Example 20.5. In a transistorized Hartley oscillator, the tank circuit has the capacitance of 100 pF. The value of inductance between the collector and tapping point is 30 mH and the value of inductance between the tapping point and the transistor base is 1 × 10^{-8} H. Determine the frequency of oscillations. Neglect the mutual inductance.

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Solution : Effective inductance,

$$L = L_1 + L_2 + 2M = 30 \times 10^{-3} + 1 \times 10^{-8} + 0 \simeq 0.03 \text{ H}$$

Capacitance,

$$C = 100 \text{ pF} = 100 \times 10^{-12} \text{ F} = 1 \times 10^{-10} \text{ F}$$

Frequency of oscillation,

$$f_o = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi \times \sqrt{0.03 \times 10^{-10}}} = 91.9 \text{ kHz} \quad \text{Ans.}$$

Example 20.6. Determine the oscillation frequency of a transistor Hartley oscillator shown in Fig. 20.16 with circuit values L_1 = 1 mH, L_2 = 100 μH, M = 50 μH and C = 100 pF.

Solution : Effective inductance,

$$L = L_1 + L_2 + 2\,M$$
$$= 1 \times 10^{-3} + 100 \times 10^{-6} + 2 \times 50 \times 10^{-6} = 1{,}200\ \mu\text{H}$$

Capacitance,

$$C = 100 \text{ pF} = 10^{-10} \text{ F}$$

Frequency of oscillation,

$$f_o = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{1{,}200 \times 10^{-6} \times 10^{-10}}} = 459 \text{ kHz Ans.}$$

Example 20.7. An amplifier with feedback has voltage gain of

Fig. 20.14. FET Colpitt's Oscillator

Example 20.4. In a transistor Colpitt's oscillator shown in Fig. 20.12, $L = 100\ \mu H$, $L_{RFC} = 0.6\ mH$, $C_1 = 0.001\ \mu F$, $C_2 = 0.01\ \mu F$ and $C_C = 10\ \mu F$. Determine (*i*) operating frequency (*ii*) feedback fraction (*iii*) minimum gain to sustain oscillations and emitter resistance if $R_C = 2.5\ k\Omega$.

Solution : Inductance, $L = 100\ \mu H = 100 \times 10^{-6}$ or 1×10^{-4} H

Capacitance, $C_1 = 0.001\ \mu F = 0.001 \times 10^{-6}$ F

Capacitance, $C_2 = 0.01\ \mu F = 0.01 \times 10^{-6}$ F

Fig

above Eq.

$\because h_{ie} \neq 0$

(*i*) Operating frequency,

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC_1} + \frac{1}{LC_2}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{1}{10^{-4} \times 0.001 \times 10^{-6}} + \frac{1}{10^{-4} \times 0.01 \times 10^{-6}}} = 528 \text{ kHz}$$

(*ii*) Feedback fraction, $\beta = h_{fe} = \dfrac{C_1}{C_2} = \dfrac{0.001 \times 10^{-6}}{0.01 \times 10^{-6}} = 0.1$ Ans.

(*iii*) Minimum gain to sustain oscillations. A by varying ... C_1 and C_2 simultaneously.

4. The overall gain is high because of two transistors.

Disadvantages. 1. The circuit needs two transistors and a large number of other components.

2. The maximum frequency output is limited because of amplitude and the phase shift characteristics of the amplifier.

Example 20.10. Design the R-C elements of a Wien bridge oscillator shown in Fig. 20.28 for operation at f = 15 kHz.

Solution : Using values of R_1 equal to R_2 and C_1 equal to C_2 and taking each of R_1 and R_2 of 200 kΩ,

$$\text{Required value of C} = \frac{1}{2\pi f R}$$

$$= \frac{1}{2\pi \times 15 \times 10^3 \times 200 \times 10^3}$$

$$= 53 \text{ pF Ans.} \qquad \text{Refer to Eq. (20.43)}$$

We can use R_3 = 400 kΩ and R_4 = 200 kΩ **Ans.**

Example 20.11. Find the frequency of oscillations of a Wien bridge oscillator with R = 20 kΩ and C = 1,000 pF.

Solution :

$$R = R_1 = R_2 = 20 \text{ k}\Omega = 20{,}000\ \Omega$$

$$C = C_1 = C_2 = 1{,}000 \text{ pF} = 1 \times 10^{-9} \text{ F}$$

Frequency of oscillation,

$$f = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 20{,}000 \times 1 \times 10^{-9}} = 7.96 \text{ kHz Ans.}$$

20.18. BEAT FREQUENCY OSCILLATOR

The beat frequency oscillator used to be the most tions will remain unaffected as the frequency is adjusted. The phase-shift oscillator is operated in class A so as to keep distortion to the minimum. Frequency range from 20 Hz to 200 Hz, 200 Hz to 2 kHz, 2 kHz to 20 kHz and 20 kHz to 200 kHz can be obtained by using different set of resistors.

Phase-shift oscillators are not suitable for higher frequency operation because at higher frequency, the internal phase shift of the transistor and reduction in h_{fe} cause difficulties in designing the circuit. The frequency of the oscillator cannot be changed easily.

Example 20.9. In a phase shift oscillator shown in Fig. 20.24, $R_1 = R_2 = R_3 = 800\ k\Omega$ and $C_1 = C_2 = C_3 = 100\ pF$. Determine the frequency of oscillation.

Solution : $R_1 = R_2 = R_3 = R = 800\ k\Omega = 8 \times 10^5\ \Omega$

$C_1 = C_2 = C_3 = C = 100\ pF = 10^{-10}\ F$

Frequency of oscillation,

$$f_o = \frac{1}{2\pi RC\sqrt{6}} = \frac{1}{2\pi \times 8 \times 10^5 \times 10^{-10} \times \sqrt{6}}$$

$$= 812\ \text{Hz}\ \textbf{Ans.}$$

20.17. WIEN BRIDGE OSCILLATOR

It is one of the most popular type of oscillators used in audio and sub-audio frequency ranges (20 – 20 kHz). This type of oscillator is simple in design, compact in size and remarkably stable in its frequency output. Fur-