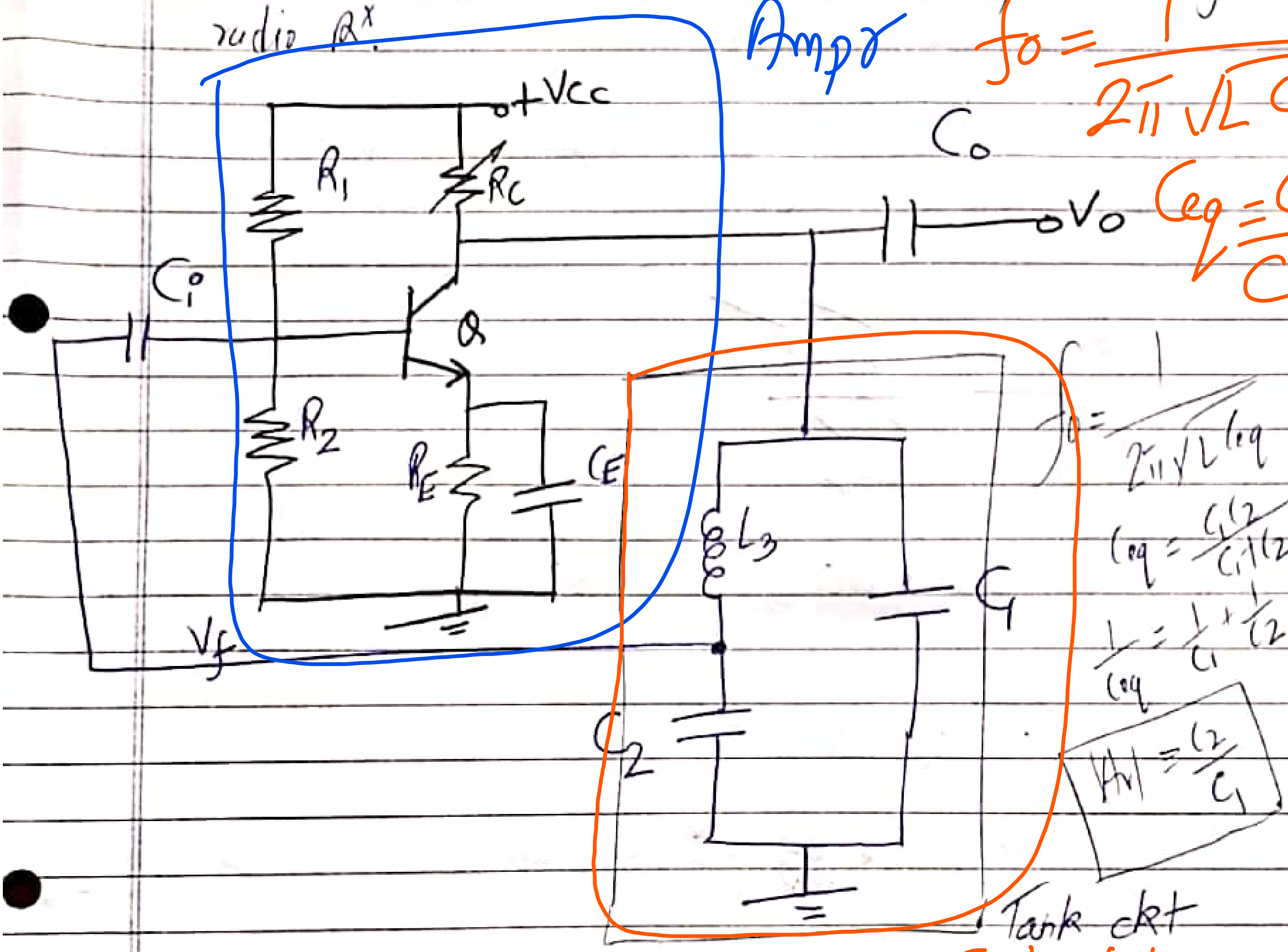
Colpitt's Oscillator

Colpitt's oscillator:-

- widely used in commercial s/g generators for frequencies betn 1MHz & 500MHz.

- also used as a Local oscillator in super heterodyne radio Rx.



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$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\boxed{|\beta| = \frac{C_2}{C_1}}$$

CE ampr - 180°
LC tank ckt - 180°

Total Phase shift - 0° or 360°

Gain (A_v) of ampr is adjusted such that $A_v \beta \geq 1$

R_1, R_2, R_E - provide dc bias to bjt.

LC tank ckt - acts as a resonant filter that passes only desired freq of oscillations

It is similar to Hartley's oscillator except that Tank circuit consists of two series capacitor's C_1 & C_2 and a parallel inductor L.

Colpitt's oscillator consists of a single-stage CE BJT Amplifier which provides the voltage gain 'A_v' and a phase-shift of 180° between its I/P and o/p terminals.

It consists of a LC tank ckt in the feedback network which provides a 180° phase shift. Thus the total phase-shift around the ckt is 0° or 360°.

The function of biasing resistors R_1, R_2, R_E is to establish dc bias for the BJT.

Coupling capacitor C_{c2} allow's only ac signals to pass to the LC tank ckt and C_{c1} blocks the dc current's reaching the base of Q_1

The LC tank ckt in the feedback network contains (C_1, C_2 and L) 25 which not only provide a phase shift of 180°, but also it acts as a resonant filter that passes only the desired frequency of oscillations.

. Working:

1. When the circuit is energized by switching on the dc supply, small oscillation's in form of noise voltage appears at the base of Q_1. This small noise voltage is further amplified by the amplifier and is fedback to the LC tank circuit

2. Small oscillations are produced in the LC tank circuit, which are again fedback to the base of transistor Q_1 and are amplified again.
3. This process continues, till the gain of the amplifier is sufficient to produce sustained oscillation's at the resonan frequency of the LC tank circuit.
4. In this way, sustained oscillation's are produced due to +ve Feedback from the tank circuit.
5. A stable sinusoidal o/p waveform is obtained at the o/p of oscillator by varying the potentiometer R_c [till a sustained oscillations (constant frequency and amplitude) are obtained].

$$f_0 = \frac{1}{2\pi\sqrt{L_3 C_{eq}}}$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = C_1 \| C_2$$

$$|A_v| = \frac{C_2}{C_1}$$

Expression ~~fo~~ ~~fo~~ -

Here, $X_1 = \frac{-1}{\omega C_1}$, $X_2 = \frac{-1}{\omega C_2}$, $X_3 = \omega L_3$

From eq^n (6a)

$$X_1 + X_2 + X_3 = 0$$

$$\frac{-1}{\omega C_1} - \frac{1}{\omega C_2} + \omega L_3 = 0.$$

$$\frac{1}{\omega}\left(\frac{1}{C_1} + \frac{1}{C_2}\right) = \omega L_3$$

$$\omega^2 = \frac{1}{L_3}\left(\frac{C_2 + C_1}{C_1 C_2}\right)$$

let $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

$$\omega = \sqrt{\frac{1}{L_3 C_{eq}}}$$

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{L_3 C_{eq}}}}$$ freq^n of oscillations

- f_0 can be varied by C

- $A_V \frac{X_2}{X_1} = 1 = AK$ from eqⁿ (7)

$$A_V = -\frac{X_1}{X_2}$$

$$= -\frac{\frac{-1}{\omega C_1}}{\frac{-1}{\omega C_2}}$$

$$A_V = \left| \frac{C_2}{C_1} \right|$$

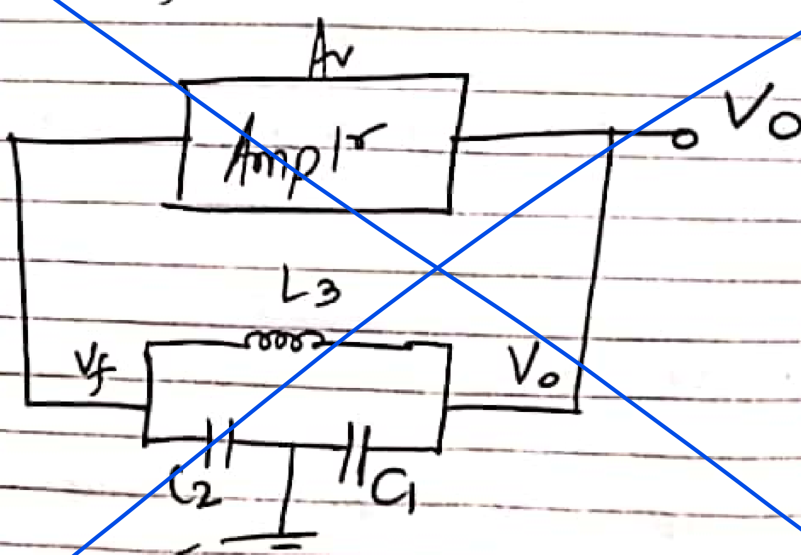
$$\boxed{|A_V| \geq \frac{C_2}{C_1}}$$

For oscillations to self-start,

$$|A_V \cdot K| = 1$$

ie $|K| = \frac{C_1}{C_2}$

→ Conditions for oscillations & start-up



$K = \frac{V_f}{V_o}$ feedback fraction K of tank ckt is

- Due to ckt being energized by dc source, the circulating tank current is flowing thr both C_1 & C_2.

Vtg developed across C_1 is oscillator's o/p (V_o) & vtg developed across C_2 is f/b vtg (V_f)

$$K = \frac{V_f}{V_o} = \frac{I X_{C2}}{I X_{C1}} = \frac{X_{C2}}{X_{C1}} = \frac{\frac{1}{2\pi f_o C_2}}{\frac{1}{2\pi f_o C_1}}$$

$$\boxed{K = \frac{C_1}{C_2}}$$

$$|A_v K| \geq 1$$

$$\boxed{|A_v| \geq \frac{1}{K} \geq \frac{C_2}{C_1}}$$

A_v must be slightly greater than (C_2/C_1) for oscillator to be self-starting & sustained.

Advantages: 1) It is possible to obtain oscillation's at very high frequencies.

Disadvantages: 1) It offers poor frequency stability.

2) This oscillator circuit will have loading effect due to its I/P impedance of BJT, thus lowering it's resonant frequency value.

3) It works for quality factors $(Q > 10)$

Applications: 1) It is used as a high frequency oscillator in radio receiver and local oscillator's in TV receivers.

2) The Colpitt's oscillator's are widely used as a signal generator's for frequencies between 1MHz and 500MHz