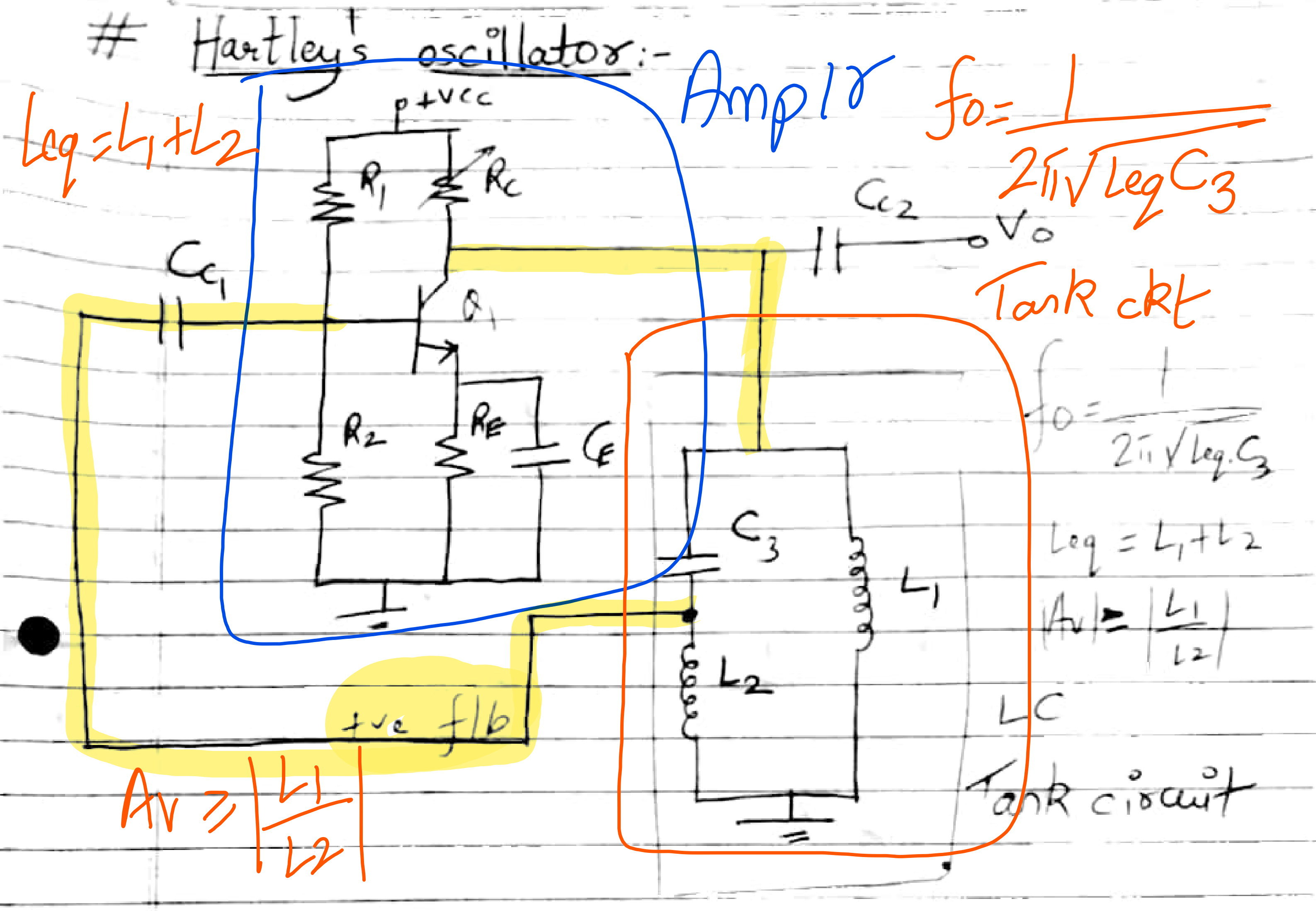
Hartley Oscillator

Hartley's oscillator:-



CE ampl^r — 180°

LC tank ckt — 180°

Total Phase shift — 0° or 360°

Gain(A_v) of ampl^r is adjusted such that $A\beta = 1$

R_1, R_2, R_E — provide dc bias to bjt

LC tank ckt — acts as a resonant filter that passes only desired freq^n of oscillations ... produced

- Hartley 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 circuit in the feedback network which provides a 180° phase shift. Thus, the total phase-shift around the circuit is 0° or 360°.
- Capacitor C_{c_2} is coupling capacitor which permits only ac currents to pass to the LC tank ckt. ie it blocks dc voltages and currents.
- Capacitor C_{c_1} blocks the dc current reaching the base of Q_1
- Resistors R_1, R_2 and R_E are used to establish dc bias for the BJT

The LC tank ckt in the Feedback network contains 21
(L_1, L_2 and c); 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 LC tank circuit.

2. Small oscillation's are produced in the tank ckt, which are again fedback to base of transistor Q_1 & are amplified again
3. This process continues, till the gain of the amplifier is sufficient to produce sustained oscillation's at the resonant frequency of the LC tank circuit.
4. In this way, sustained oscillation's are produced due to +ve f/b 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]

freq^n of oscillat^n is given by

$$f_o = \frac{1}{2\pi\sqrt{L_{eq} C_3}}$$

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

$$A_v = \left| \frac{L_1}{L_2} \right|$$

Expression for f_o:- Tank ckt is responsible for development of Vnoise & f_o is dependent on tank ckt itself

Here, $X_1 = \omega L_1$, $X_2 = \omega L_2$ and $X_3 = -\frac{1}{\omega C_3}$

From eq^n (6a),

$$X_1 + X_2 + X_3 = 0$$

$$\omega L_1 + \omega L_2 - \frac{1}{\omega C_3} = 0$$

$$\omega (L_1 + L_2) = \frac{1}{\omega C_3}$$

$$\omega^2 = \frac{1}{(L_1+L_2) C_3}$$

Let $L_{eq} = L_1 + L_2$

$$\therefore \boxed{f_o = \frac{1}{2\pi\sqrt{L_{eq} C_3}}}$$

w/o mutual inductance

Inductor not wound on same core
$M = 0$

Considering mutual inductance M.

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

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- f_0 can be varied by varying C_3

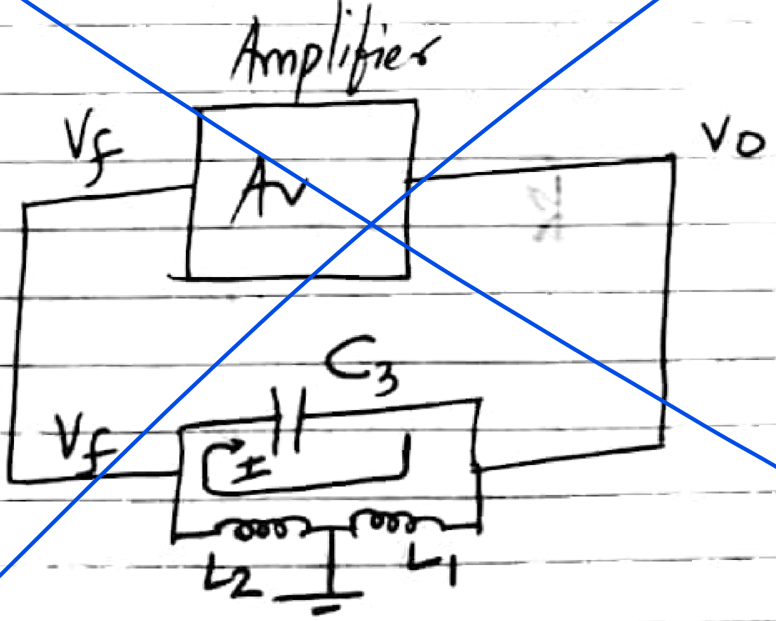
$$AK = 1 = -A_v \frac{X_2}{X_1} \quad \text{from eq}^n \text{ (7)}$$

$$A_v = \frac{X_1}{X_2} = \frac{-\omega L_1}{\omega L_2}$$

$$|A_v| = \left| \frac{L_1}{L_2} \right| \Rightarrow$$

$$\boxed{A_v \geq \left| \frac{L_1}{L_2} \right|}$$

- Conditions for oscillations & Start-up.



K (f/b fraction) of LC tank ckt is,

$$K = \frac{V_f}{V_o}$$

- Due to ckt being energized by dc source, the circulating tank current is flowing through L_1 & L_2.

The vtg developed across L_1 is oscillator's o/p vtg V_0 & vtg developed across L_2 is the f/b vtg V_f

$$K = \frac{V_f}{V_0} = \frac{I X_{L2}}{I X_{L1}} = \frac{X_{L2}}{X_{L1}}$$

$$K = \frac{2\pi f_0 L_2}{2\pi f_0 L_1}$$

$$\boxed{K = \frac{L_2}{L_1}}$$

ie $|A_v K| \geq 1$

$$\boxed{|A_v| \geq \frac{1}{K} \geq \frac{L_1}{L_2}}$$

ie vtg gain of ampl^r $\geq \frac{L_1}{L_2}$ for oscillation's to be self-starting & sustained.

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Advantages: 1) It is extremely simple to change the frequency of the oscillations by changing the tuning capacitor C.

2) It can operate over a wide frequency range up 50 MHz to 500 MHz.

3) It is possible to obtain oscillation's at very high frequencies.

Disadvantages: 1) It offers poor frequency stability.

2) This oscillator ckt will have loading effect due to i/p impedance of BJT, thus lowering it resonant frequency value

3) It works for quality factor [Q > 10]

Applications:-

1) They have wide variety of application's in Radio (FM) receiver, in function generator's, as local oscillator in TV receiver's.