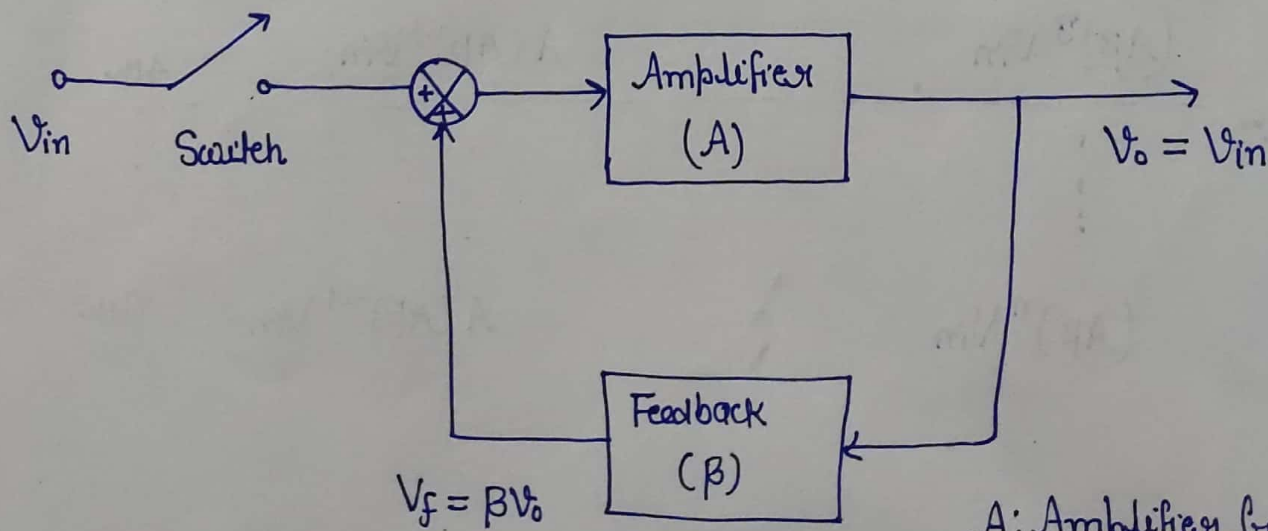
Oscillators

Function: Waveform generator / Generation

Types

- Sinusoidal Waveform Generator → Harmonic Oscillator
- Non- Sinusoidal → Relation Oscillators

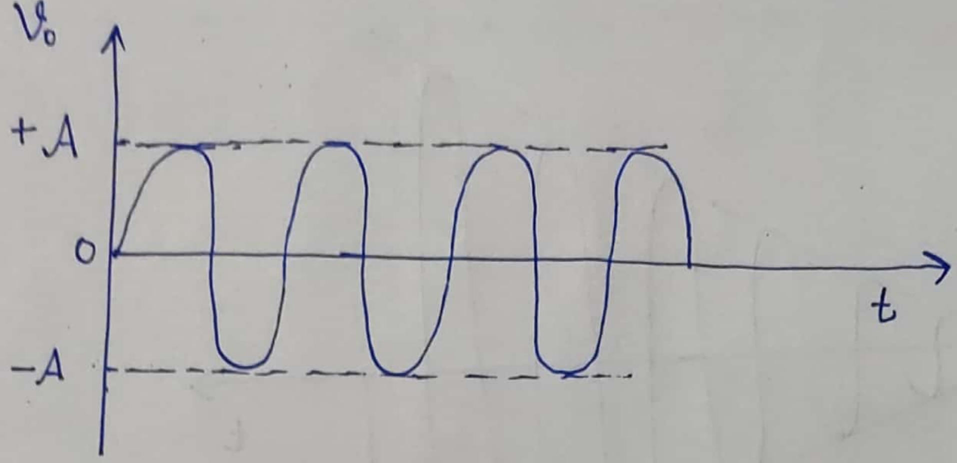
Principle of operation



A: Amplifier Gain

β: Feedback Factor

Case-3: Sustained Oscillations



$$\boxed{\begin{aligned} |A\beta| &= 1 \\ \angle A\beta &= 2n\pi \end{aligned}}$$ Barkhausen Criteria

Classification of Oscillators

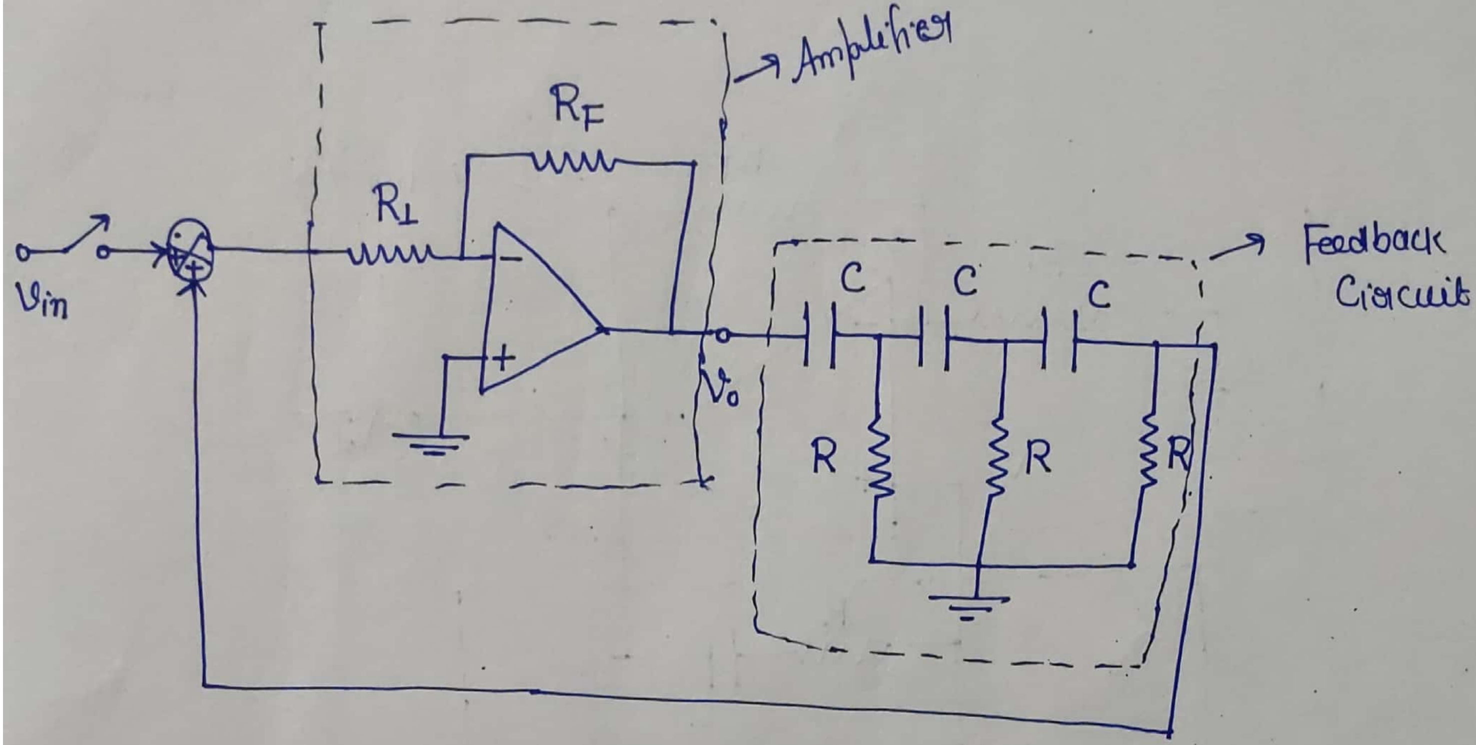
Audio Frequency Oscillators
(20 Hz < f < 20 KHz)

1. RC Phase Shift
2. Wein Bridge

Radio Frequency Oscillators
(f > 20 KHz)

1. LC Oscillators
2. Crystal Oscillators

RC Phase-Shift Oscillators



$$A = -\frac{R_F}{R_1} = \frac{V_o}{V_f}$$

$$\boxed{\begin{array}{l} |A\beta| = 1 \\ \angle A\beta = 2n\pi; \\ \quad n = 1, 2, \cdots \end{array}}$$

$$\boxed{\omega = \frac{1}{RC\sqrt{6}}}$$

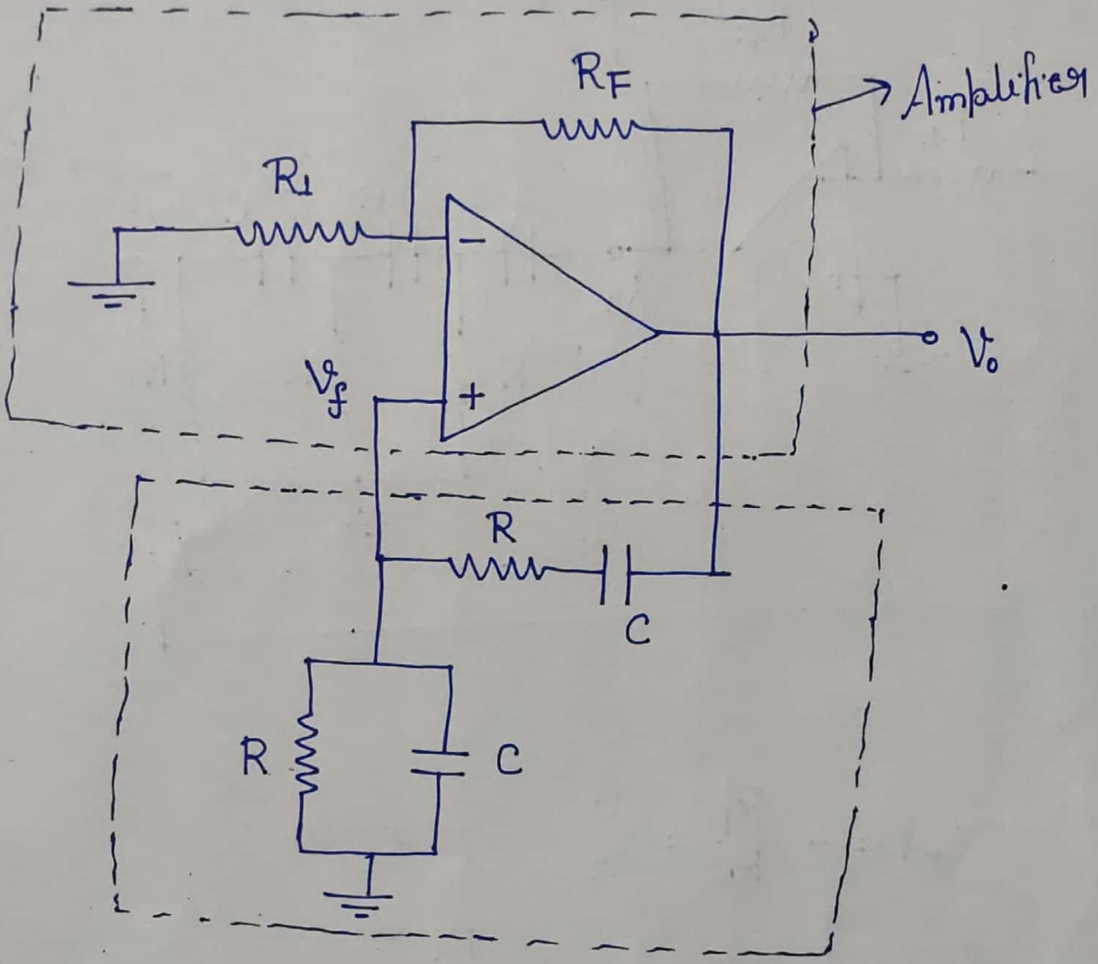
$$\boxed{\beta = -\frac{1}{29}}$$

$$A\beta = 1$$

$$\left(-\frac{R_F}{R_1}\right)\left(-\frac{1}{29}\right) = 1$$

$$\boxed{R_F = 29 R_1}$$

Wein Bridge Oscillator



$$A = -\frac{R_F}{R_1}$$

$\beta = ?$

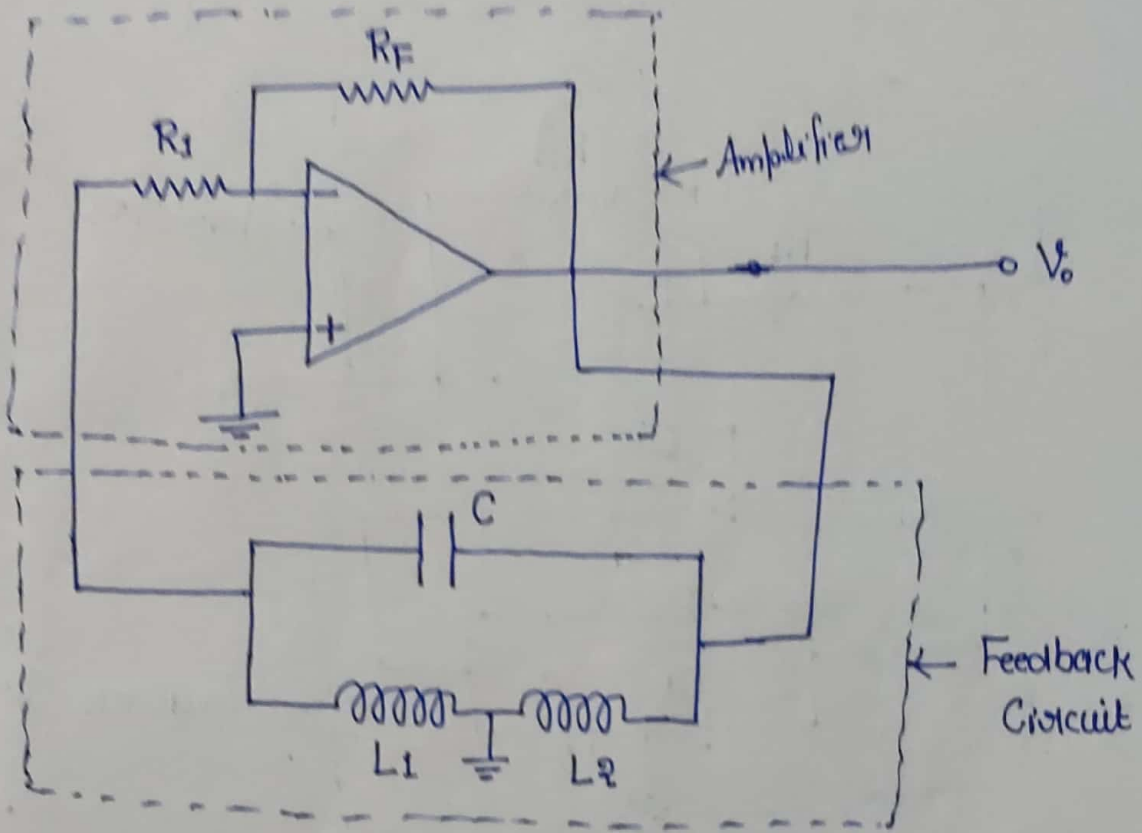
$\omega = ?$

$$\boxed{\omega = \frac{1}{RC}} \qquad \boxed{\beta = \frac{1}{3}}$$

$$|A\beta| = 1$$

$$\left| -\frac{R_F}{R_1} \cdot \frac{1}{3} \right| = 1 \Rightarrow \boxed{R_F = 3R_1}$$

LC Oscillator



$$\boxed{A = -\frac{R_F}{R_1}}$$

$\beta = ?$

$\omega = ?$

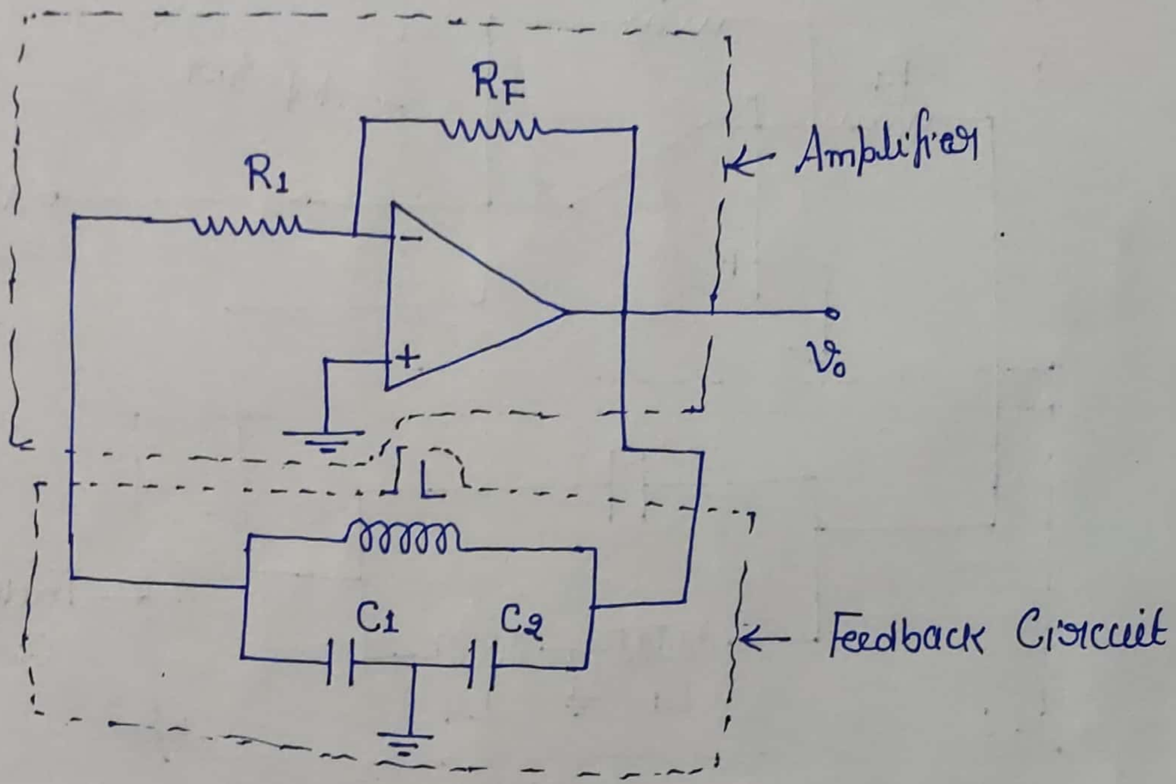
$$\omega = \frac{1}{\sqrt{(L_1+L_2)C}} = \frac{1}{\sqrt{L_{eq}C}}$$

If inductors are mutually coupled, then

$$L_{eq} = L_1 + L_2 + 2M$$

$$f = \frac{1}{2\pi\sqrt{L_{eq}C}}$$

Colpitt Oscillator

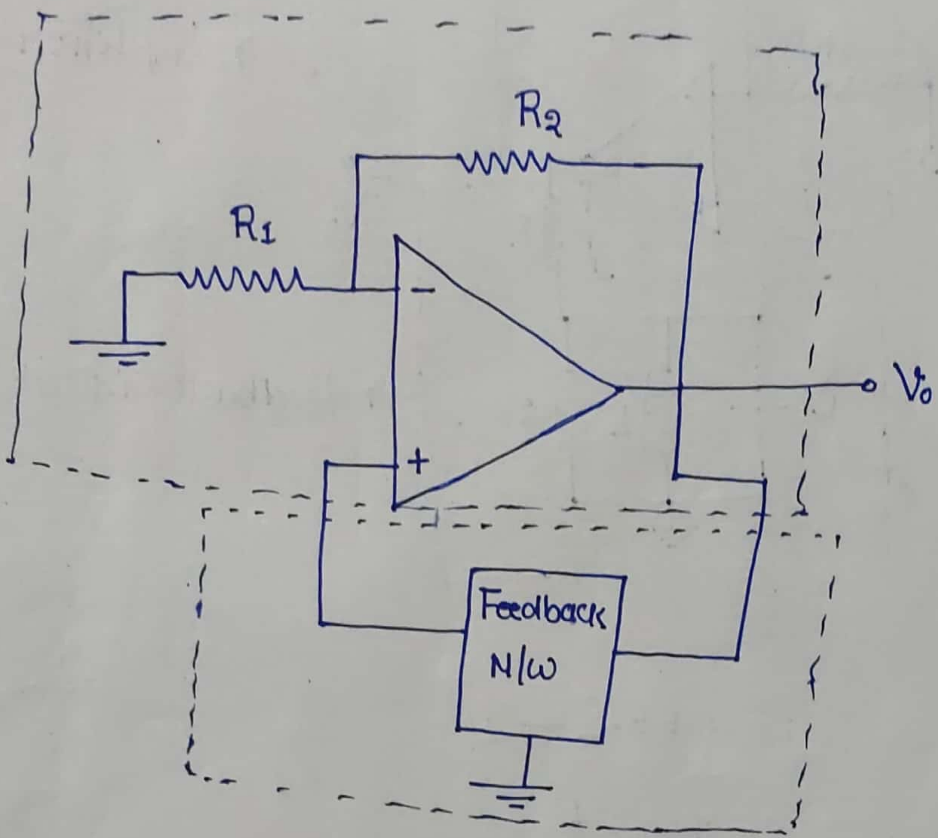


$$A = -\frac{R_F}{R_1} \qquad \beta = ? \qquad \omega = ?$$

$$\omega = \frac{1}{\sqrt{L\,C_{eq}}} \quad \text{and} \quad C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

$$f = \frac{1}{2\pi\sqrt{L \cdot C_{eq}}}$$

Example :- Determine $\frac{R_1}{R_2}$? Given that $\beta = \frac{1}{6}$. Assume that the oscillator is providing sustained oscillations.

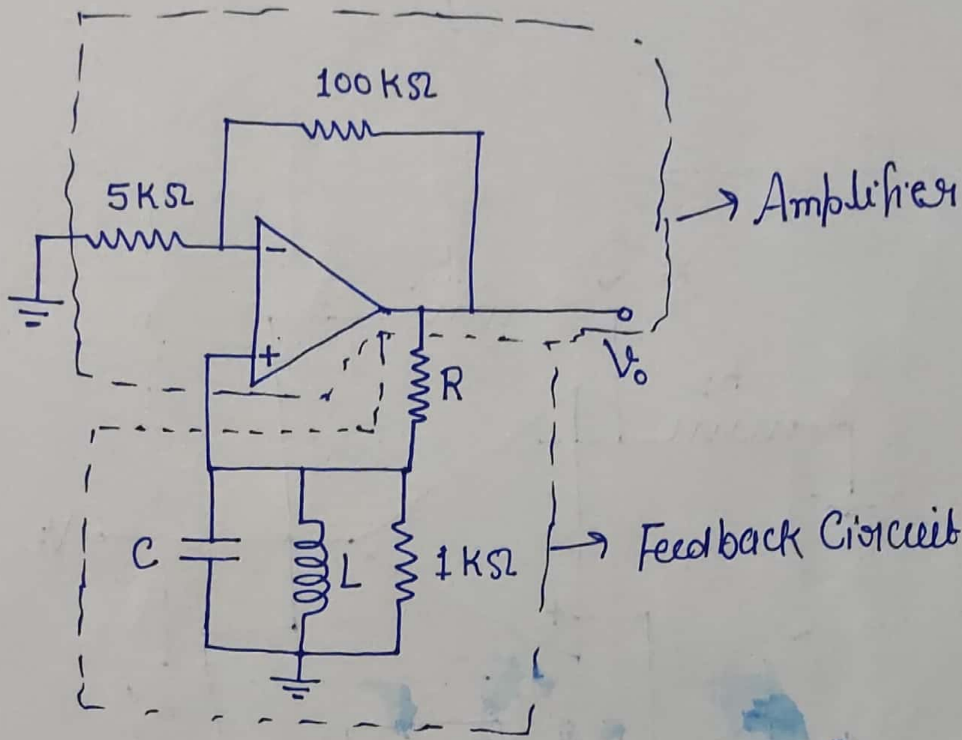


$$\text{Gain} = 1 + \frac{R_2}{R_1} = A$$

$$|A\beta| = 1$$

$$\left(1 + \frac{R_2}{R_1}\right) \cdot \frac{1}{6} = 1 \Rightarrow \boxed{\frac{R_1}{R_2} = \frac{1}{5}}$$

Ex:- Find the Value of R ? Given that L = 10 mH and C = 0.01 μF.



$$A = 1 + \frac{100}{5} = 21.$$

$$\beta = \frac{1}{1+R}$$

$$|A\beta| = 1 \Rightarrow 21 \times \frac{1}{1+R} = 1$$

$$\boxed{R = 20\,\Omega}$$