Ques-13 "Section B" Tej Pratap 1802731167

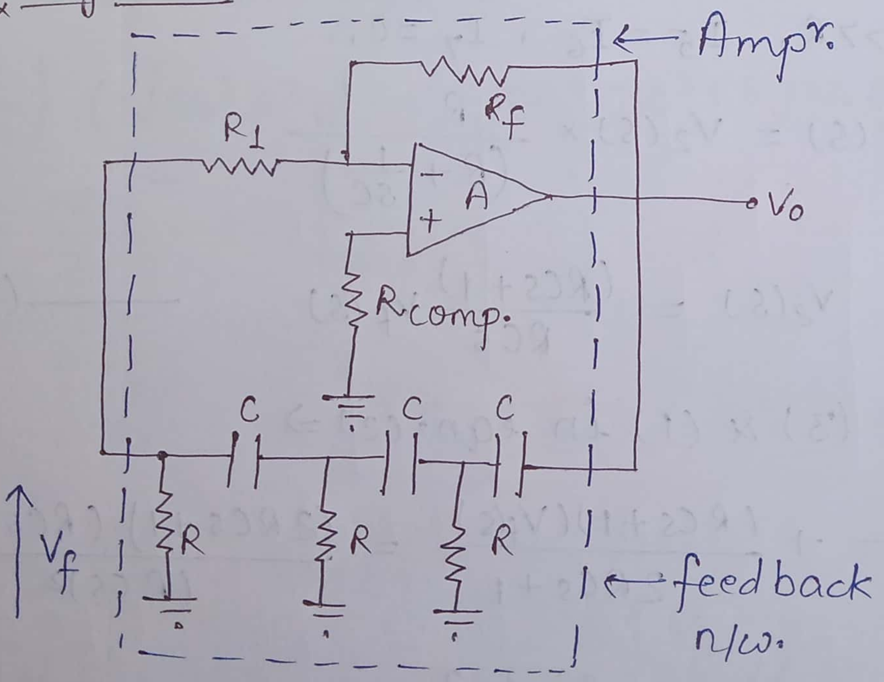
RC Phase shift Oscillator:-

(1.) The RC Phase shift oscillator consisting of an op-amp serving as the ampr. stage and the cascaded RC n/w. acting as the feedback ckt.

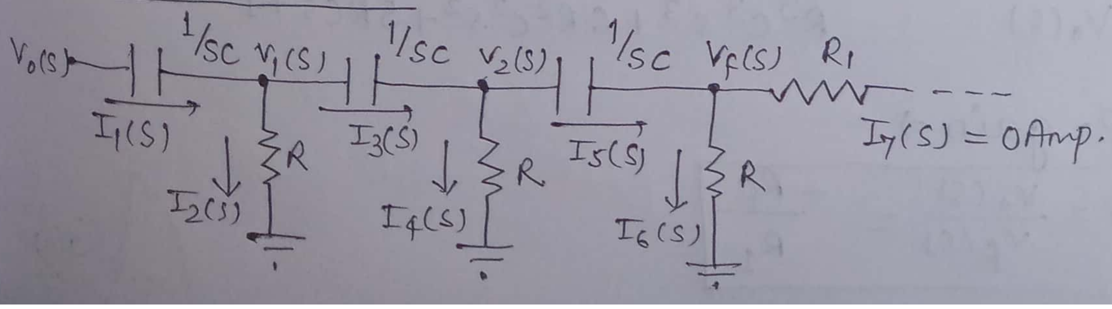
(2.) The op-amp. is used in inverting confn. and it produces 180° phase shift at O/P.

(3.) The cascaded RC n/w. connected in feedback in the feedback n/w. path provide an additional phase shift of 180°, the total phase shift around the loop is 360° (or 0°)

Circuit diagram:-



freq. oscillation:-



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Apply KCL at $V_1(S) \Rightarrow$

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

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

$$V_1(S) = \frac{[V_o(S) + V_2(S)]\, RCs}{2RCs+1} \quad \text{——— (1)}$$

at $V_2(S) \Rightarrow$

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

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

for solving $V_1(S) \Rightarrow$

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

when $R_1 >> R$, $I_5 = I_6$, $I_7 = 0$,

$$V_f(S) = V_2(S) \times \frac{R}{\left(R + \frac{1}{sC}\right)}$$

$$V_2(S) = \frac{(RCs+1)}{RCs} V_f(S) \quad \text{——— (3)}$$

Substitude (3) & (1) in eqn. (2) $\Rightarrow$

$$\frac{RCs\, V_o(S)}{2RCs+1} + \frac{(RCs+1)(V_f(S))}{2RCs+1} = \frac{(2RCs+1)(RCs+1)V_f(S)}{(RCs)^2} - V_f(S)$$

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

Op-amp-gain $\Rightarrow$

$$\boxed{A = \frac{V_o(S)}{V_f(S)} = \frac{-R_f}{R_1}}$$

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We know that

$$A\beta = 1 = \frac{-R_F}{R_1} \frac{R^3C^3s^3}{R^3C^3s^3 + 6R^2C^2s^2 + 5RCs + 1}$$

$s = j\omega$

$$\left(\frac{-R_F}{R_1}\right)(-j\omega_0^3 R^3C^3) = (-j\omega_0^3 R^3C^3) - 6\omega_0^2R^2C^2 + 5j\omega_0 RC + 1$$

equate real parts to zero ⇒

$$-6\omega_0^2R^2C^2 + 1 = 0$$

$$\omega_0^2 = \frac{1}{6R^2C^2}$$

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

equate imaginary parts:-

$$\left(\frac{-R_F}{R_1}\right)(-j\omega_0^3 R^3C^3) = -j\omega_0^3R^3C^3 + 5j\omega_0 RC$$

$$\frac{-R_F}{R_1} = 1 - \frac{5}{\omega_0^2R^2C^2}$$

$$\left|\frac{R_F}{R_1}\right| = |1-30| \quad \because \left(\text{Put } \omega_0 = \frac{1}{\sqrt{6}\,RC}\right)$$

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

This is the condn. for RC phase shift oscillator.

Ques-15 "Section B"

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Non-sinusoidal Oscillator:-

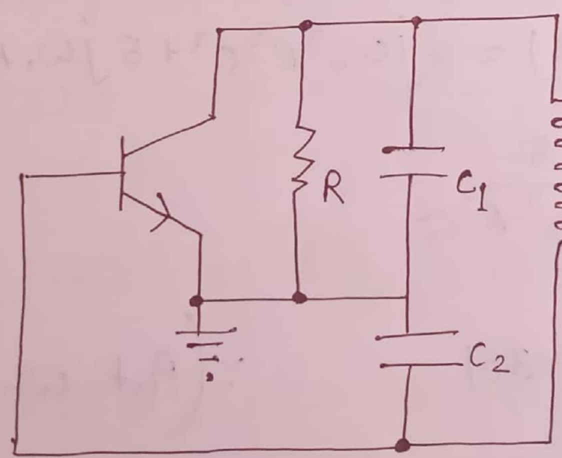
Non-sinusoidal oscillators or relaxation oscillators which produce square waves, triangular waves, pulses or sawtooth waves are known as non-sinusoidal oscillators.

Non-sinusoidal oscillators are three types-

(1.) Monostable
(2.) Bistable
(3.) Astable

Colpitt's Oscillator:-

Circuit:-



"colpitt's Oscillator"

(1.) Colpitt's oscillator utilize a parallel LC ckt, connected b/w collector and base with a fraction of the tuned ckt. vol. fed to emitter.

(2.) This feedback is achieved by the way of a capacitive divider in colpitt's oscillator ckt.

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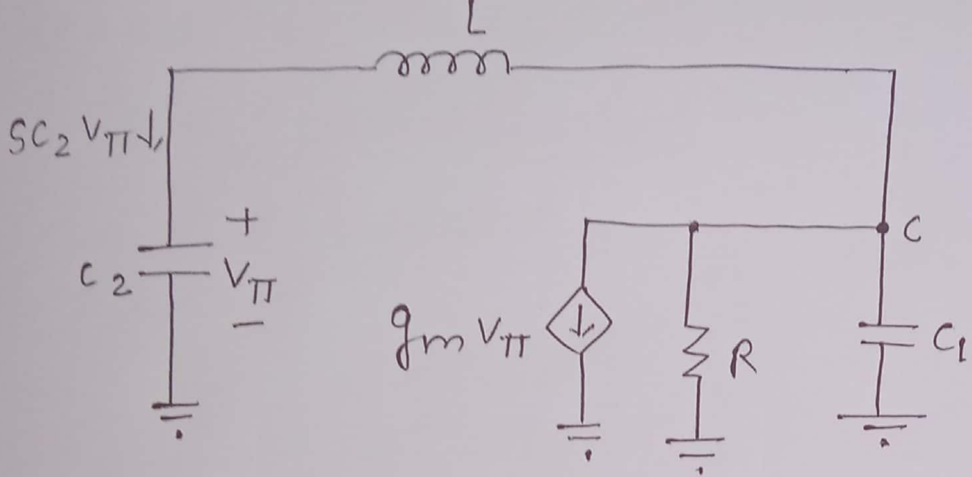
freq. response of colpitt's oscillator:-

$$\omega_0 = 1 / \sqrt{L\left(\frac{C_1 C_2}{C_1 + C_2}\right)}$$

Derivation for loop gain and freq. of operation:-



Apply KCL at C ⇒

$$sC_2 V_\pi + g_m V_\pi + \left(\frac{1}{R} + sC_1\right)(1 + s^2 L C_2) V_\pi = 0$$

$V_\pi \neq 0$,

$$s^3 L C_1 C_2 + s^2 (L C_2 / R) + s(C_1 + C_2) + \left(g_m + \frac{1}{R}\right) = 0$$

$s = j\omega$ (Put)

$$\left(g_m + \frac{1}{R} - \frac{\omega^2 L C_2}{R}\right) + j[\omega(C_1 + C_2) - \omega^3 L C_1 C_2] = 0$$

$$\boxed{\omega_0 = 1 / \sqrt{L\left(\frac{C_1 C_2}{C_1 + C_2}\right)}}$$

Codn. for Colpitt's:-

$$\boxed{C_2 / C_1 = g_m R}$$

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