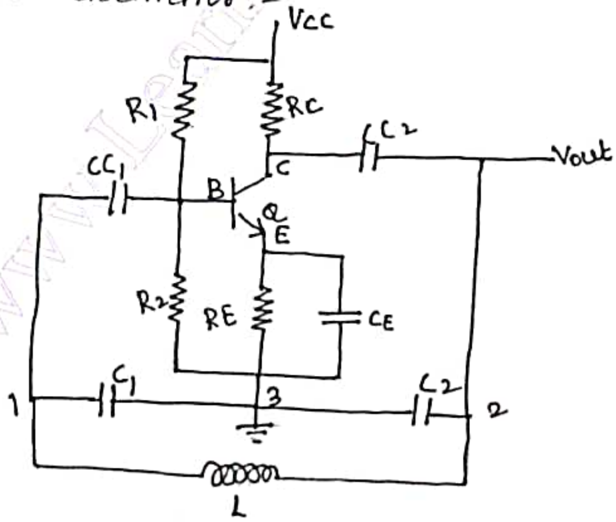
Colpitts Oscillator:-



→ In colpits Z_1 & Z_2 are the capacitors and Z_3 is an Inductor. The resistors R_1, R_2 and RE provides the necessary dc bias to the transistor. The bypass capacitor is CE. The coupling capacitors are CC_1 & CC_2. The feedback network consisting of C_1, C_2 & L determines the frequency of oscillator. Operation is similar to the Hartley oscillator.

$$f = \frac{1}{2\pi\sqrt{LC_{eq}}} \quad \text{where } C_{eq} = \frac{C_1C_2}{C_1+C_2}$$

Application:-

1) It is used for commercial signal generators for freq 1M to 800 MHz

2) It is used as local oscillator in super heterodyne radio receiver.

Analysis:-

$$Z_1 = \frac{1}{j\omega C_1} = -\frac{j}{\omega C_1}, \quad Z_2 = \frac{1}{j\omega C_2} = -\frac{j}{\omega C_2}$$

$$Z_3 = j\omega L$$

General form: $(Z_1+Z_2+Z_3)h_{ie} + Z_1Z_2(1+h_{fe}) + Z_1Z_3 = 0$

Substituting Z_1, Z_2 & Z_3 in above eqn

$$h_{ie}\left[\frac{-j}{\omega C_1} - \frac{j}{\omega C_2} + j\omega L\right] + \left(\frac{-j}{\omega C_1}\right)\left(\frac{-j}{\omega C_2}\right)(1+h_{fe}) + \left(\frac{-j}{\omega C_1}\right)(j\omega L) = 0$$

$$h_{ie}\, j\left[\omega L - 1/\omega C_1 - 1/\omega C_2\right] - \frac{(1+h_{fe})}{\omega^2 C_1 C_2} + \frac{\omega L}{\omega C_1} = 0$$

$$j h_{ie}\left[\omega L - 1/\omega C_1 - 1/\omega C_2\right] + \left[\frac{L}{C_1} - \frac{(1+h_{fe})}{\omega^2 C_1 C_2}\right] = 0 \rightarrow (2)$$

Equating the imaginary part of eqn to zero

$$\omega L - 1/\omega C_1 - 1/\omega C_2 = 0 \rightarrow (3)$$

$$\omega L = 1/\omega C_1 + 1/\omega C_2, \quad \omega L = 1/\omega\left[1/C_1 + 1/C_2\right]$$

$$\omega^2 = \frac{1}{L}\left[\frac{C_1 + C_2}{C_1 C_2}\right] \rightarrow (4)$$

$$\omega = \sqrt{\frac{C_1 + C_2}{L C_1 C_2}} \rightarrow (5)$$

$$f = \frac{1}{2\pi}\sqrt{\frac{C_1 + C_2}{L C_1 + C_2}}$$

$$f = \frac{1}{2\pi\sqrt{L C_{eq}}} \rightarrow (6)$$

$$\text{Where } C_{eq} = \frac{C_1 C_2}{C_1 + C_2} \rightarrow (7)$$

The condition for sustained oscillation is

(70)

obtained by equating the real part of eqn(2) to zero

$$\frac{L}{C_1} - \frac{(1+h_{fe})}{\omega^2 C_1 C_2} = 0 \rightarrow (8)$$

$$\frac{L}{C_1} = \frac{(1+h_{fe})}{\omega^2 C_1 C_2}$$

$$L = \frac{(1+h_{fe})}{\omega^2 C^2}$$

Substituting for ω^2 from eqn (4)

$$L = \frac{(1+h_{fe}) L C_1 C_2}{C_2 (C_1 + C_2)}$$

$$L = \frac{(1+h_{fe}) L C_1}{C_1 + C_2}$$

$$= C_1 C_2 = (1+h_{fe}) C_1$$

$$C_1\left[1 + \frac{C_2}{C_1}\right] = (1+h_{fe}) C_1$$

$$h_{fe} = \frac{C_2}{C_1} \rightarrow (9)$$

This is the condition for sustained oscillation.

(71)