Feedback Oscillator

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To get sustained sinusoidal oscillations two requirements are as follows:

<1> Total Phase shift must be zero or 360°

<2> Loop Gain AB must be equal to unity.

Feedback Oscillators

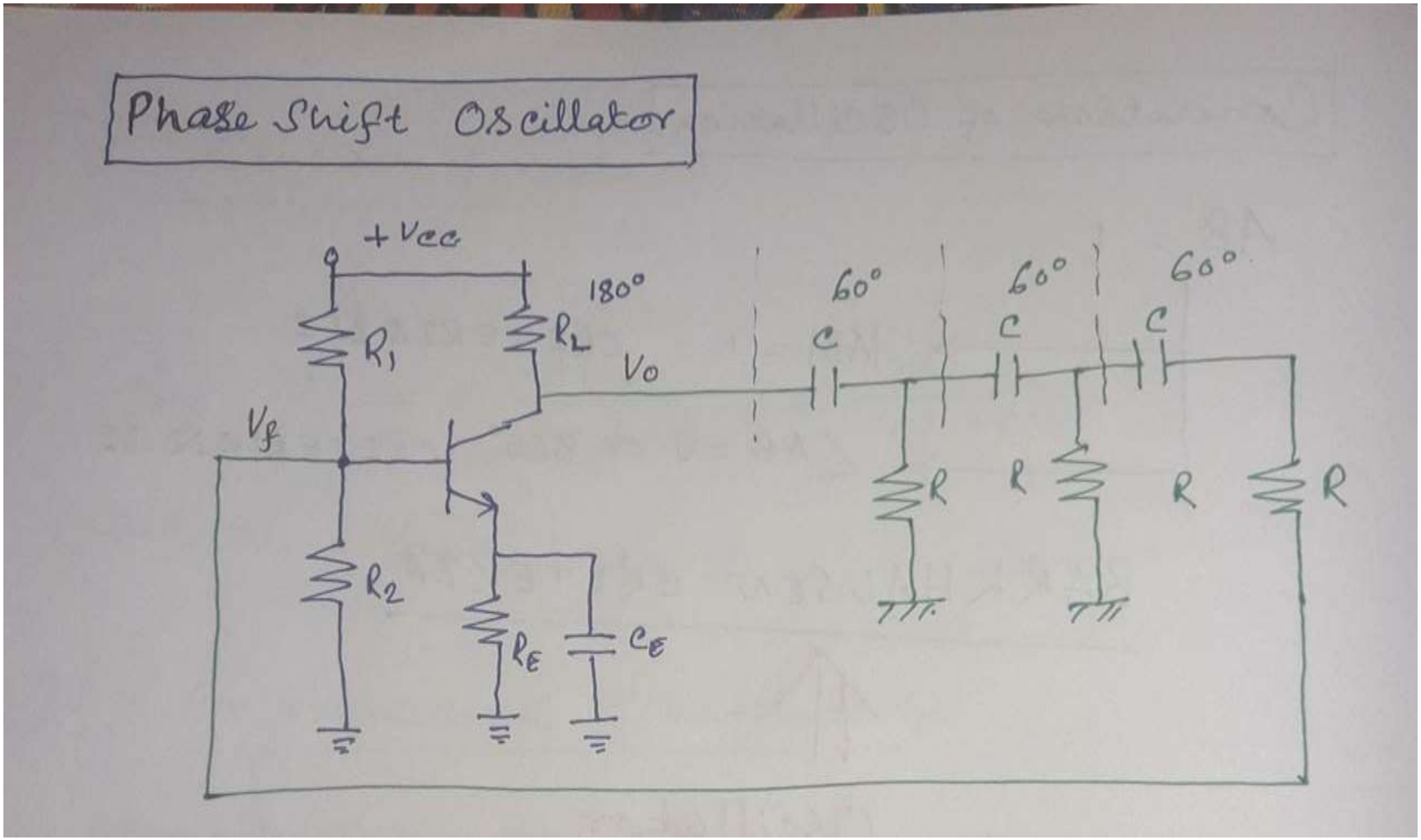
In Audio Frequency Range.

- Phase Shift Oscillator
- Wien Bridge Oscillator

In Radio Frequency Range.

- Hartley Oscillator
- Colpit Oscillator

Feedback Oscillators



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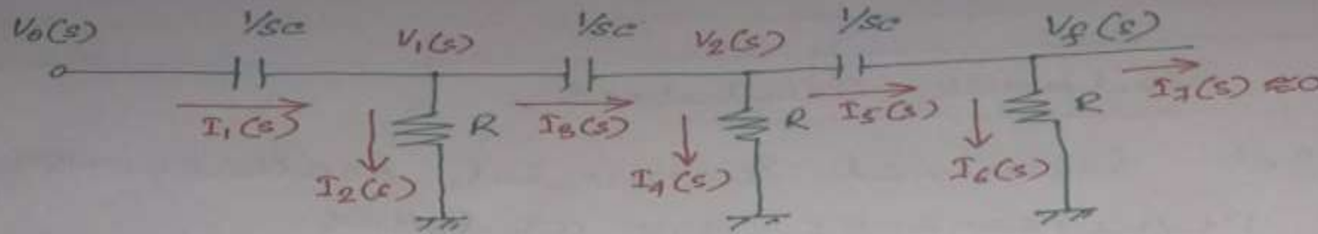

By KCL

$$I_1(s) = I_2(s) + I_3(s)$$

$$\frac{V_0(s) - V_1(s)}{1/sC} = \frac{V_1(s)}{R} + \frac{V_1(s) - V_2(s)}{1/sC}$$

$$V_1(s) = \frac{[V_0(s) + V_2(s)]\,RCs}{2RCs + 1} \quad \text{- - - - (1)}$$

$$I_3(s) = I_4(s) + I_5(s)$$

$$\therefore \quad \frac{V_1(s) - V_2(s)}{1/sC} = \frac{V_2(s)}{R} + \frac{V_2(s) - V_f(s)}{1/sC}$$

$$\therefore \quad V_1(s) = \frac{(2RCs + 1)\,V_2(s)}{RCs} - V_f(s) \quad \text{- - - (2)}$$

Feedback Oscillators

Since $I_7(s) = 0$

$$I_5(s) = I_6(s)$$

$$V_f(s) = \frac{R}{R + 1/sC} \cdot V_2(s)$$

$$\therefore V_2(s) = \frac{(RCs + 1)}{RCs} \cdot V_f(s) \quad \text{----} \ (3)$$

Substituting this in eqn. no. (1)

$$V_1(s) = \frac{RCs \cdot V_o(s)}{2RCs + 1} + \frac{(RCs+1)\, V_f(s)}{2RCs + 1} \quad \text{---} \ (4)$$

Also substituting the value of $V_2(s)$ in equation (2)

$$V_1(s) = \frac{(2RCs + 1)(RCs + 1)\, V_f(s)}{(RCs)(RCs)} - V_f(s) \quad \text{----} \ (5)$$

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Equating eqⁿ ④ & ⑤

$$\frac{V_f(s)}{V_o(s)} = B = \frac{R^3C^3s^3}{R^3C^3s^3 + 6R^2C^2s^2 + 5RCs + 1}$$

$A = -\frac{R_f}{R_1}$ · Gain · & Substitute, $s = j\omega$

$$\boxed{\cancel{A\left(-jR^3C^3\omega^3\right) - 6R^2C^2\omega^2 + j5RC\omega + 1}}$$

$AB = -1$

$$A\left(-jR^3C^3\omega^3\right) = -jR^3C^3\omega^3 - 6R^2C^2\omega^2 + j5RC\omega + 1$$

real part, $0 = -6R^2C^2\omega^2 + 1$

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

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Imaginary part

$$A\left(-j R^3 C^3 \omega^3\right) = -j R^3 C^3 \omega^3 + j 5 R C \omega$$

$$-A = 1 - \frac{5}{R^2 C^2 \omega^2}$$

$$= 1 - \frac{5}{R^2 C^2 \cdot \frac{1}{6 R^2 C^2}}$$

$$\therefore \boxed{A = 29}$$

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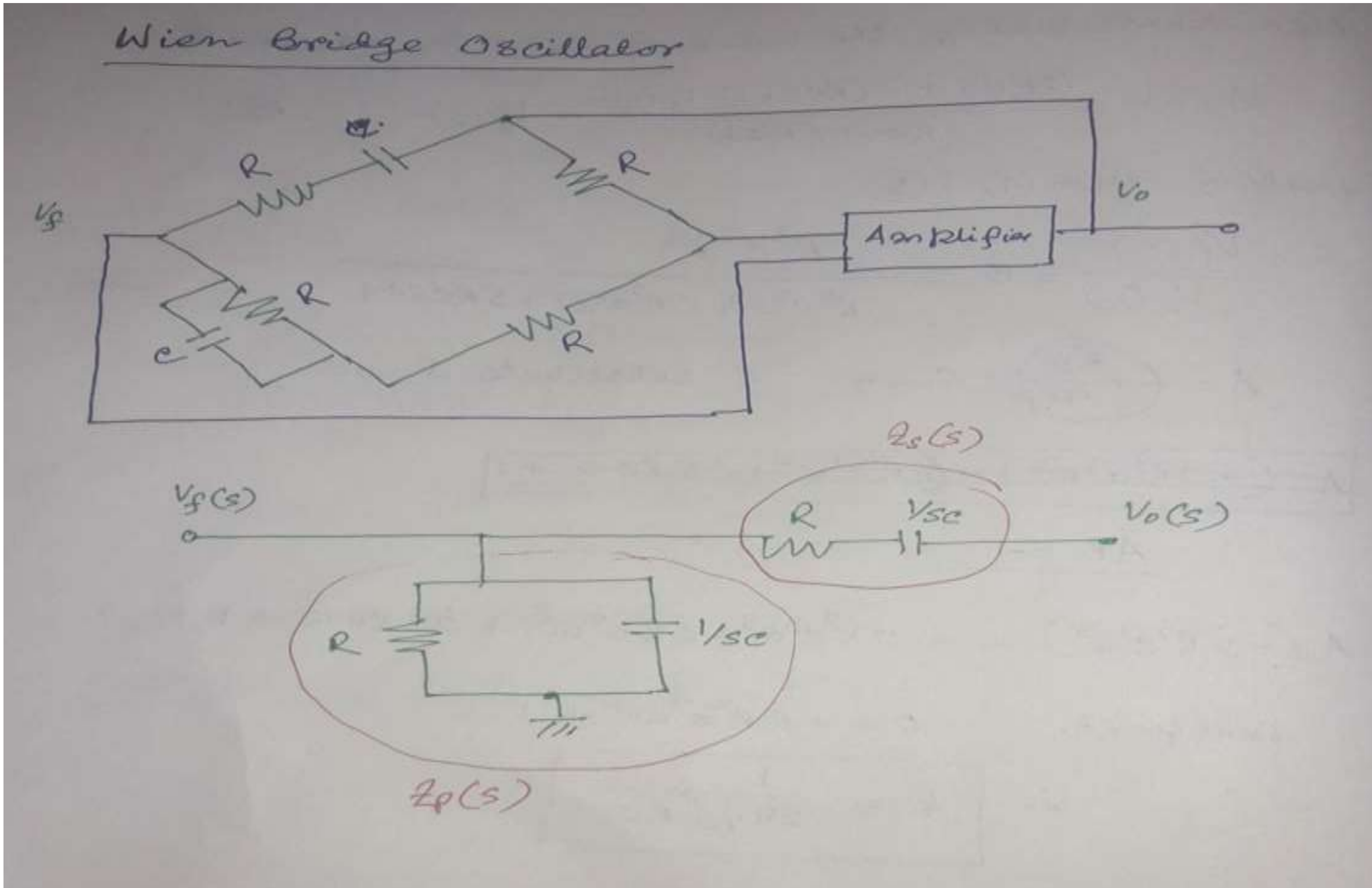

Feedback Oscillators

$$Z_P(s) = R \parallel \frac{1}{sC} = \frac{R}{RsC+1}.$$

$$Z_S(s) = R + \frac{1}{sC} = \frac{RsC+1}{sC}.$$

$$V_f(s) = \frac{Z_P(s)\, V_o(s)}{Z_P(s) + Z_S(s)}$$

$$= \frac{(RCs)\, V_o(s)}{(RCs+1)^2 + RCs}$$

$$\therefore B = \frac{V_f(s)}{V_o(s)} = \frac{RCs}{R^2C^2s^2 + 3RC + 1}$$

Feedback Oscillators

$$AB = 1$$

$$(A) \cdot \frac{RCs}{R^2C^2s^2 + 3RCs + 1} = 1$$

$$s = j\omega$$

$$A\,RC\,j\omega = -R^2C^2\omega^2 + 3jRC\omega + 1$$

$$\omega^2 = \frac{1}{R^2C^2} \quad \therefore \boxed{f = \frac{1}{2\pi RC}}$$

$$A \cdot RC\,j\omega = 3j\omega RC.$$

$$\therefore \boxed{A = 3}$$

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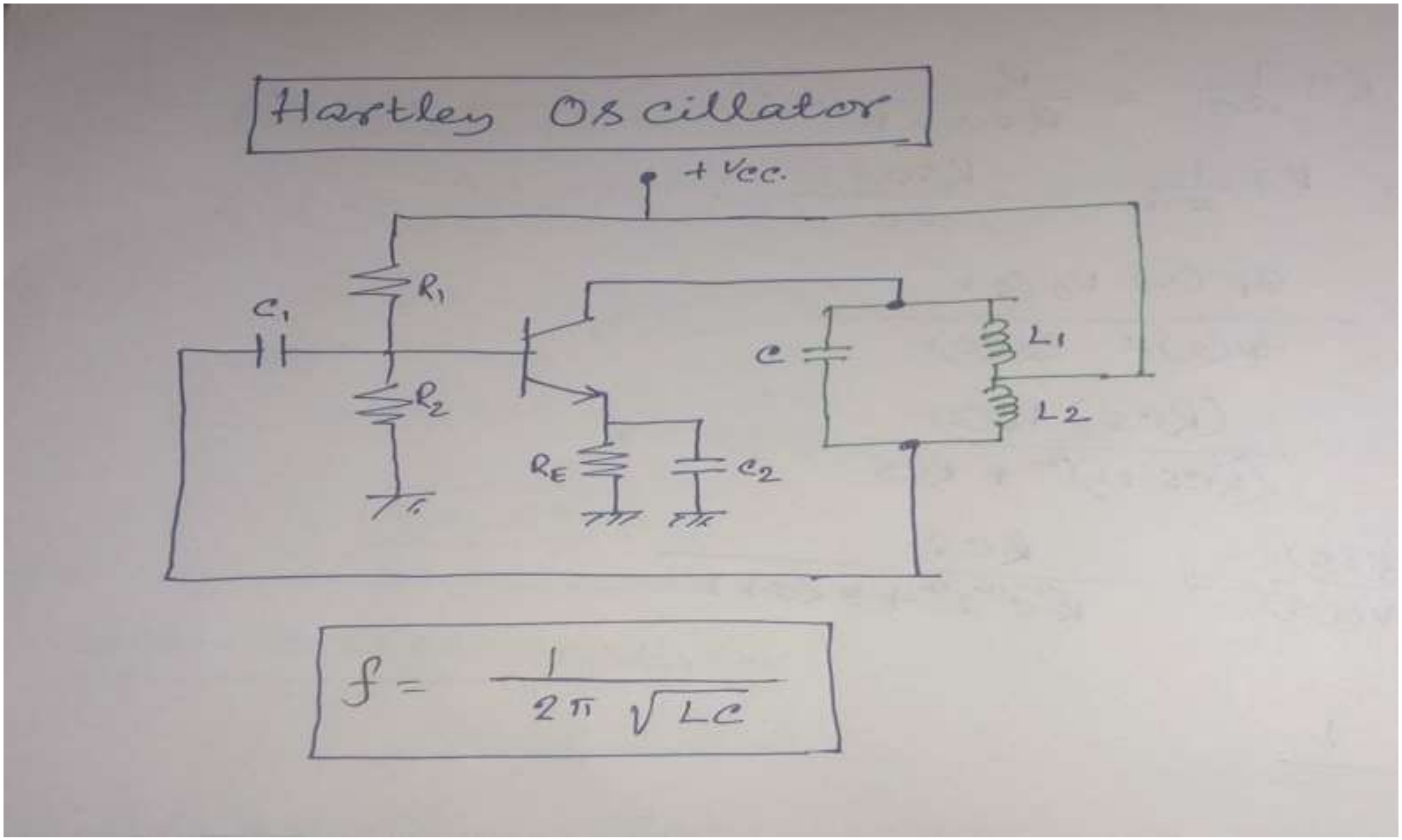

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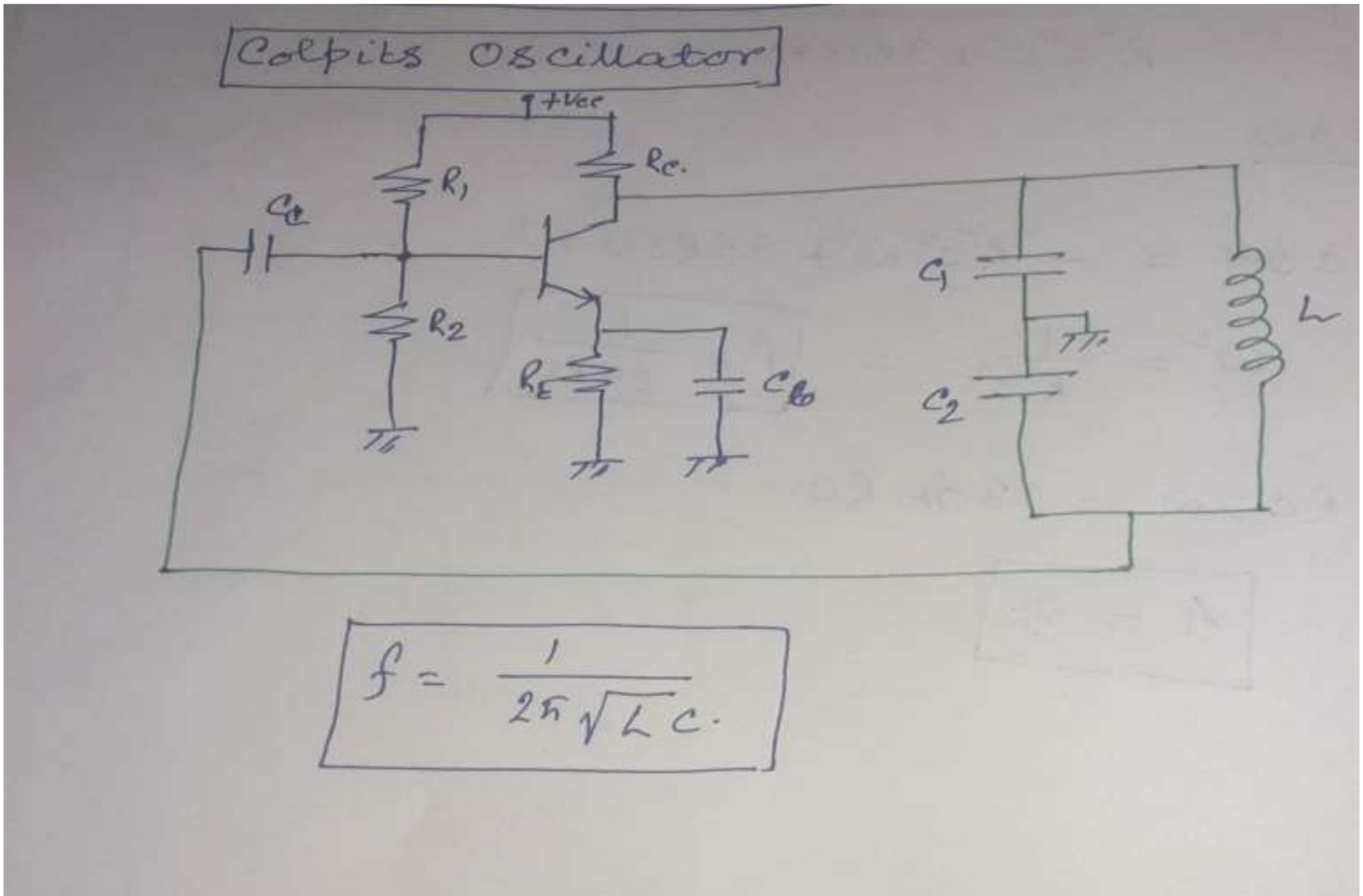

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