K. J. SOMAIYA COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
Oscillator Circuits

Numerical 1:

In a Hartley oscillator, amplifier components are $R_1 = 100k\Omega$, $R_2 = 18k\Omega$, $R_C = 12k\Omega$, $R_E = 1k\Omega$, $C_{C_1} = 1\mu F$, $C_{C_2} = 1\mu F$, $C_E = 1\mu F$, $V_{CC} = 10V$. Select the LC tank circuit elements such that frequency of oscillation is close to $100kHz$.

BJT transistor: 2N2222

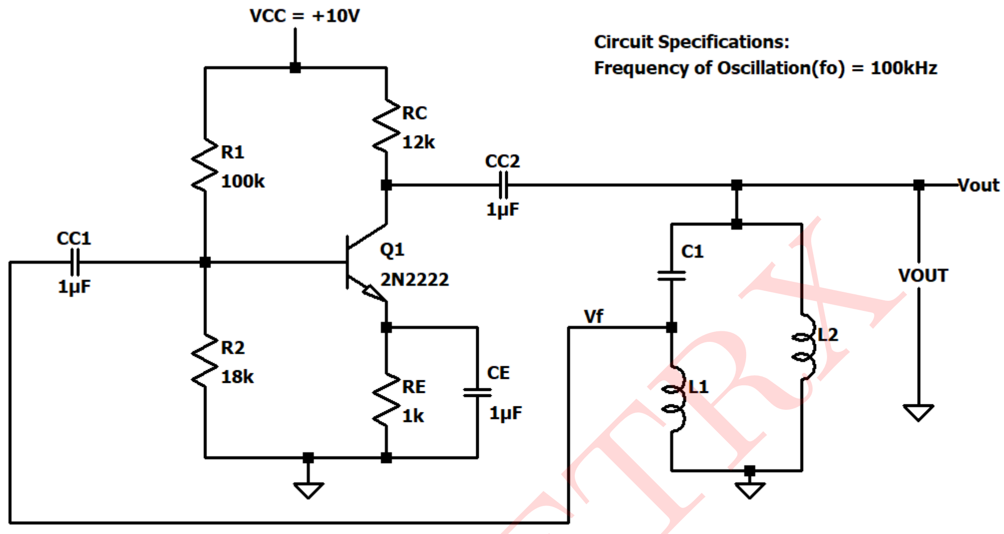

Figure 1: Circuit 1

Solution:

$f_o = 100Hz$

For Hartley's Oscillator,

$$f_o = \frac{1}{2\pi\sqrt{L_{eq}C_3}}, \text{ where } L_{eq} = L_1 + L_2$$

Assume, $C_3 = 47\text{nF}$

$$100kHz = \frac{1}{2\pi\sqrt{(L_1 + L_2) \times 47nF}}$$

$$\sqrt{(L_1 + L_2) \times 47nF} = \frac{1}{2\pi \times 100kHz}$$

$$L_1 + L_2 = \frac{2.533 \times 10^{-12}}{47nF}$$

$$L_1 + L_2 = \mathbf{5.389 \times 10^{-5}}$$

Let $L_1 = L_2$

$\therefore 2L_1 = 5.389 \times 10^{-5}$

$L_1 = \mathbf{26.95\mu F} = L_2$

$$\text{Feedback Fraction (k)} = \frac{L_2}{L_1} = 1$$

Time period of oscillator $= \dfrac{1}{f_o} = 10\mu s$

Phase shift offered by LC tank circuit = 180°

SIMULATED RESULTS

The above circuit is simulated in LTspice and results are presented below:

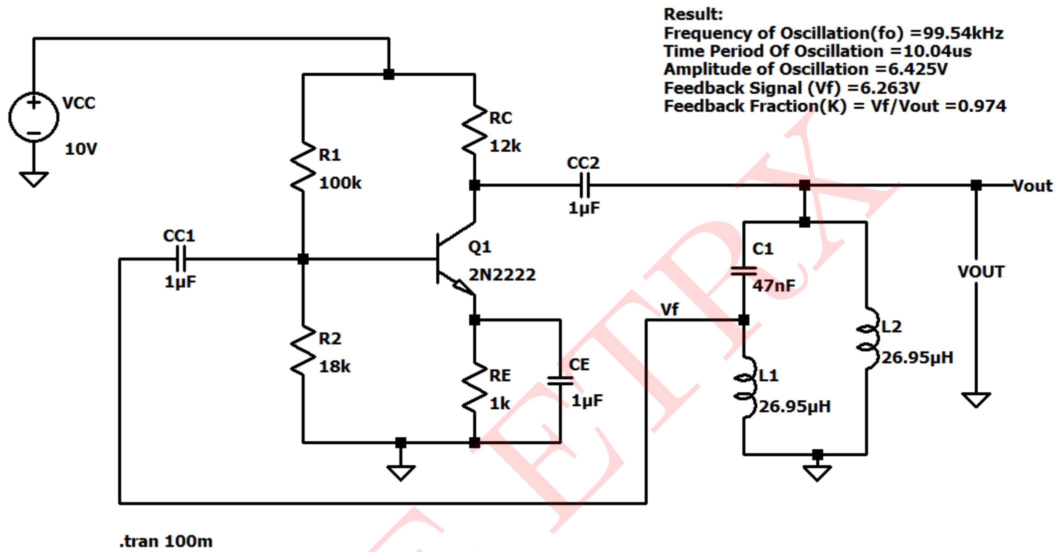

Figure 2: Circuit Schematic

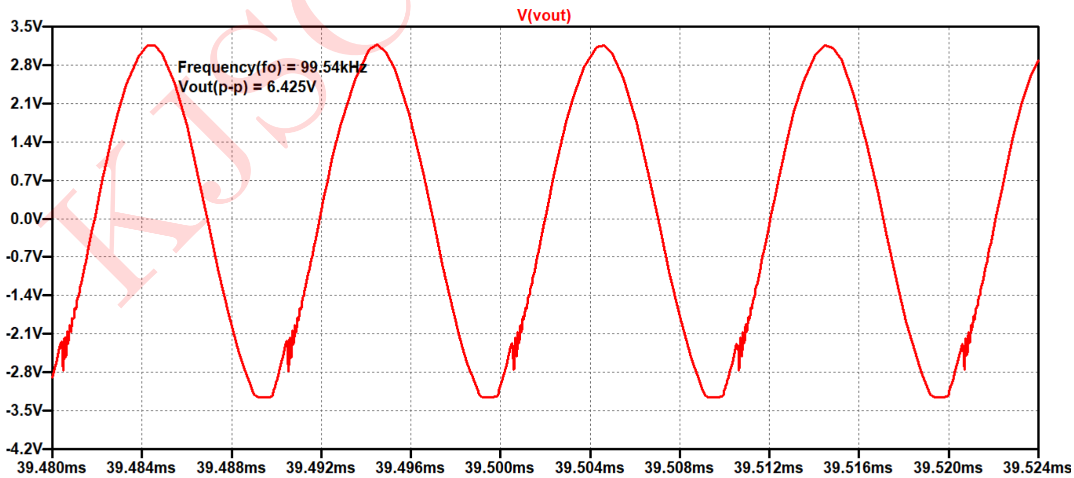

Figure 3: Output of Hartley Oscillator

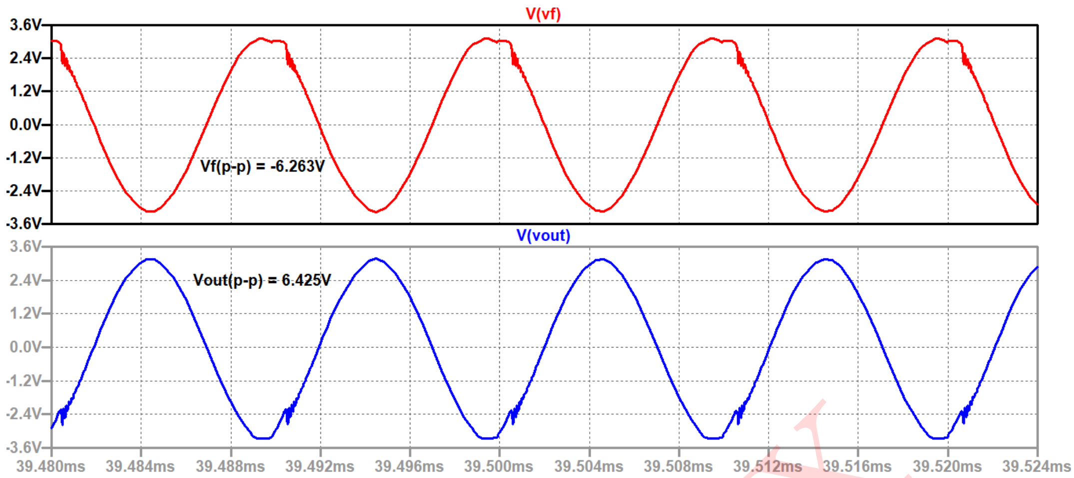

Figure 4: Output & Feedback Voltage of Hartley Oscillator

Comparison of Theoretical and Simulated results:

Parameters	Theoretical	Simulated
Frequency of Oscillation f_o	$100kHz$	$99.54kHz$
Time period of Oscillations	$10\mu s$	$10.04\mu s$
Amplitude of Oscillations	–	6.425Vp-p
Feedback signal V_f amplifude & phase w.r.t V_{out}	–	6.263Vp-p 180°[out of phase]
Feedback Fraction	1	0.974
Phase shift offered by LC tank circuit	180°	180°

Table 1: Numerical 1

Numerical 2:

In a Colpitts oscillator, amplifier components are $R_1 = 100k\Omega$, $R_2 = 18k\Omega$, $R_C = 12k\Omega$, $R_E = 1k\Omega$, $C_{C_1} = 1\mu F$, , $C_{C_2} = 1\mu F$, , $C_E = 150\mu F$, $V_{CC} = 10V$. Select the LC tank circuit elements such that frequency of oscillation is close to $400kHz$.

BJT transistor: 2N2222. Comment on phase shift offered by LC tank circuit.

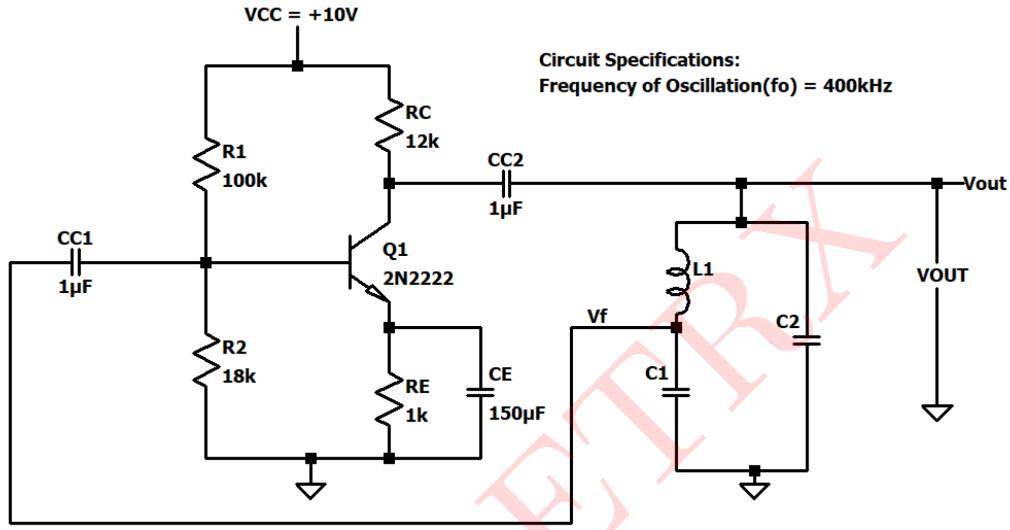

Figure 5: Circuit 2

Solution:

$f_o = 400Hz$

For Colpitts Oscillator,

$$f_o = \frac{1}{2\pi\sqrt{C_{eq}L_3}}, \text{ where } C_{eq} = \frac{C_1 \times C_2}{C_1 + C_2}$$

Assume, $L_3 = 1\mu$ F

$$400 \times 10^3 = \frac{1}{2\pi\sqrt{(10^{-6}) \times C_{eq}}}$$

$C_{eq} = \mathbf{0.158\mu F}$

Let $C_1 = C_2$

$$\therefore C_{eq} = \frac{C_1}{2} = 0.158\mu F$$

$C_1 = C_2 = \mathbf{0.316\mu F}$

$$\text{Feedback Fraction (k)} = \frac{C_1}{C_2} = 1$$

$$\text{Time period of oscillator} = \frac{1}{f_o} = 2.5\mu s$$

Phase shift offered by LC tank circuit = 180°

SIMULATED RESULTS

The above circuit is simulated in LTspice and results are presented below:

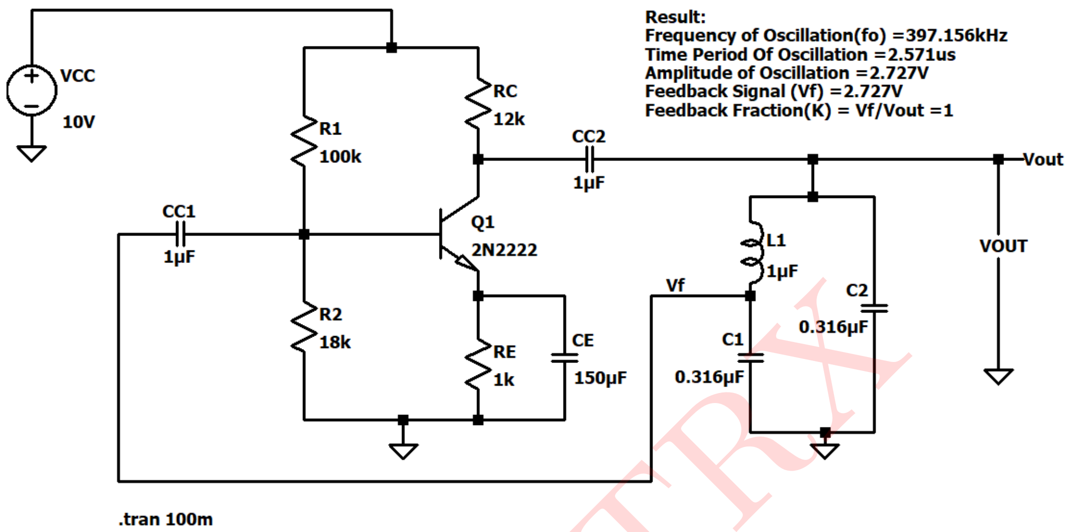

Figure 6: Circuit Schematic

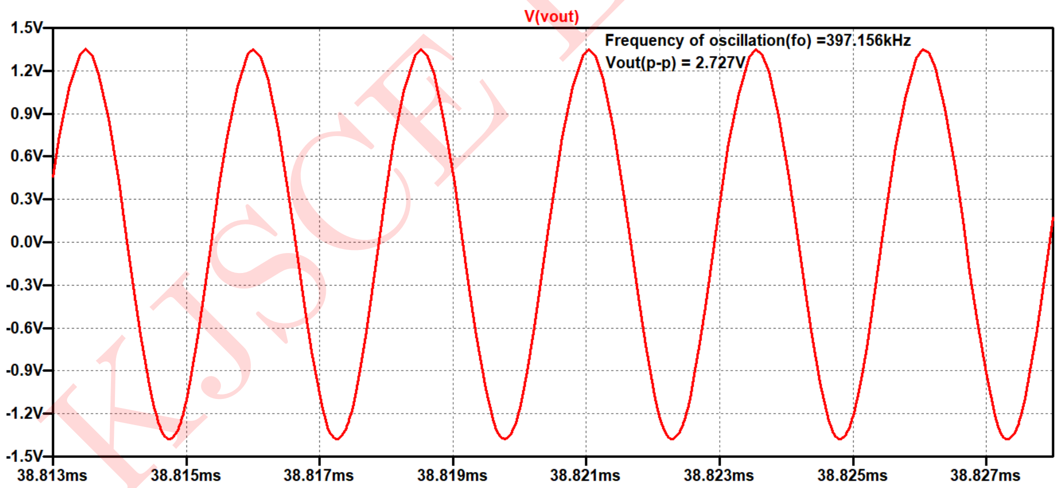

Figure 7: Output of Colpitts Oscillator

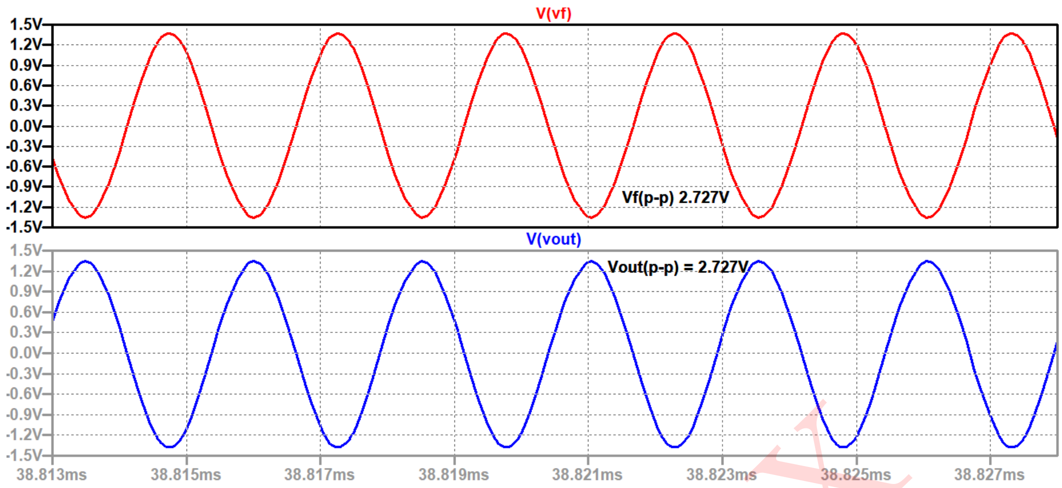

Figure 8: Output & Feedback Voltage of Colpitts Oscillator

Comparison of Theoretical and Simulated results:

Parameters	Theoretical	Simulated
Frequency of Oscillation f_o	$400kHz$	$397.156kHz$
Time period of Oscillations	$2.5\mu s$	$2.517\mu s$
Amplitude of Oscillations	–	2.727Vp-p
Feedback signal V_f amplifude & phase w.r.t V_{out}	–	2.727Vp-p 180°[out of phase]
Feedback Fraction	1	1
Phase shift offered by LC tank circuit	180°	180°

Table 2: Numerical 2

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