U3: Timing Circuits and Signal Generators

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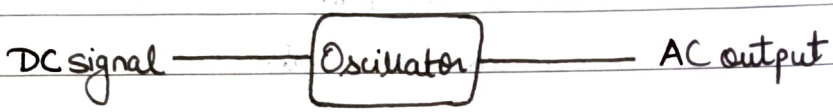
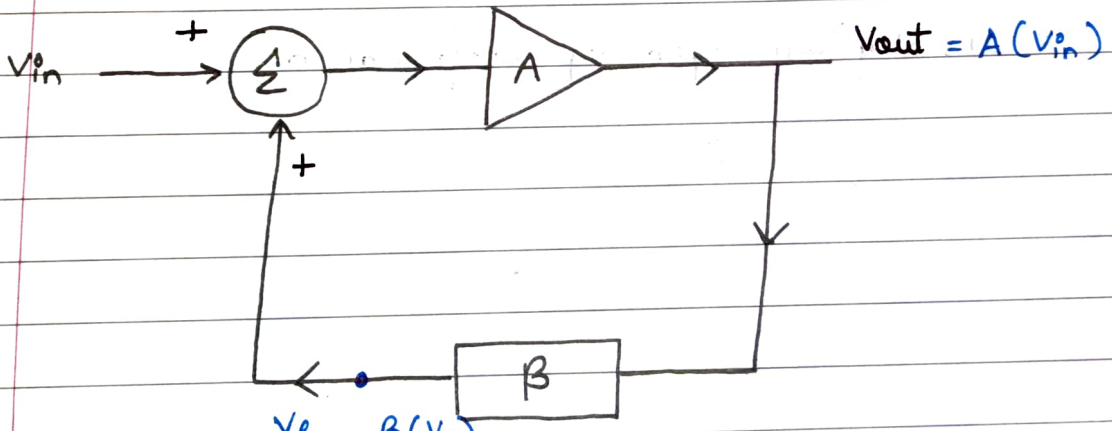
Oscillators: It accepts the DC voltage and it generates the periodic AC signal of the desired frequency

Output: it can be either sinusoidal or non sinusoidal signal like square wave & triangular wave

oscillators are nothing but amplifier given with a positive feedback



frequency: few Hz to even any GHz.



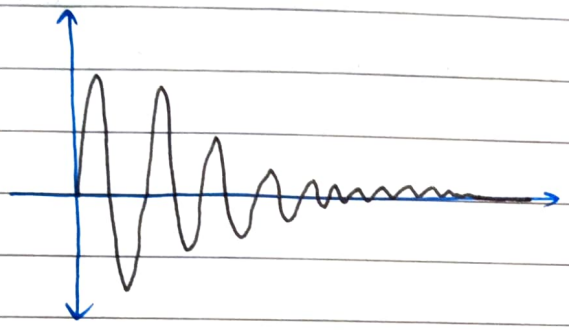
β: feedback factor = what fraction of out put voltage is given to the input stage

V_f will act as input signal

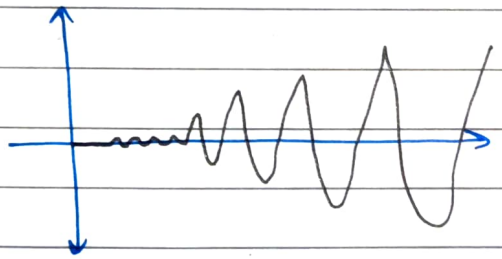
product of feedback factor (β) and voltage gain (A) is known as loop gain of oscillator ($A\beta$).

So whether there will sustained oscillations or not after removing the input signal V_{in} · it is decided by the loop gain of oscillator ie $\beta \cdot A$

⇒ If $A\beta < 1$ (over the period of time, the input signal will die out)



⇒ If $A\beta > 1$ (over the period of time the input signal will build up).



So in order to get sustained oscillations, two conditions should get satisfied —

$$\{|A\beta| = 1 \;;\; \angle A\beta = 0\}$$

↳ This is known as Barkhausen criteria for the oscillation.

How we can get output signal in an oscillator even without giving it a input signal?

Sol^n Thermal noise is present in every circuit and that thermal noise acts as an input which gets amplified.

feedback circuit is the frequency selective circuit so out of all frequency component only for one particular frequency, the phase shift for only one frequency would be in-phase (ie phase diffunce = zero)

Types of oscillators

RC oscillator
LC oscillator
Crystal oscillator
→ sinusoidal oscillators

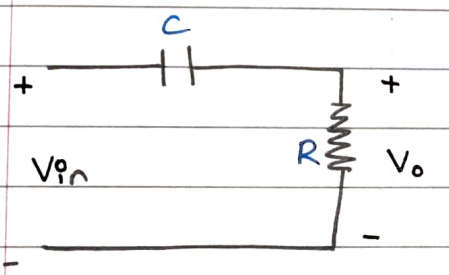
Relaxation oscillator
555 timer
→ Non sinusoidal oscillators

RC Phase shift oscillator

Here the RC circuit is used at the feedback path which helps in generating stable sine waves used in the low-frequencies generation Typically in range of audio frequencies.

amplifier provides 180° phase shift. So in order to satisfies the Barkhausen criteria the feedback RC circuit also provides the 180° phase shift in order to reach the initial phase (ie +360°)

$$\angle A\beta = 0 \text{ or } 360$$
$$|A\beta| = 1$$



$$\frac{V_o}{V_{in}} = \frac{R}{R - jX_c} \quad ; \quad X_c = \frac{1}{\omega C}$$

$$= \frac{R}{\left(R - \frac{j}{\omega C}\right)} = \left(\frac{1}{1 - \frac{j}{\omega CR}}\right)$$

$$\angle\phi = 0 - \tan^{-1}\left(\frac{-1}{\omega CR}\right)$$

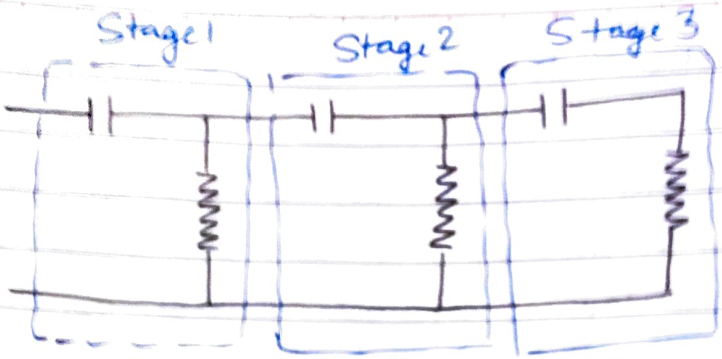
$$= \tan^{-1}\left(\frac{1}{\omega CR}\right) \Rightarrow \left[\tan\phi = \frac{X_c}{R}\right]$$

when $R = 0$ @ that time X_c/R become ∞.

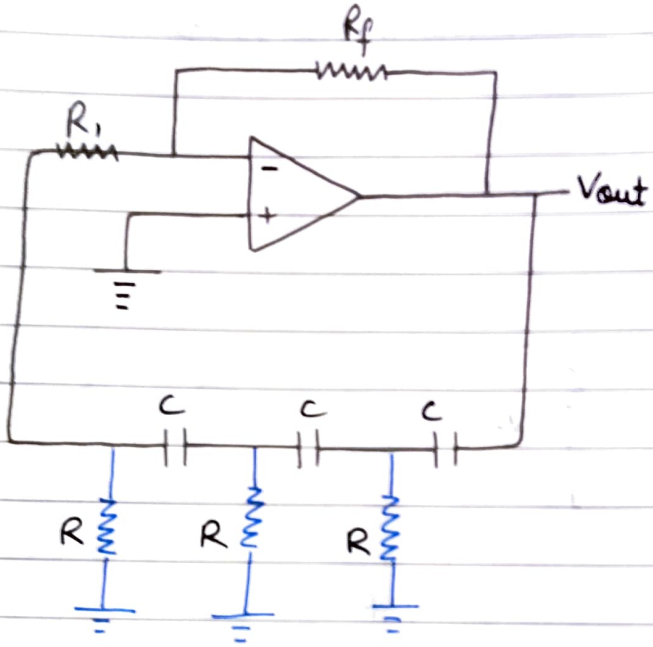
$$\phi = \tan^{-1}(\infty) = \pi/2$$

Hence 2 RC's combination is used to get $\pi\ \angle\phi$.

In practical cases, we use more RC combination ie 3 are used.



$60^\circ + 60^\circ + 60^\circ = 180^\circ$



RC phase shift oscillator

If $\beta = 1/29$; A should be 29
so that $(A\beta = 1)$
that particular frequency for 3 RC sets will be

$$f = \frac{1}{2\pi RC\sqrt{6}}$$

In general,

$$\left(f = \frac{1}{2\pi RC\sqrt{2N}} \right)^{***}$$

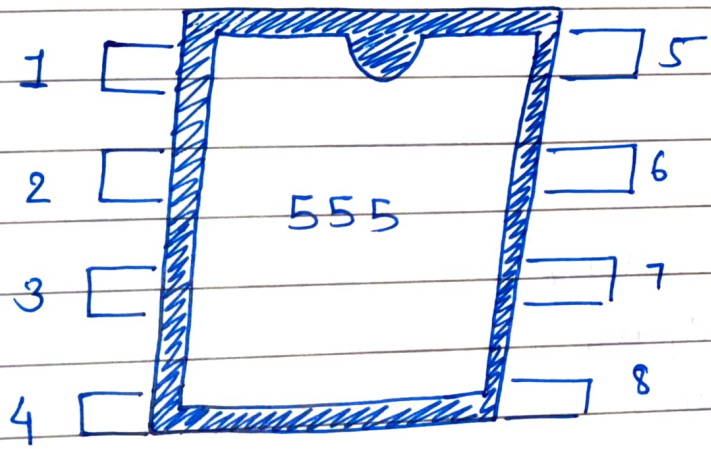
where,
N = no. of RC sets

555 Timer IC

Application of 555 Timer

⇒ Tone alarm generator
⇒ Frequency Division
⇒ To provide Timing Delays
⇒ As relaxation Oscillator.

Pin Diagram of 555 Timer



1	Ground
2	Trigger
3	Output
4	Reset
5	Control
6	Threshold
7	Discharge
8	Vcc

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Block Diagram of 555 Timer