INDUSTRIAL ELECTRONICS
DDPE 3103
TOPIC 3
OSCILLATOR

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OSCILLATOR

- Oscillation is a form of **instability** caused by feedback that regenerates or reinforces a signal. The key to oscillator operation is **positive feedback.**

- Oscillators are circuits that **generates a periodic ac output** waveform **without an external** signal source (except DC supply).

- **Sinusoidal** oscillators produce a sine wave output while **multivibrators** produce square waves and rectangular pulses.

The Barkhausen Criterion

In order for the system to oscillate, the circuit design must satisfy the **Barkhausen criterion**:

- **$A\beta = 1$** (A is the amplitude gain and β is the feedback factor)
- **The total voltage phase shift** around the circuit loop is 360°or 0°.

Types of Oscillator Circuits

1. Phase-Shift Oscillator
2. **Wien Bridge Oscillator**
3. Tuned Oscillator Circuits
   - Colpitts
   - Hartley
4. **Crystal Oscillators**

1. Phase - Shift Oscillator

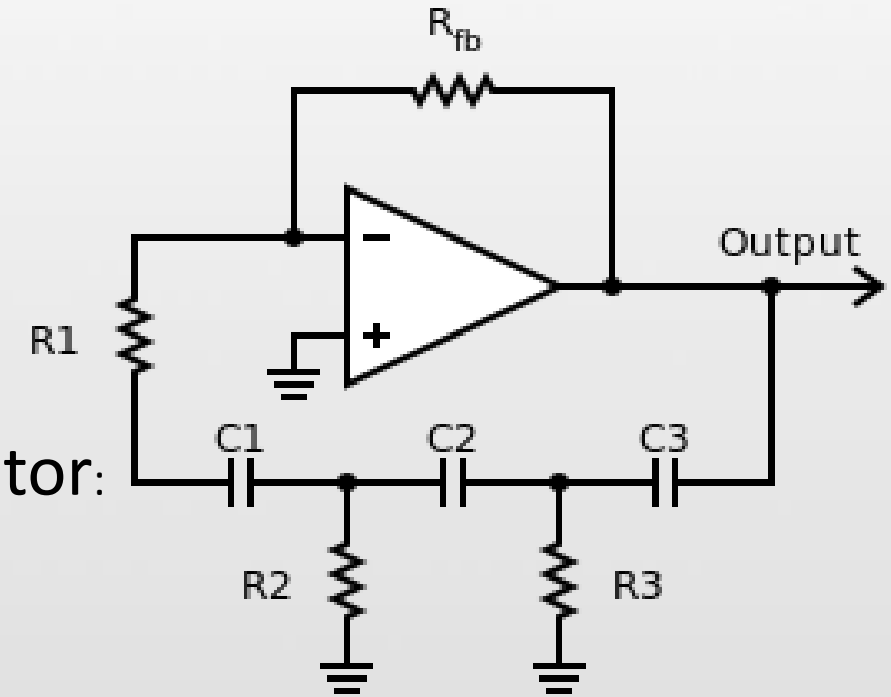
The phase-shift oscillator uses the property of three RC filters to cause a phase shift of 60^0 degree each .

Frequency of the oscillator:

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

Feedback factor of the oscillator:

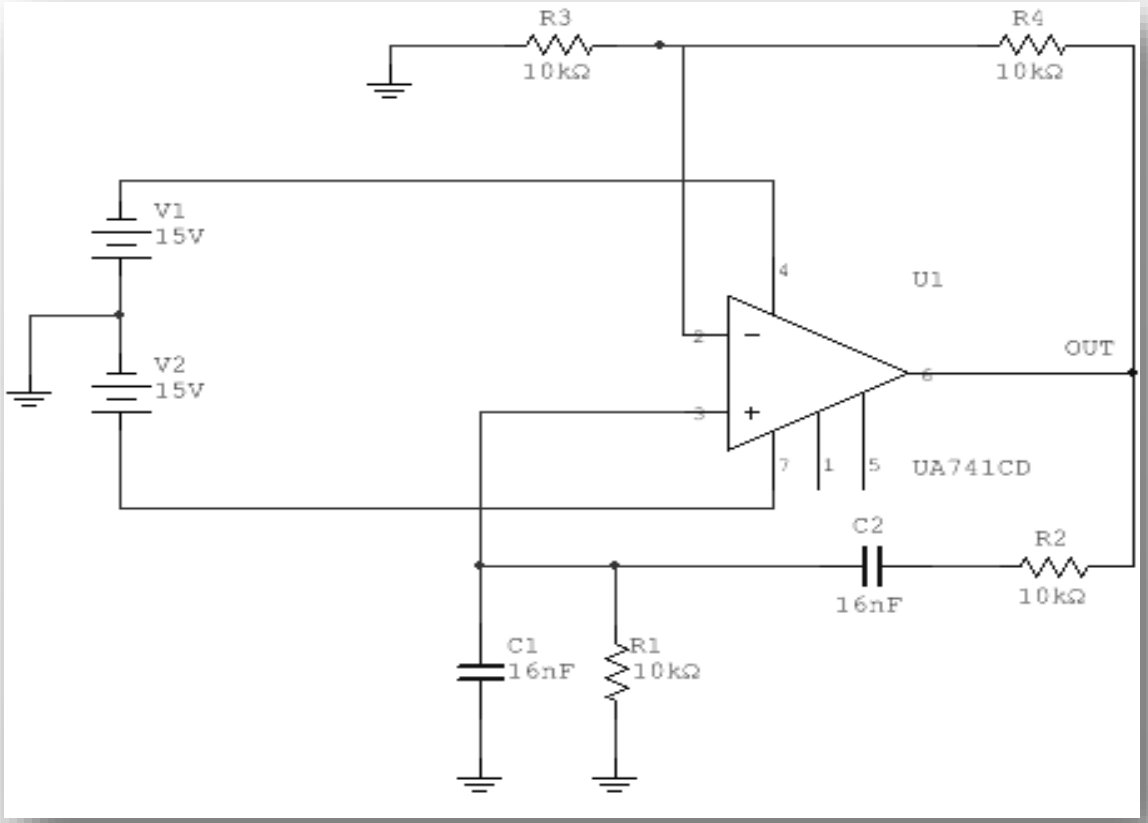
$$\beta = \frac{1}{29}$$



Wien Bridge Oscillator

The Wien Bridge Oscillator can produce a large range of frequencies.

The Voltage gain of the amplifier must be greater than 3.



Frequency of oscillations:

$$f_o = \frac{1}{2\pi\sqrt{(R_1C_1R_2C_2)}}$$

Tuned Oscillator Circuits

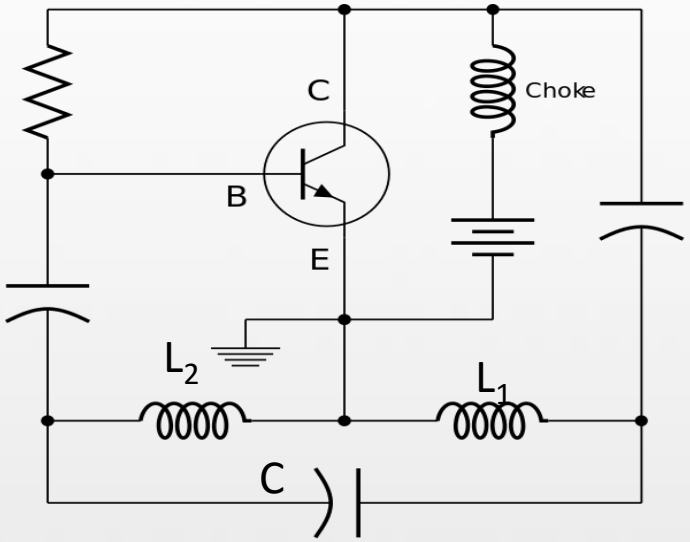
i. The circuit consists of an **inductive coil, L** and a **capacitor, C**. The frequency of oscillations in the circuit depends upon the values of inductance of the coil and capacitance of the capacitor.

ii. These oscillator are commonly used to produce **high range of frequencies** ranging from 1MHz to 500MHz and are also known as **radio frequencies (RF).**

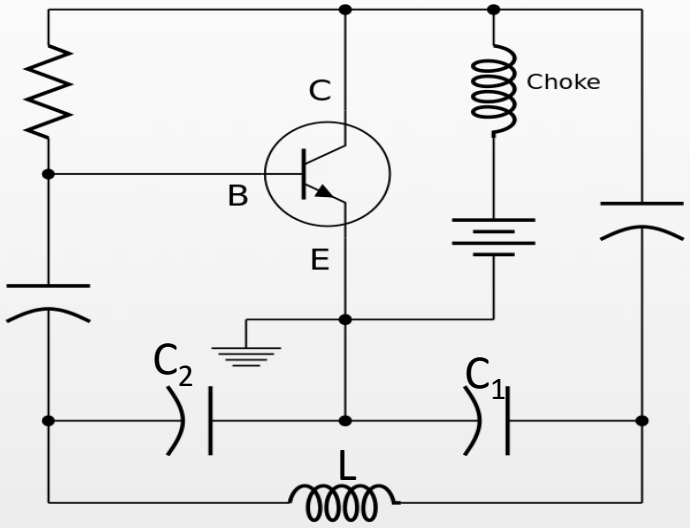
iii. There are two common types:

- **Colpitts**
  - The resonant circuit is an inductor and two capacitors.
- **Hartley**
  - The resonant circuit is a tapped inductor or two inductors and one capacitor.

Hartley Oscillator & Colpitts Oscillator



HartleyOscillator



ColpittsOscillator

Frequency of oscillations for Hartley oscillator : $f_o = \frac{1}{2\pi\sqrt{(L_T C)}}$

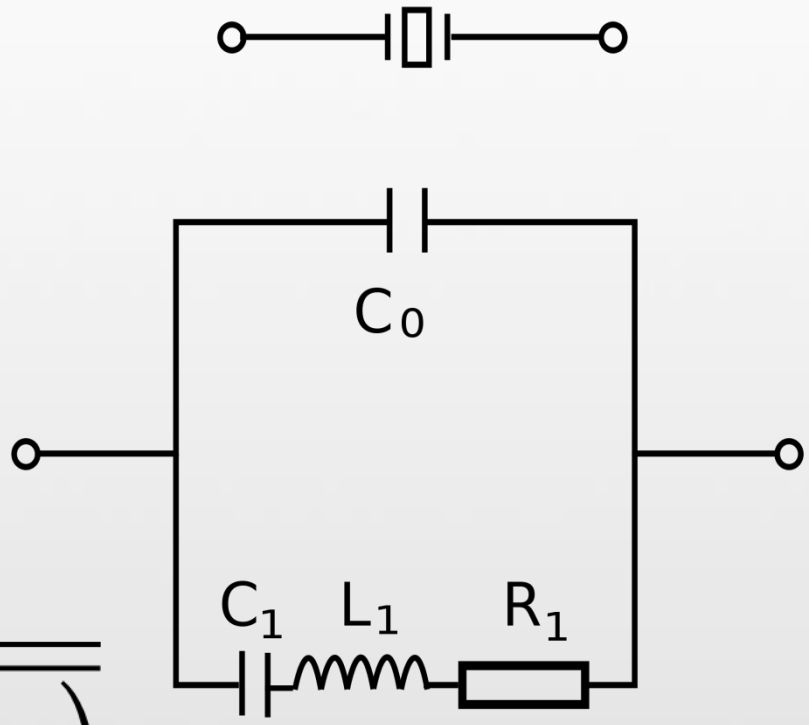
Frequency of oscillations for Colpitts oscillator : $f_o = \frac{1}{2\pi\sqrt{(L C_T)}}$

CRYSTAL OSCILLATOR

- A **crystal oscillator** is an electronic **oscillator** circuit.
- The vibrating **crystal** of the piezoelectric material creates an electrical signal with a precise frequency.
- The purpose of the crystal oscillator is to produce **high frequency stability** of the output signal.

Frequency Stability

$$f_{series} = \frac{1}{2\pi\sqrt{C_1 L_1}}$$



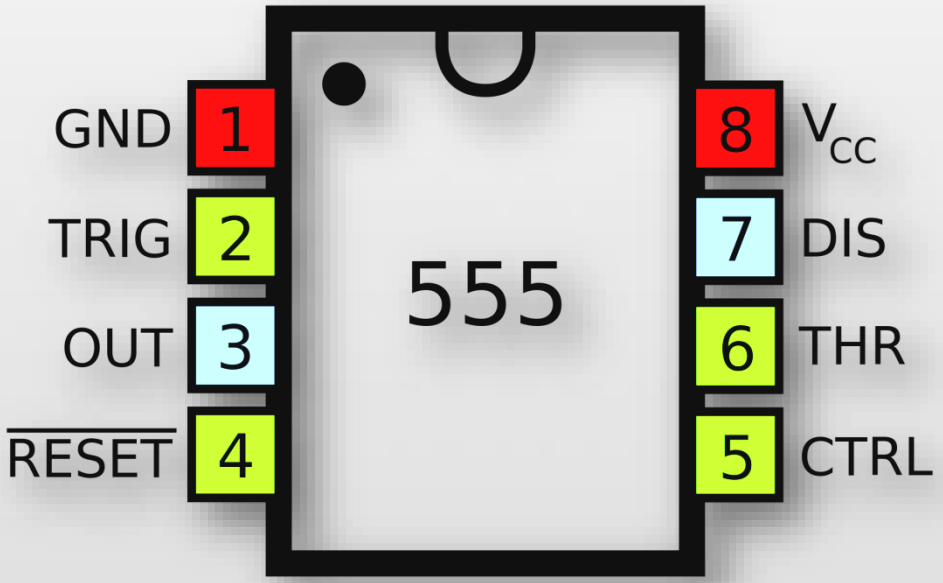
$$f_{parallel} = \frac{1}{2\pi\sqrt{L_1\left(\frac{C_0 C_1}{C_0 + C_1}\right)}}$$

MULTIVIBRATOR

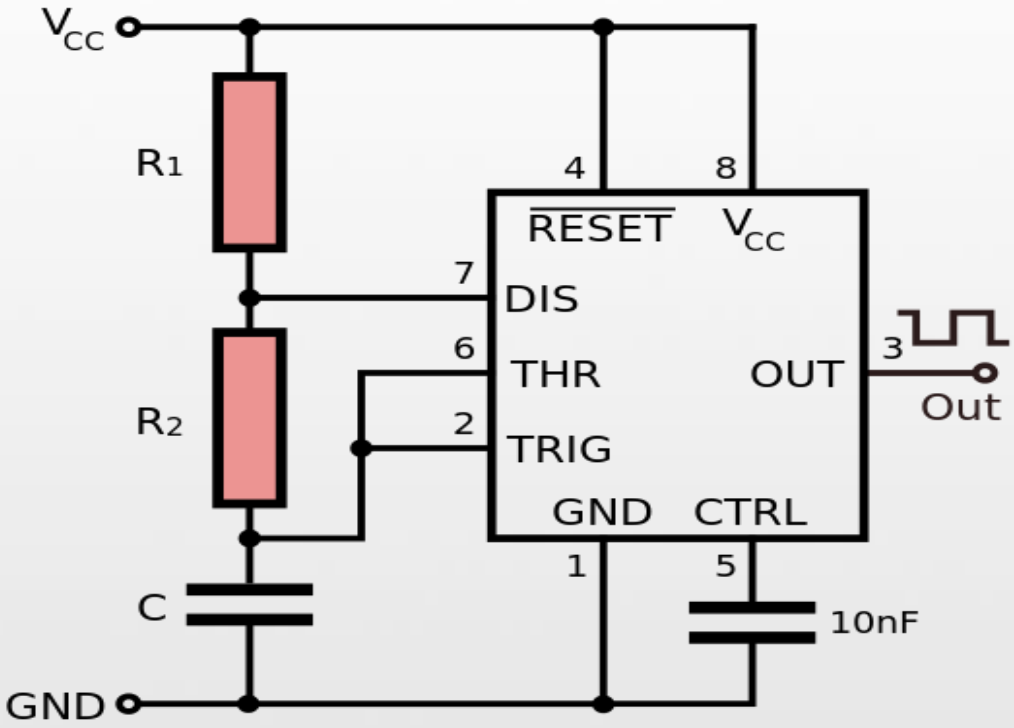
- A multivibrator circuit **oscillates** between a **"HIGH"** state and a **"LOW"** state producing a continuous output which are square or rectangular waves.
- Types of multivibrator :
  - **i. Astable**
    - A square wave oscillator.
  - **ii. Bistable**
    - A digital device with two stable states.
  - **iii. Monostable**
    - Has one stable state

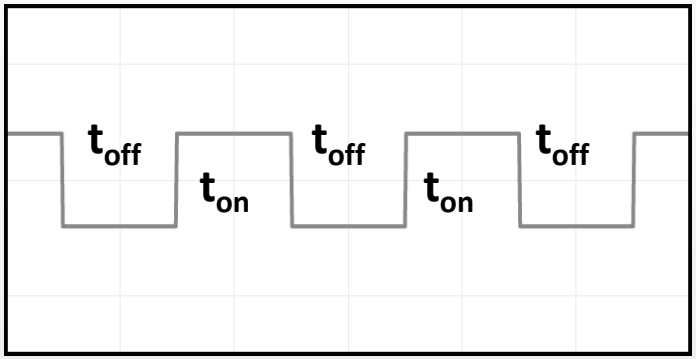
555 TIMER

- The most popular square wave oscillator is the 555 timer.



ASTABLE MULTIVIBRATOR – TIMER 555



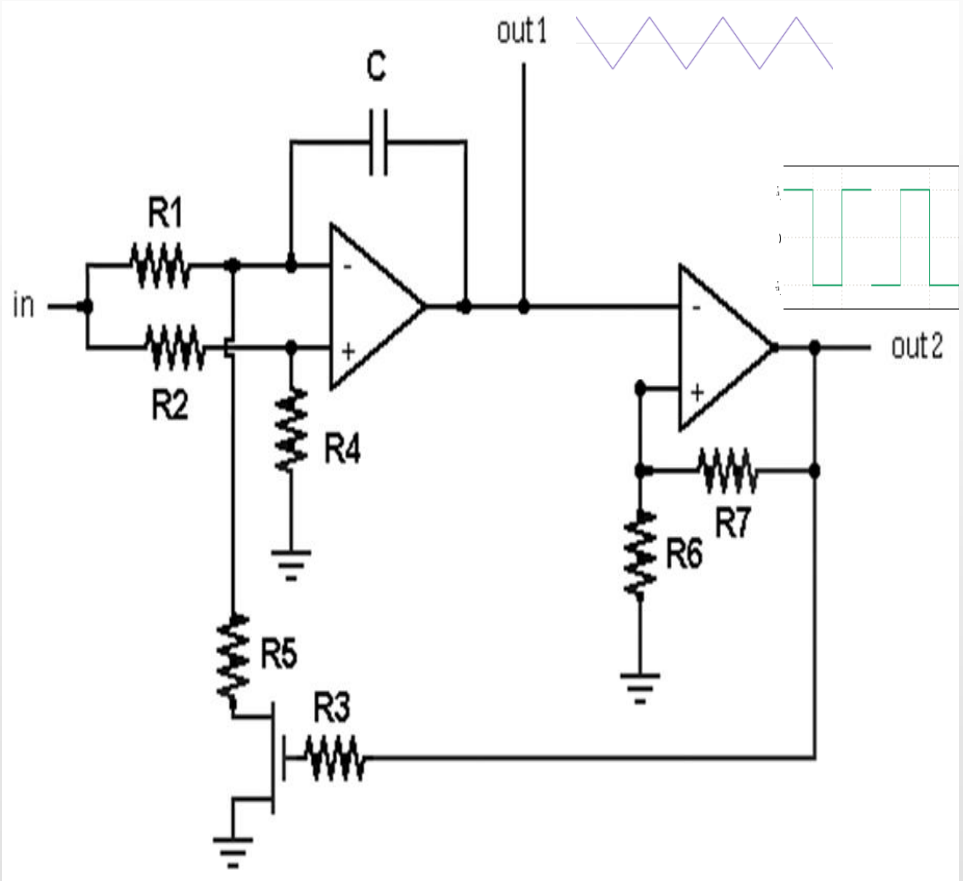


$t_{on} = t_1$ $t_{off} = t_2$

- $t_1 = 0.693 (R_1 + R_2) C$
- $t_2 = 0.693 R_2 C$
- $T = t_1 + t_2 = 0.693 (R_1 + 2R_2) C$

Voltage Controlled Oscillator (VCO)

A VCO is a type of oscillator where the frequency of the output oscillations can be varied by varying the amplitude of an input voltage signal.
It consist of an **Integrator,** a **Schmitt trigger** and a **MOSFET.**



References

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