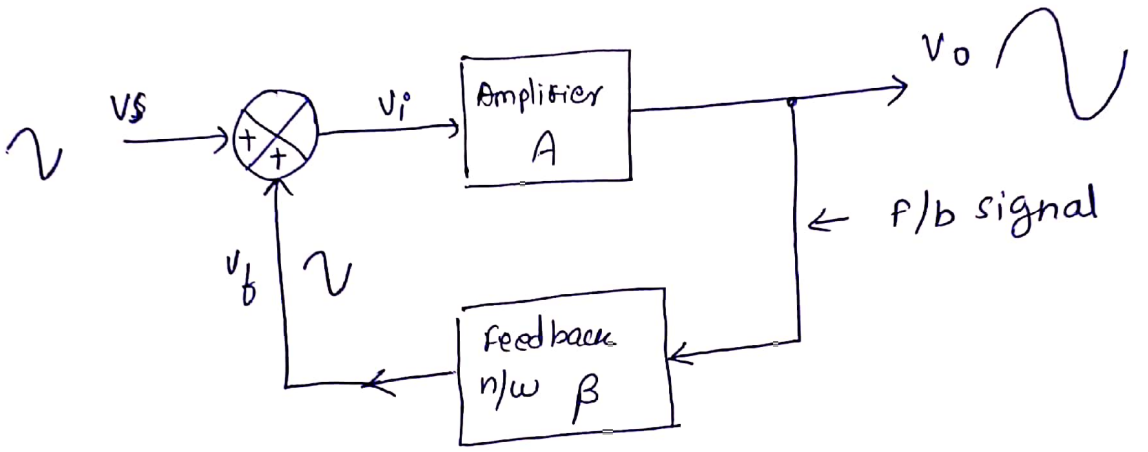
Oscillators

If something is oscillating at a constant frequency, we can generate an oscillator.

Oscillations are everywhere: any signal generated by our body is an oscillation eg. Brain waves (eeg), ecg ...

Oscillator definition: An oscillator is an amplifier, which uses a positive feedback, and without an external signal, generates an output waveform at a desired frequency.



Consider a non-inverting Amp with voltage gain A, as shown in the above figure. There is a feedback n/w with feedback factor β. The feedback is said to be positive whenever the part of the output that is fed back into the input is in phase with the original signal applied to the Amp.

(Note: if the f/b signal is out of phase with i/p then it will be $V_s - V_f$, only if the f/b signal is inphase with i/p then it will be $V_s + V_f$).

$V_i = V_s + V_f$

$\therefore V_s = V_i - V_f$

$= V_i - \beta V_o$

Circuit gain $A_f = \dfrac{V_o}{V_i - \beta V_o}$

$= \dfrac{V_o/V_i}{1 - \beta\left(\frac{V_o}{V_i}\right)}$

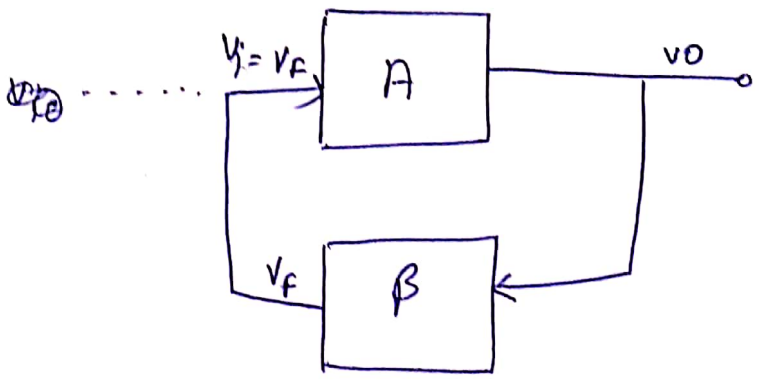
$= \dfrac{A}{1 - A\beta}$

A	β	Af
20	0.005	22.22
20	0.04	100
20	0.045	200
20	0.05	∞

substitute these values in the equation

The table shows that the gain with feedback increased as the amount of +ve F/b increased. In the limiting case, the gain becomes infinite. This indicates that circuit can produce output without external input ($V_s = 0$), just by feeding the part of the output as its own input. Similarly, the output cannot be infinite but gets driven into oscillations. In other words, the circuit stops amplifying & starts oscillating.

Barkhausen criteria for sustained oscillations:



① $V_o = A V_i$

$V_f = \beta V_o$

$\therefore V_f = \beta A \cdot V_i$

But $V_i = V_f$

$\therefore |A\beta| = 1$ — loop gain

② The phase of V_f should be same as V_i i.e. the fb n/w should introduce 0° phase shift if the amplifier is non-inverting & 180° ($\pm 180^\circ$) phase shift if the amp is inverting to ensure positive feedback

In practice, $A\beta$ is made greater than 1 to start the oscillations and then the circuit adjusts itself to get $A\beta = 1$, finally resulting into self-sustained oscillations.

$\|A\beta\| > 1$	$\|A\beta\| = 1$	$\|A\beta\| < 1$