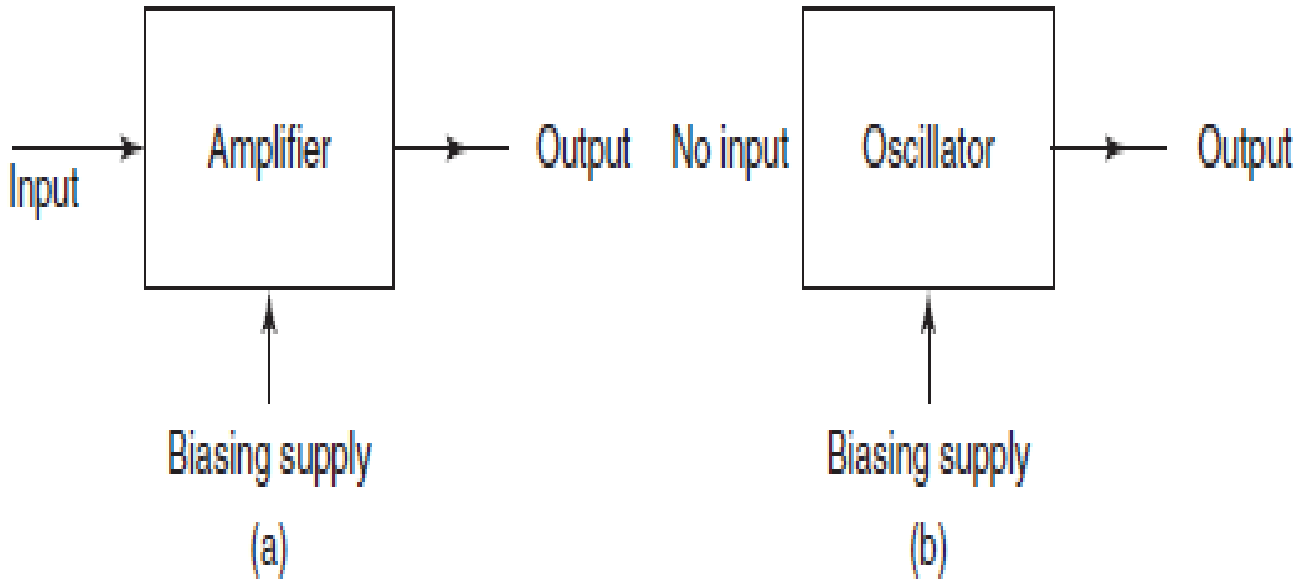
Oscillators

- An oscillator is an electronic system.
- It comprises active and passive circuit elements and sinusoidal produces repetitive waveforms at the output without the application of a *direct external input signal to the circuit.*
- It converts the dc power from the source to ac power in the load. A rectifier circuit converts ac to dc power, but an oscillator converts dc noise signal/power to its ac equivalent.

Difference between an amplifier and an oscillator:



Schematic block diagrams showing the difference between an amplifier and an oscillator

Need of an Oscillator

- An oscillator circuit is capable of producing ac voltage of desired frequency and waveshape.
- To test performance of electronic circuits, it is called signal generator.
- It can produce sine, square, pulse, triangular, or sawtooth waveshape.
- High frequency oscillator are used in broadcasting.
- Microwave oven uses an oscillator.
- Used for induction heating and dielectric heating.

Types of Oscillators

- Sinusoidal or non-sinusoidal.
- An oscillator generating square wave or a pulse train is called multivibrator :
  1. Bistable multivibrator (Flip-Flop Circuit).
  2. Monostable multivibrator.
  3. Astable multivibrator (Free-running).
- Depending upon type of feedback, we have
  1. Tuned Circuit (*LC*) oscillators.
  2. *RC* oscillators, and
  3. Crystal oscillators.

Using Positive Feedback

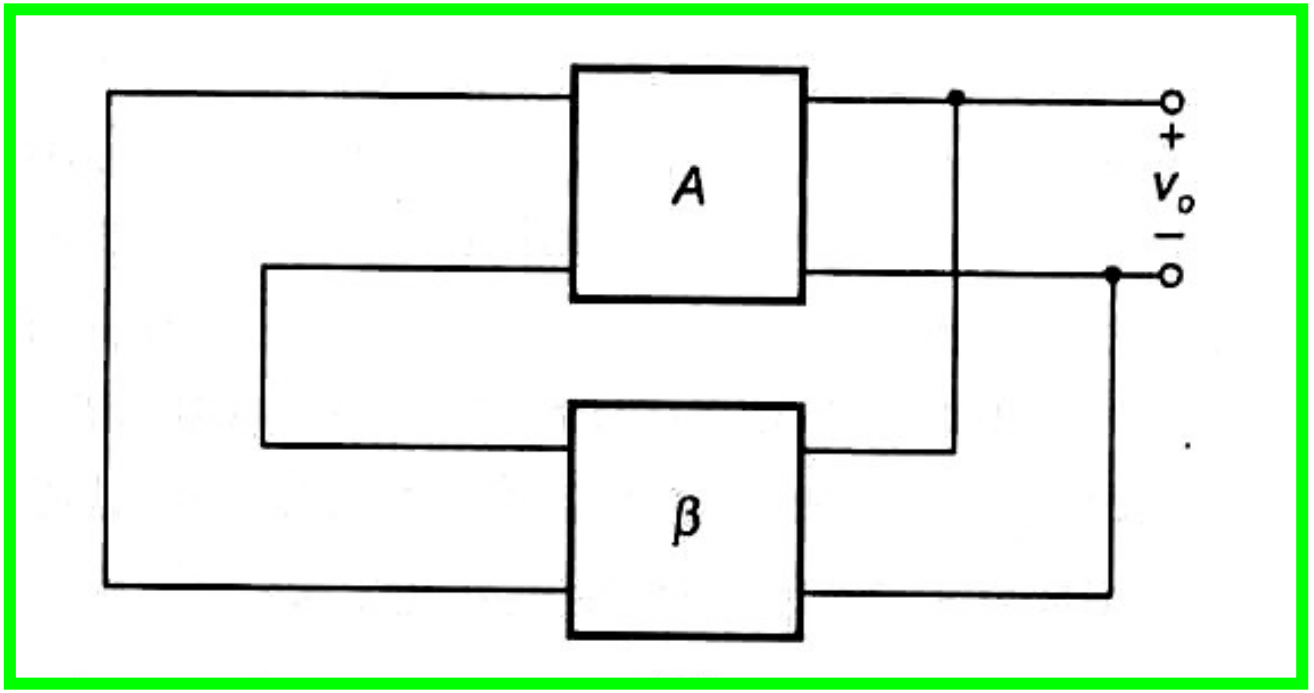
The gain with positive feedback is given as

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

By making $1 - A\beta = 0$, or $A\beta = 1$, we get gain as infinity.

This condition ($A\beta = 1$) is known as Barkhausen Criterion of oscillations.

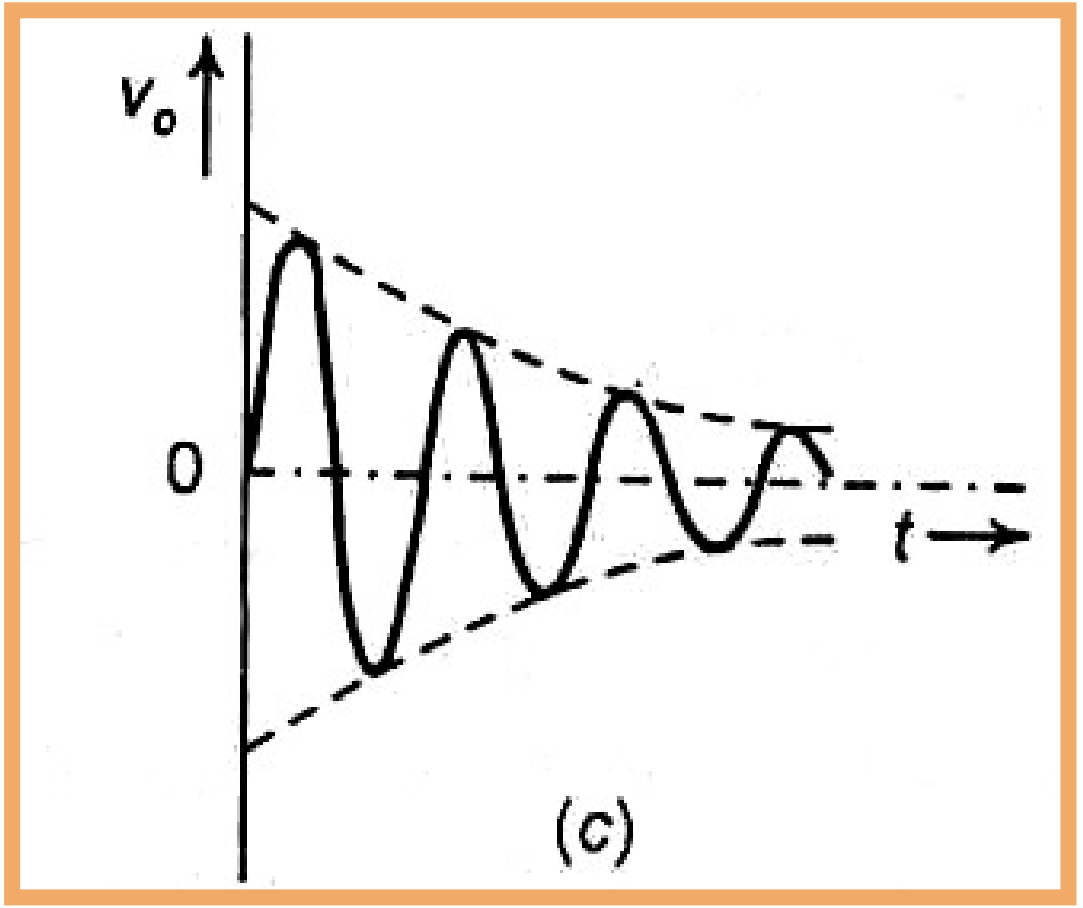
It means you get output without any input !



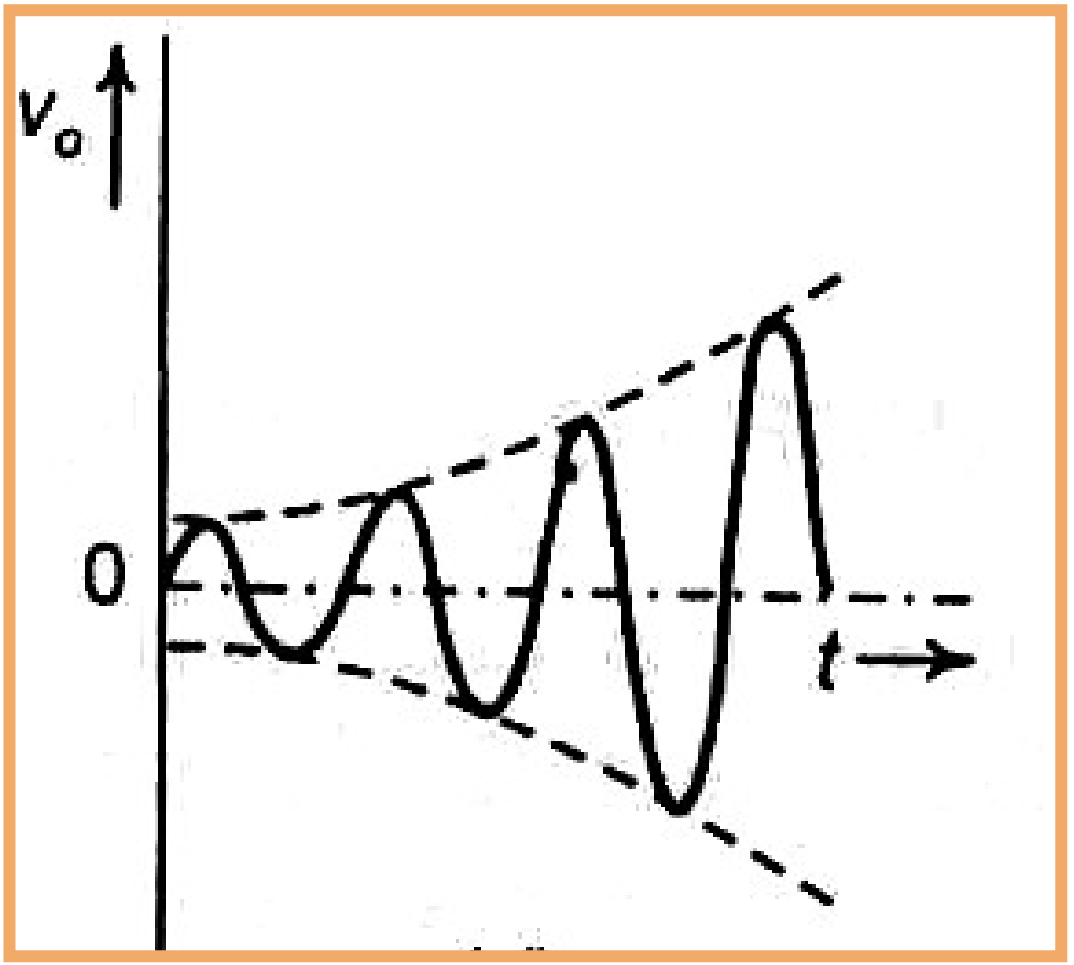
What happens to the output ?

There are three possibilities.

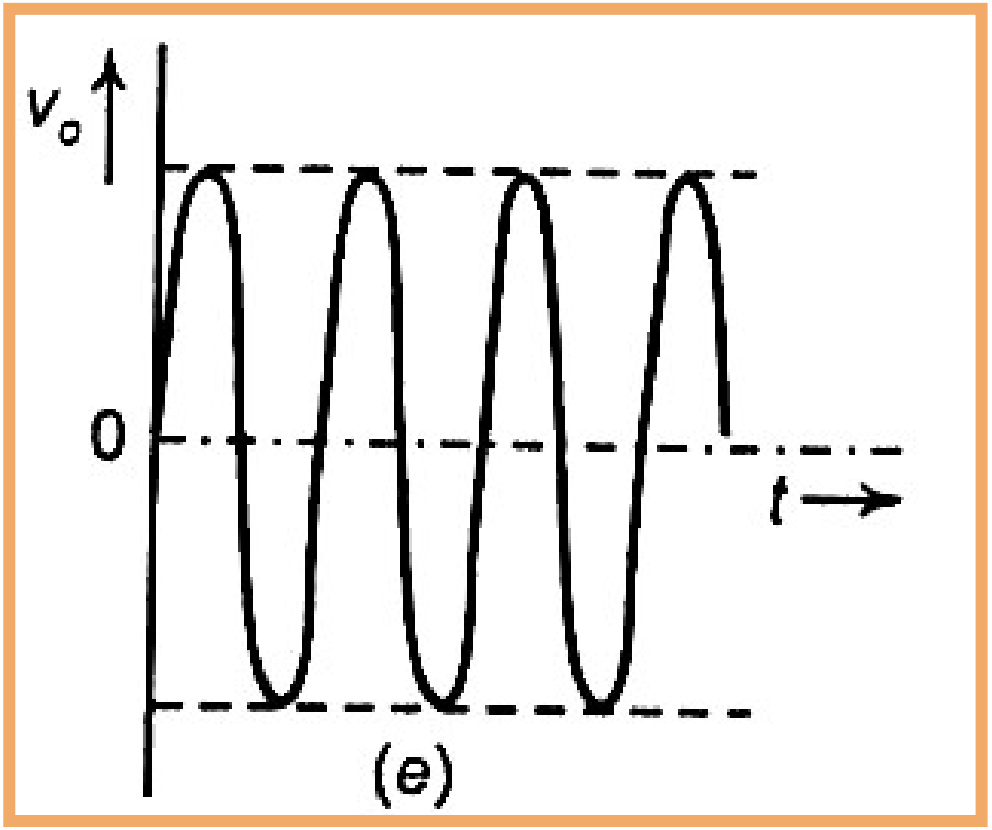
(1) If $A\beta < 1$, we get decaying of damped oscillations.



(2) If $A\beta > 1$, we get growing oscillations.



(3) If $A\beta = 1$, we get sustained oscillations. In this case, the circuit supplies its own input signal.



Wherefrom comes the starting voltage ?

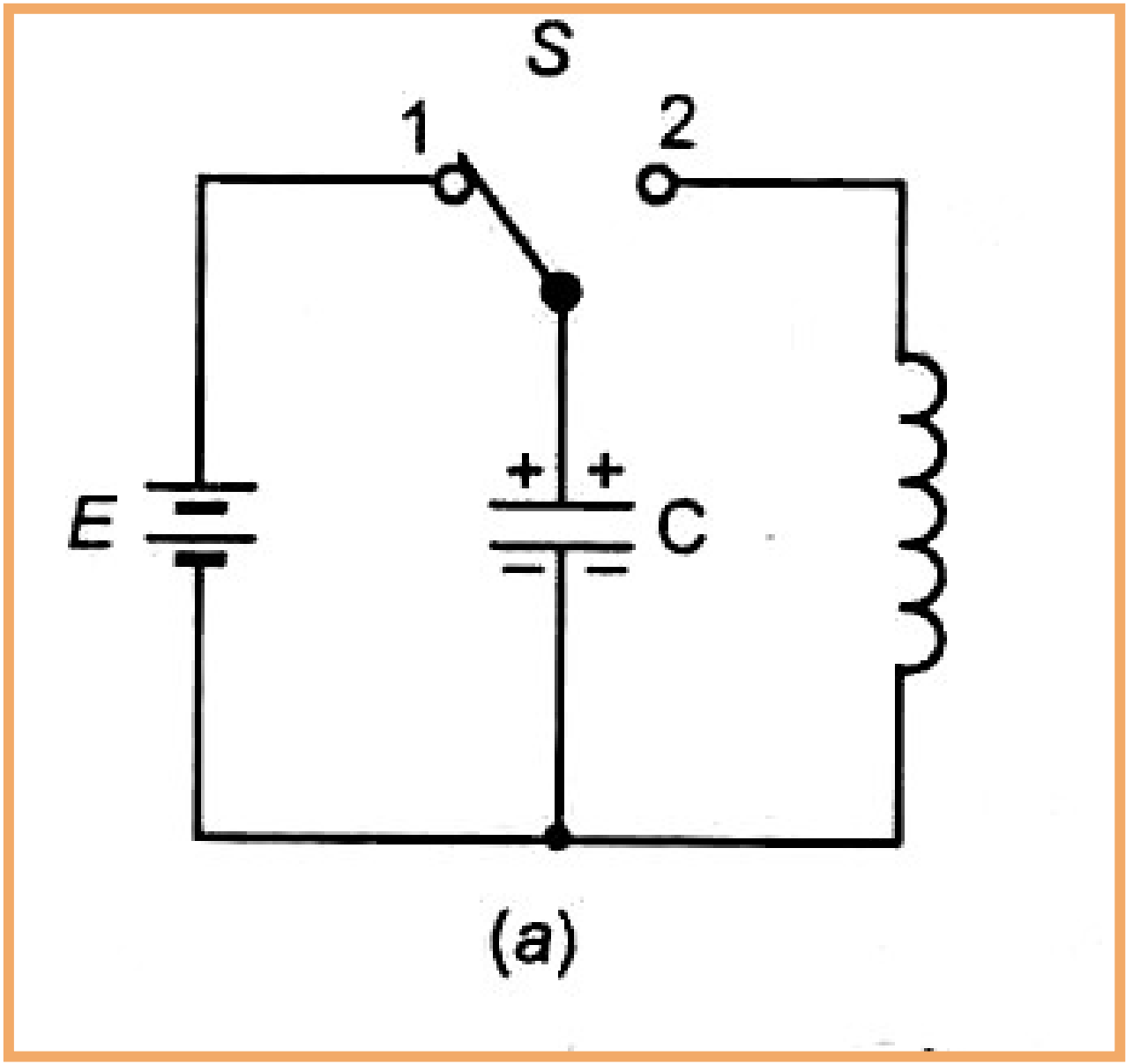
- Each resistor is a noise generator.
- The feedback network is a resonant circuit giving maximum feedback voltage at frequency f_0, providing phase shift of 0° only at this frequency.
- The initial loop gain $A\beta > 1$.
- The oscillations build up only at this frequency.
- After the desired output is reached, $A\beta$ reduces to unity.

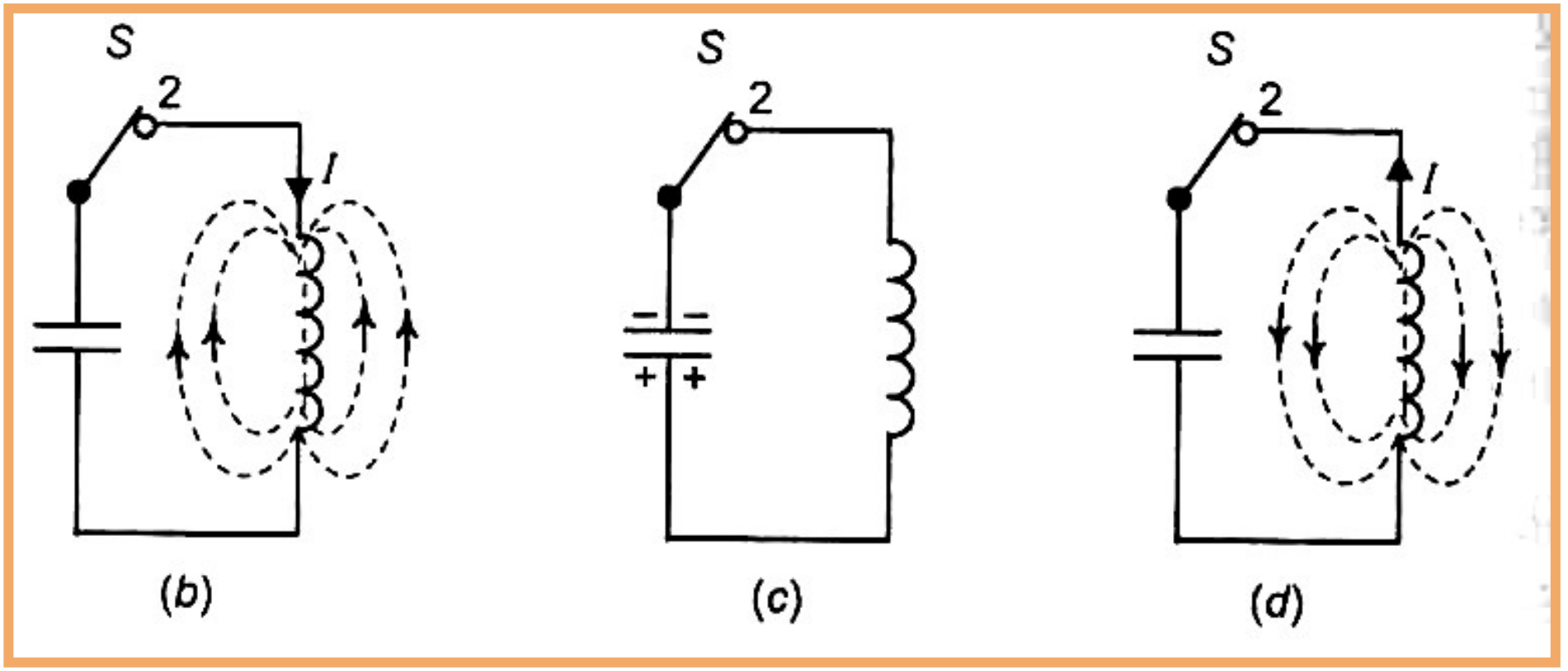
Tank Circuit

LC parallel circuit is called tank circuit.

Once excited, it oscillates at

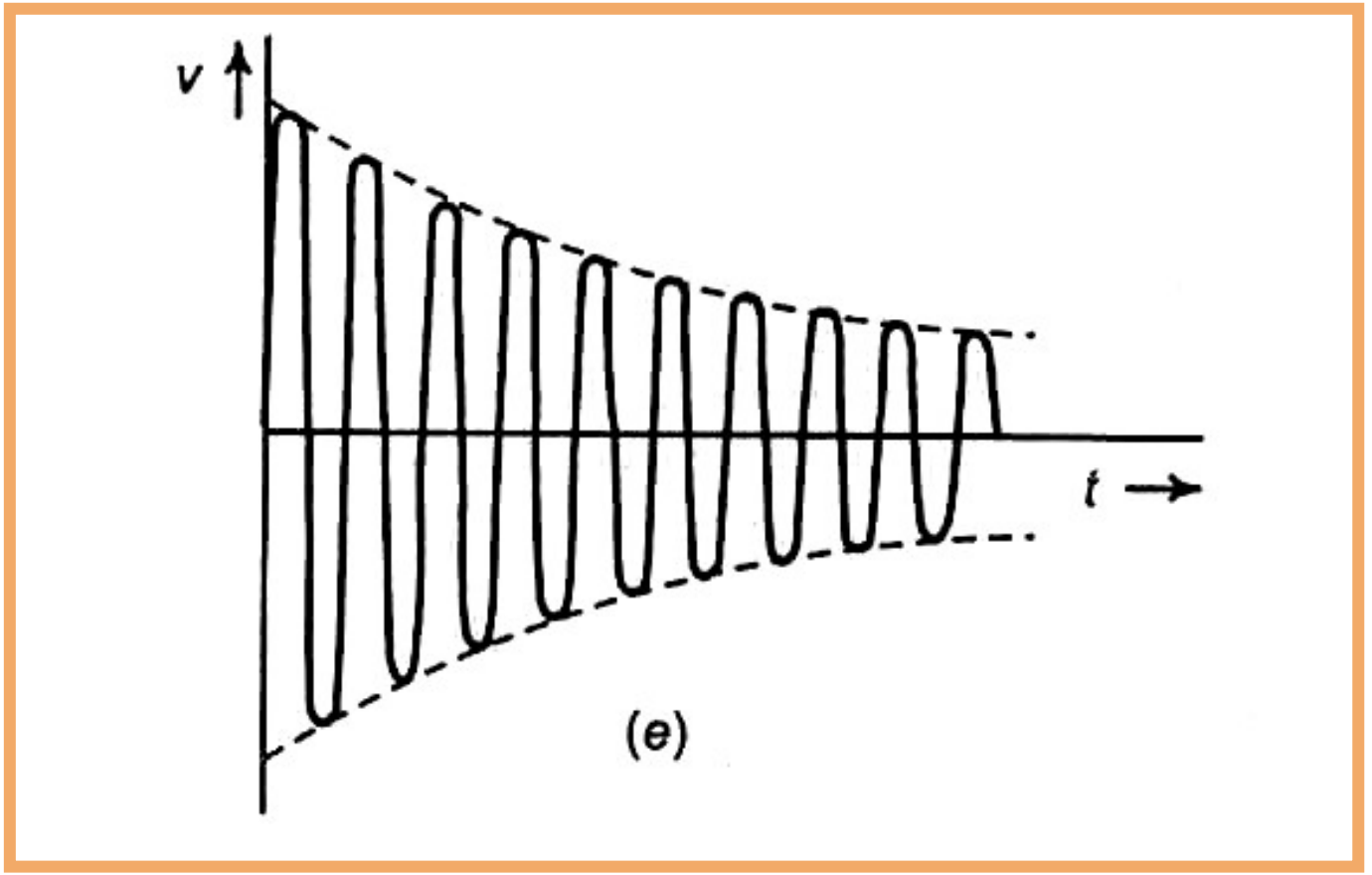
$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$


S
1
2
E
C
(a)

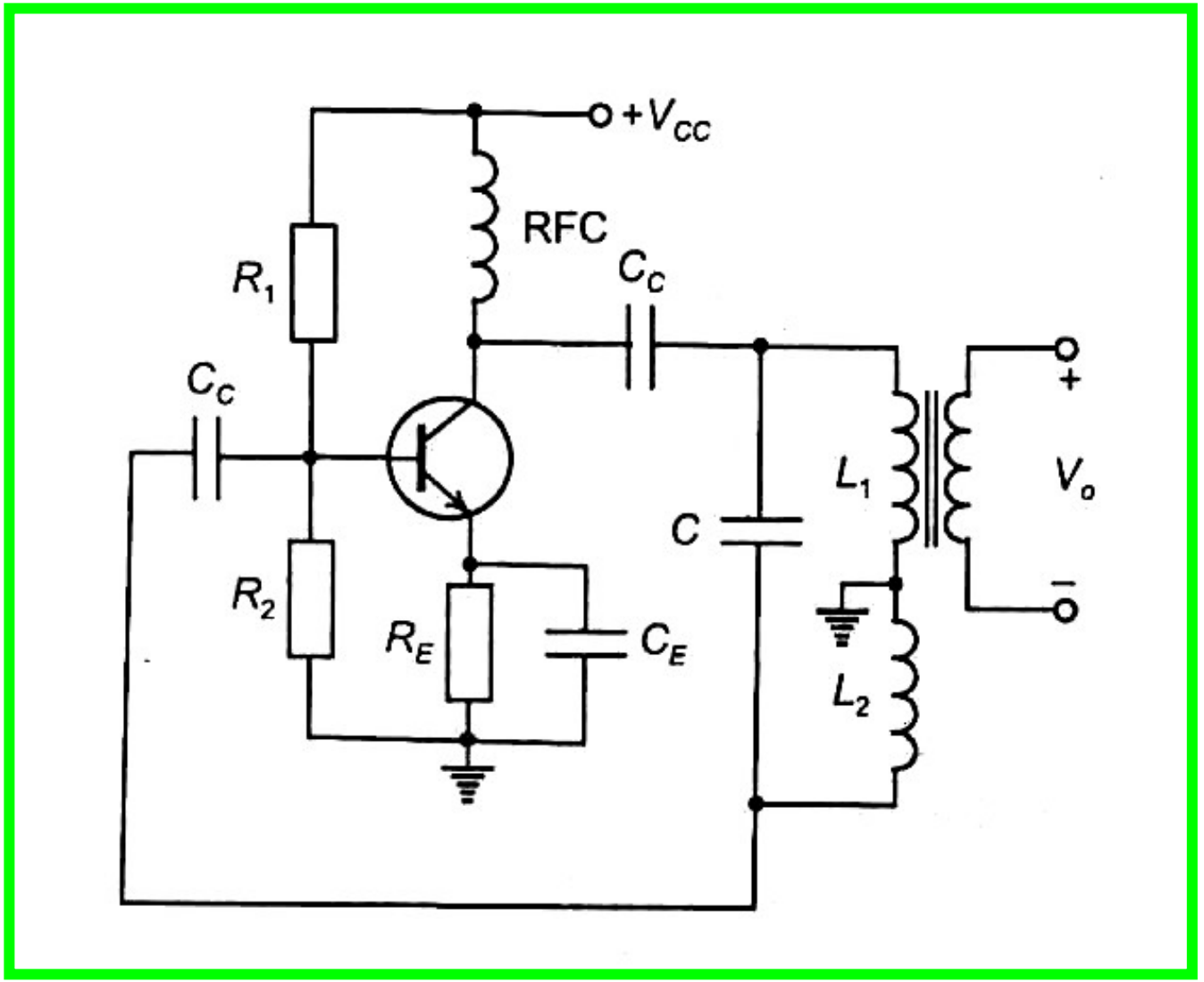


The energy keeps oscillating between electric potential energy and magnetic filed energy.

Damped oscillations are produced.



Hartley Oscillator



Hartley Oscillator

When the tank circuit resonates, the circulating current flows through L_1 in series with L_2. Hence the equivalent inductance is

$$L = L_1 + L_2$$

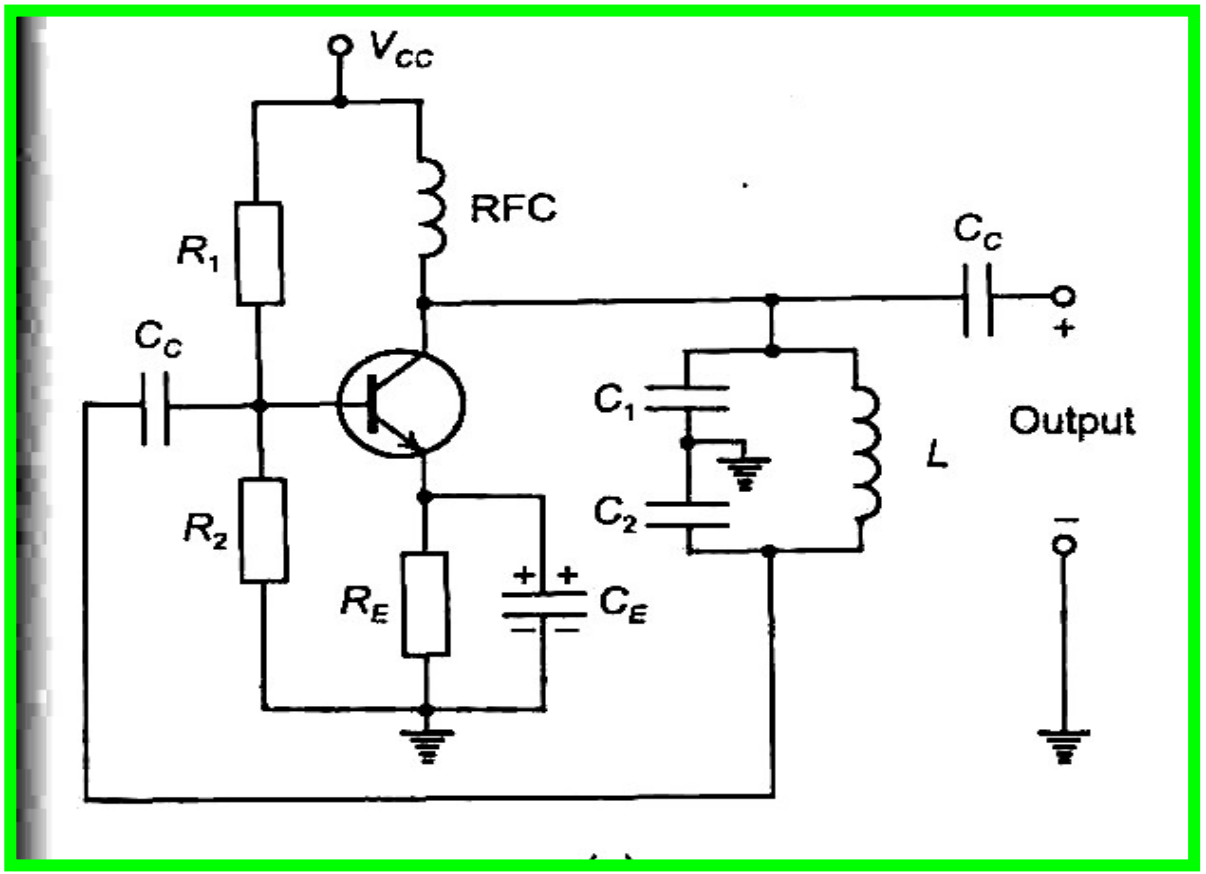
$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

The feedback factor is

$$\beta = \frac{L_2}{L_1}$$

Colpitts Oscillator

- An excellent circuit.
- Widely used in commercial signal generators.
- Uses two capacitors instead of the inductive voltage divider.



$$C = \frac{C_1 C_2}{C_1 + C_2}$$

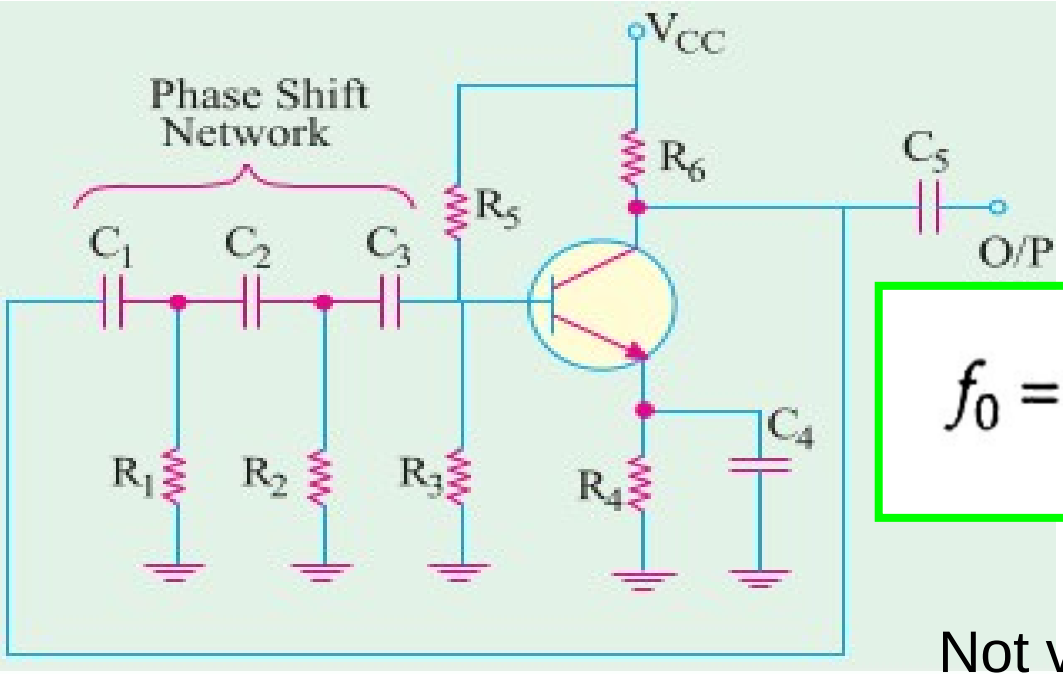
$$\beta = \frac{1/\omega C_2}{1/\omega C_1} = \frac{C_1}{C_2}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

RC Oscillators

- Two types :
  1. *RC* Phase shift Oscillator.
  2. Wein Bridge Oscillator.

RC Phase shift Oscillator



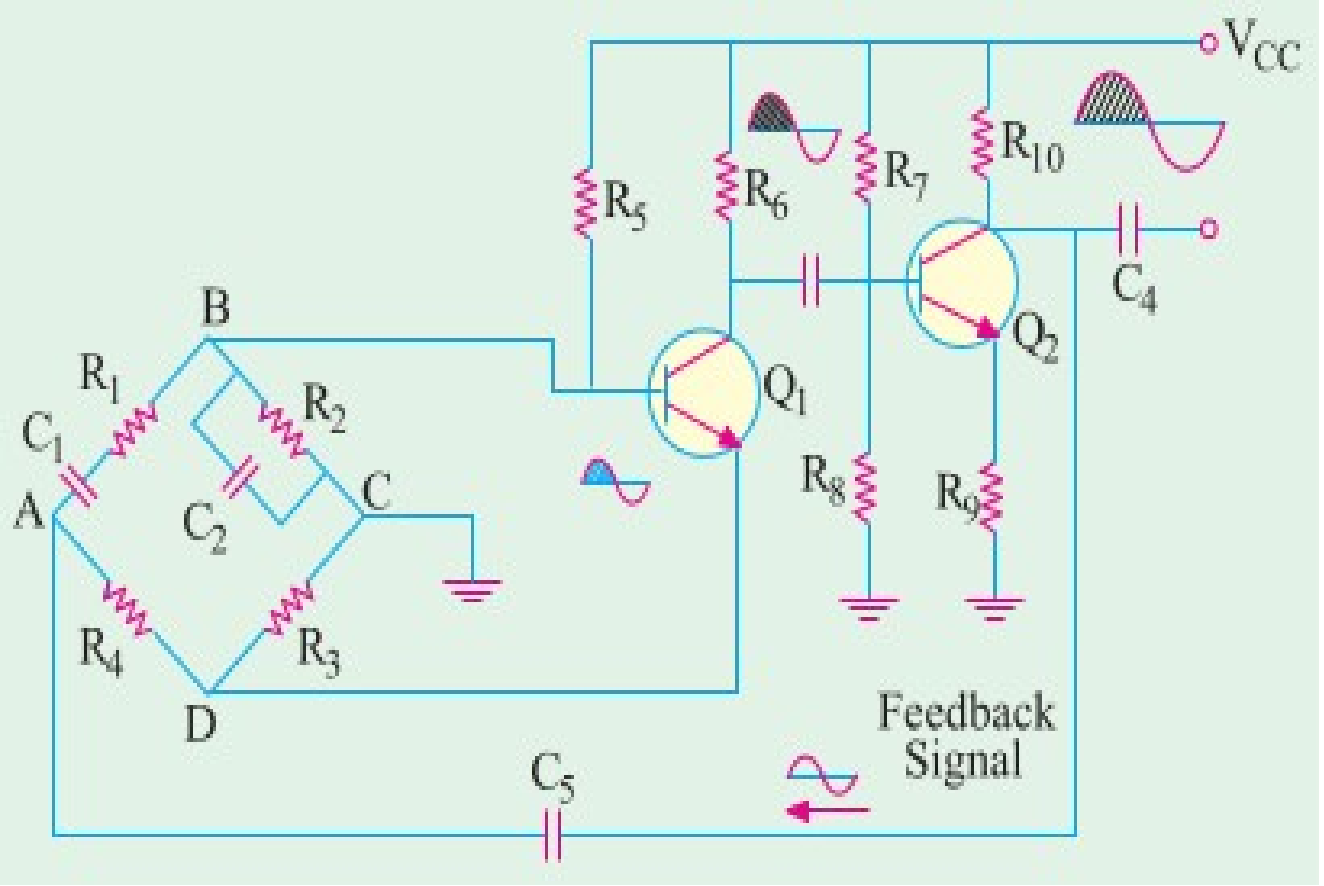
A phase-lead or phases-lag circuit can provide phase shift between 0° and 90°.

For total phase shift 180°, we use three identical sections each giving a phase shift of 60°.

$$f_0 = \frac{1}{2\pi RC\sqrt{6}}$$

Not very popular, as the frequency cannot be adjusted over large range.

Wien Bridge Oscillator



$$\frac{R_4}{R_3} = \frac{R_1}{R_2} + \frac{C_2}{C_1} \quad \text{and} \quad \omega_0 = \frac{1}{\sqrt{R_1 C_1 R_2 C_2}} \quad \text{or} \quad f_0 = \frac{1}{2\pi\sqrt{R_1 C_1 R_2 C_2}}$$

If $R_1 = R_2 = R$ and $C_1 = C_2 = C$, then $f_0 = \frac{1}{2\pi RC}$ and $\frac{R_4}{R_3} = 2$

Multivibrators

- **A multivibrator produces an output voltage that alternates between a HIGH and LOW level.**
- **An astable multivibrator produces a continuous train of pulses.**
- **A bistable multivibrator is stable at the HIGH or LOW state, but can be triggered to the opposite state.**