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

Numerical 1:

In a Hartley oscillator, amplifier components are $R_1 = 100k\Omega$, $R_2 = 18k\Omega$, $R_C = 12k\Omega$, $R_E = 1k\Omega$, $C_{C_1} = 1\mu F$, $C_E = 1\mu F$, $C_{C_2} = 1\mu F$, $V_{CC} = 10V$. Select the LC tank circuit elements such that frequency of oscillation is close to 225kHz. BJT transistor: 2N2222

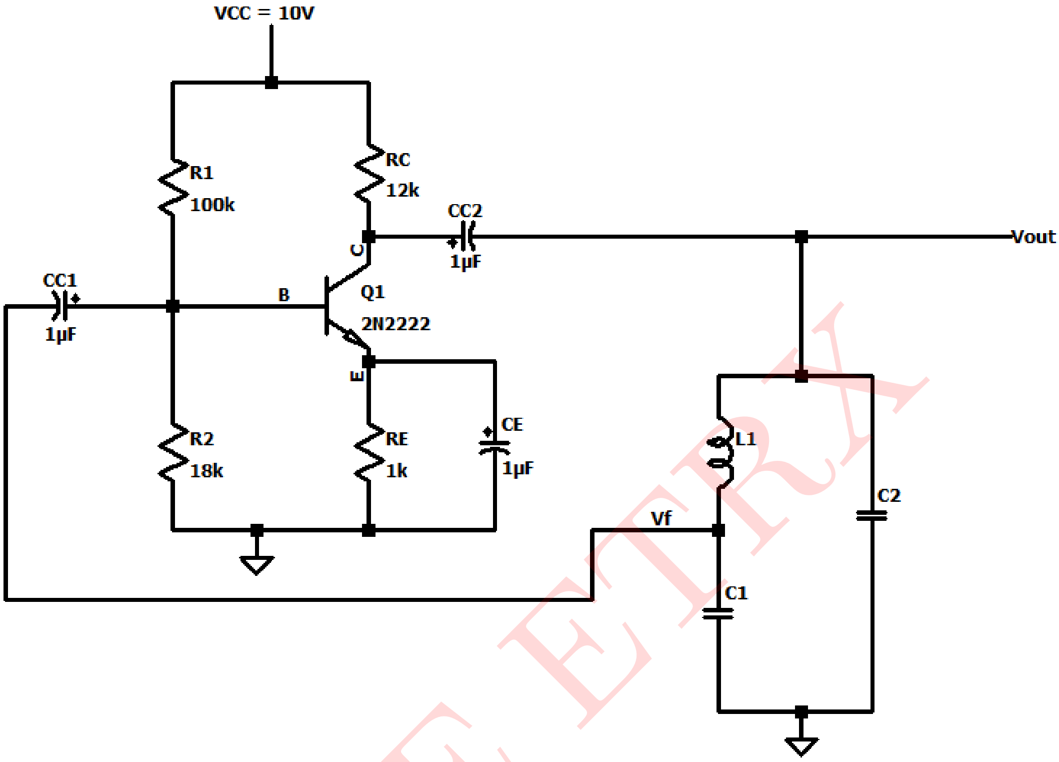

Figure 1: Circuit 1

Solution:

Frequency of oscillation,

$$f_o = \frac{1}{2\pi\sqrt{L_{eq}C_1}}$$

$$225kHz = \frac{1}{2\pi\sqrt{L_{eq}C_1}}$$

$$225kHz \times 2\pi = \frac{1}{\sqrt{L_{eq}C_1}}$$

Let $C_1 = 47nF$

$$225kHz \times 2\pi \times \sqrt{47nF} = \frac{1}{\sqrt{L_{eq}}}$$

$$306.331 = \frac{1}{\sqrt{L_{eq}}}$$

$$\therefore \sqrt{L_{eq}} = \frac{1}{306.331}$$

$$\sqrt{L_{eq}} = 3.264 \times 10^{-3}$$

$\therefore L_{eq} = \mathbf{10.656\mu H}$

$\because L_{eq} = L_1 + L_2 + 2M$

Where M is the mutual inductance and M = 0, if both the inductors(L_1 and L_2) are not wound on the same core.

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

$\therefore L_{eq} = L_1 + L_1 \qquad (\because L_1 = L_2)$

$\therefore L_{eq} = 2L_1$

$\therefore 10.656\mu F = 2L_1$

$\therefore L_1 = \mathbf{5.328\mu F}$

$\because L_1 = L_2$

$\therefore L_2 = \mathbf{5.328\mu F}$

k(feedback fraction) of LC tank circuit,

k $= \dfrac{V_f}{V_o}$

k $= \dfrac{L_2}{L_1}$

$= \dfrac{5.328\mu F}{5.328\mu F} = \mathbf{1}$

$\therefore$ Phase shift offered by LC tank circuit is 180°

SIMULATED RESULTS:
Above circuit is simulated in LTspice and results are as follows:

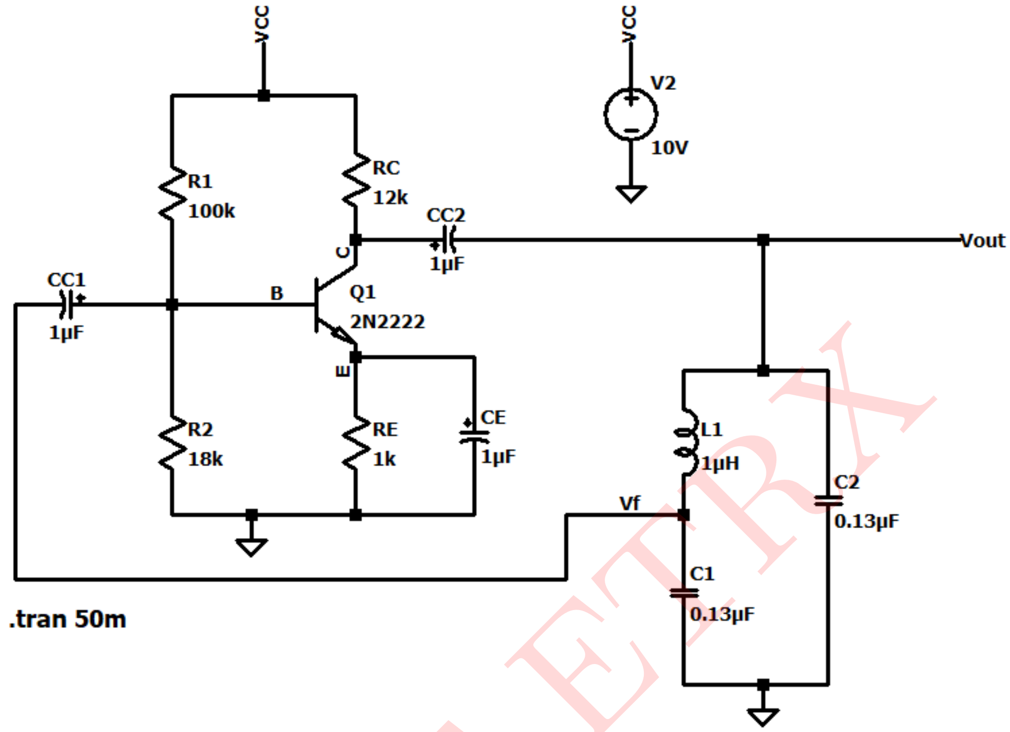

Figure 2: Circuit Schematic 1

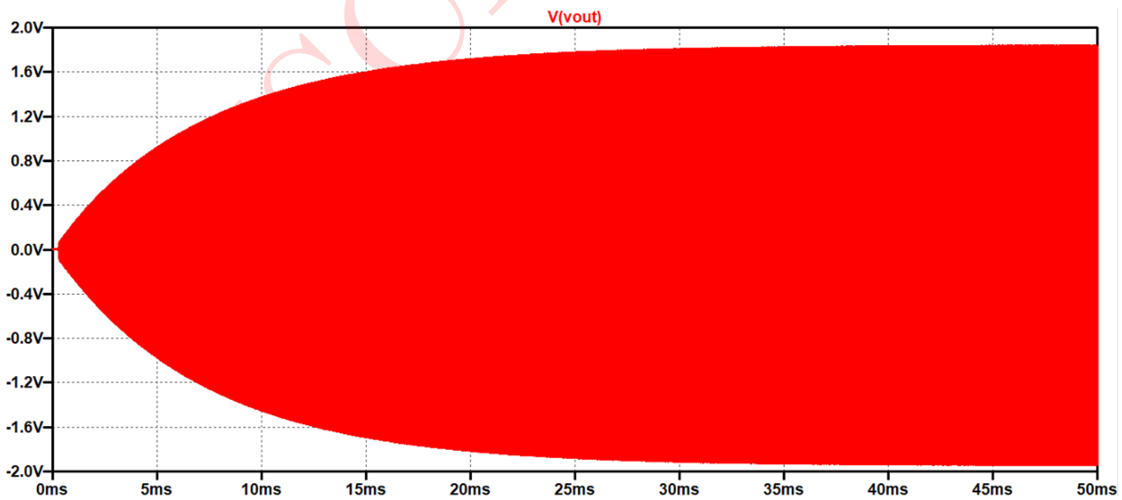

Figure 3: Output wave before zooming in

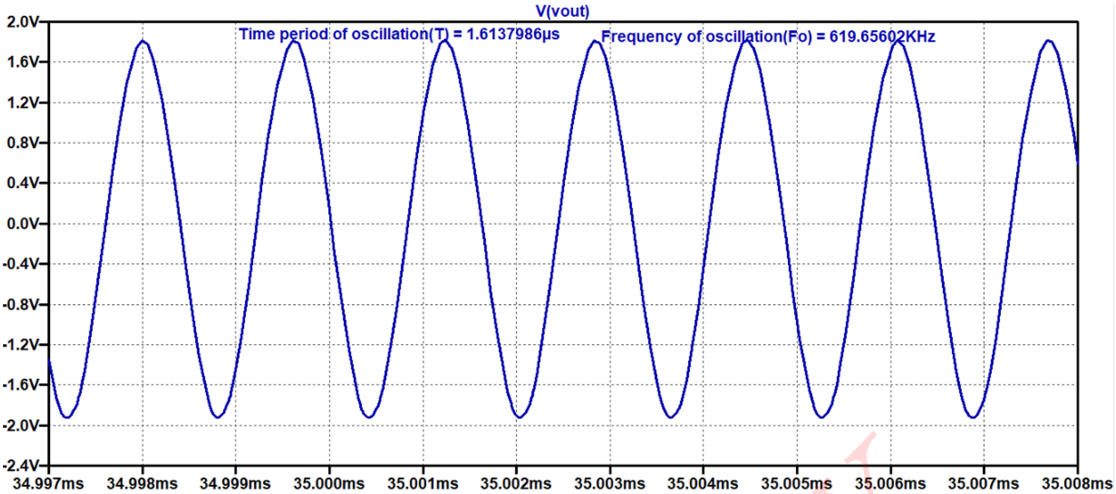

Figure 4: Output wave after zooming in

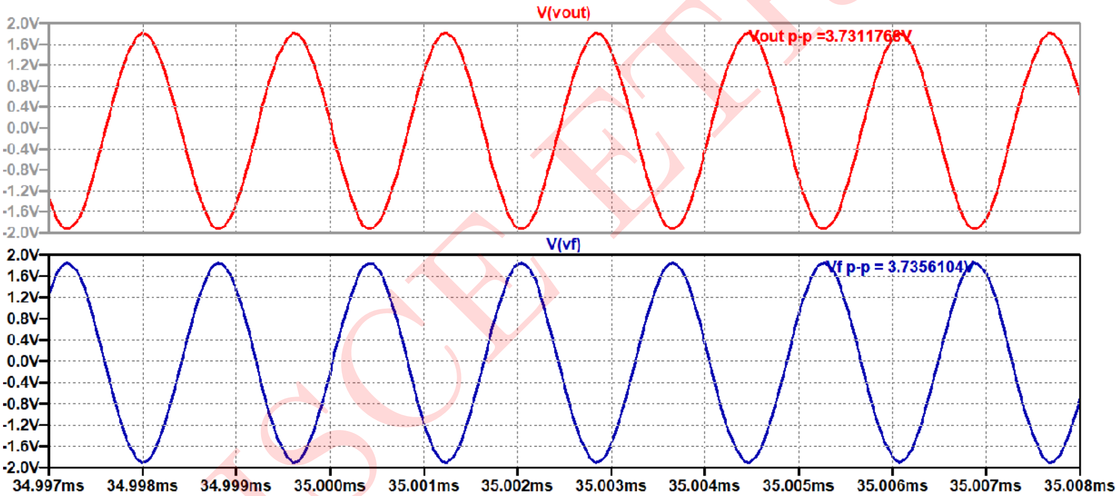

Figure 5: Peak to peak values of V_{out} and V_f

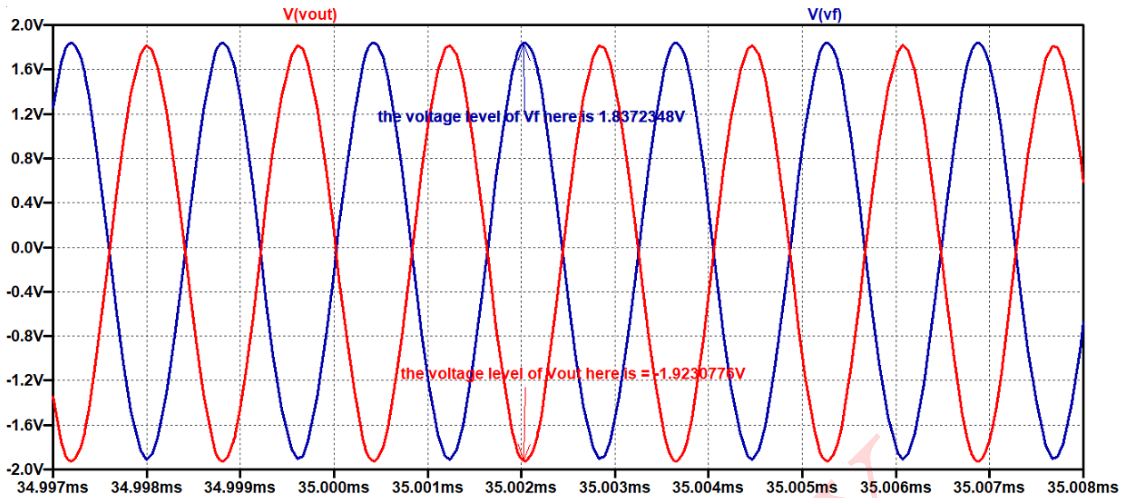

Figure 6: Phase difference between V_{out} and V_f

Comparison between theoretical and simulated values:

Parameters	Theoretical values	Simulated values
Frequency of oscillations(f_o)	225kHz	224.5370kHz
Timeperiod of oscillations(T)	4.44μs	4.4750μs
Amplitude of oscillations	–	5.4247V
Feedback signal VF amplitude and phase w.r.t V_{out}	–	5.3801V, 180°
Feedback fraction in dB	1	0.9917
Phase shift offered by LC tank circuit	180°	180°

Table 1: Numerical 1

Numerical 2:
In a Colpitts oscillator, amplifier components are $R_1 = 100k\Omega$, $R_2 = 18k\Omega$, $R_C = 12k\Omega$, $R_E = 1k\Omega$, $C_{C_1} = 1\mu F$, $C_{C_2} = 1\mu F$, $V_{CC} = 10V$. Select the LC tank circuit elements such that frequency of oscillation is close to 620kHz. BJT transistor: 2N2222
Comment on phase shift offered by LC tank circuit.

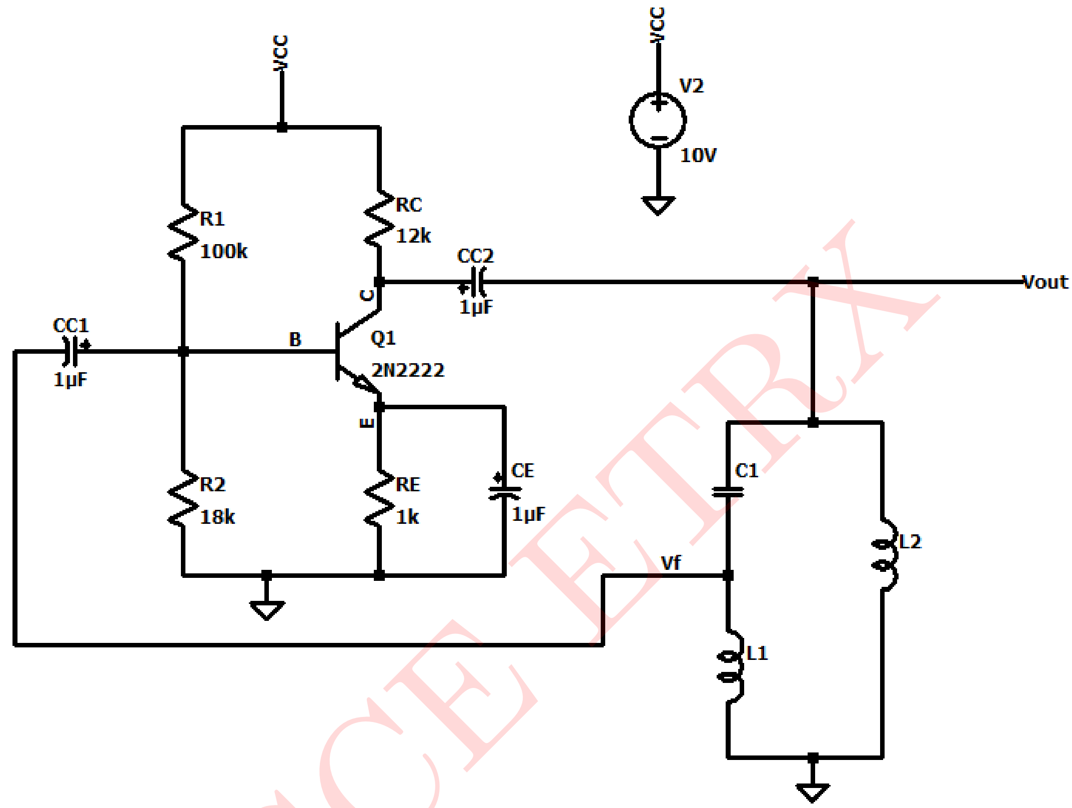

Figure 7: Circuit 2

Solution:

Frequency of oscillation,

$$f_o = \frac{1}{2\pi\sqrt{L_1 C_{eq}}}$$

$$620kHz = \frac{1}{2\pi\sqrt{L_1 C_{eq}}}$$

$$620kHz \times 2\pi = \frac{1}{\sqrt{L_1 C_{eq}}}$$

Let $L_1 = 1\mu H$

$$620kHz \times 2\pi \times \sqrt{1\mu H} = \frac{1}{\sqrt{C_{eq}}}$$

$$3893.6 = \frac{1}{\sqrt{C_{eq}}}$$

$$\therefore \sqrt{C_{eq}} = \frac{1}{3893.6}$$

$$\sqrt{C_{eq}} = 2.56 \times 10^{-4}$$

$\therefore C_{eq} = \mathbf{65.96nF}$

$\because C_{eq} = \dfrac{C_1C_2}{C_1 + C_2}$

$\therefore \dfrac{C_1C_2}{C_1 + C_2} = 65.96nF$

$\therefore \dfrac{C_1C_1}{C_1 + C_1} = 65.96nF \qquad (\because C_1 = C_2)$

$\therefore \dfrac{{C_1}^2}{2C_1} = 65.96nF$

$\therefore C_1 = 2 \times 65.96nF$

$\therefore C_1 = \mathbf{0.13\mu F}$

$\because C_1 = C_2$

$\therefore C_2 = \mathbf{0.13\mu F}$

$$\text{Time period of oscillations(T)} = \frac{1}{frequency\ of\ oscillation(f_o)}$$
$$= \frac{1}{620kHz} = \mathbf{1.61\mu s}$$

k(feedback fraction) of LC tank circuit,

k $= \dfrac{V_f}{V_o}$

k $= \dfrac{C_1}{C_2}$

$= \dfrac{0.13\mu F}{0.13\mu F} = \mathbf{1}$

$\therefore$ Phase shift offered by LC tank circuit is $180°$

SIMULATED RESULTS:
Above circuit is simulated in LTspice and results are as follows:

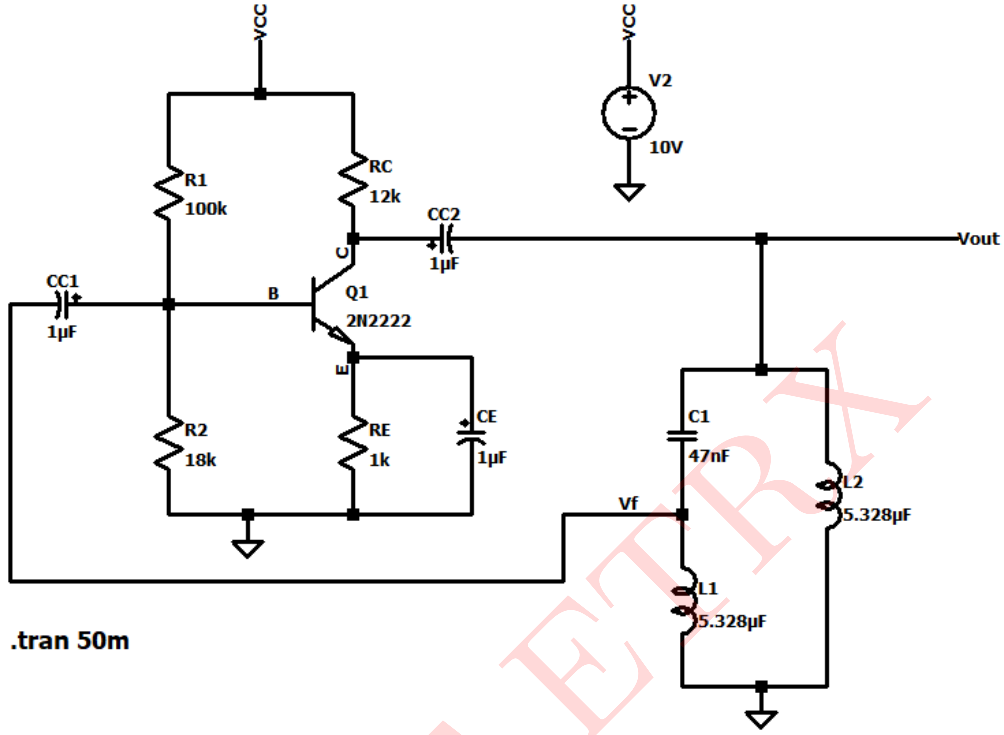

Figure 8: Circuit Schematic

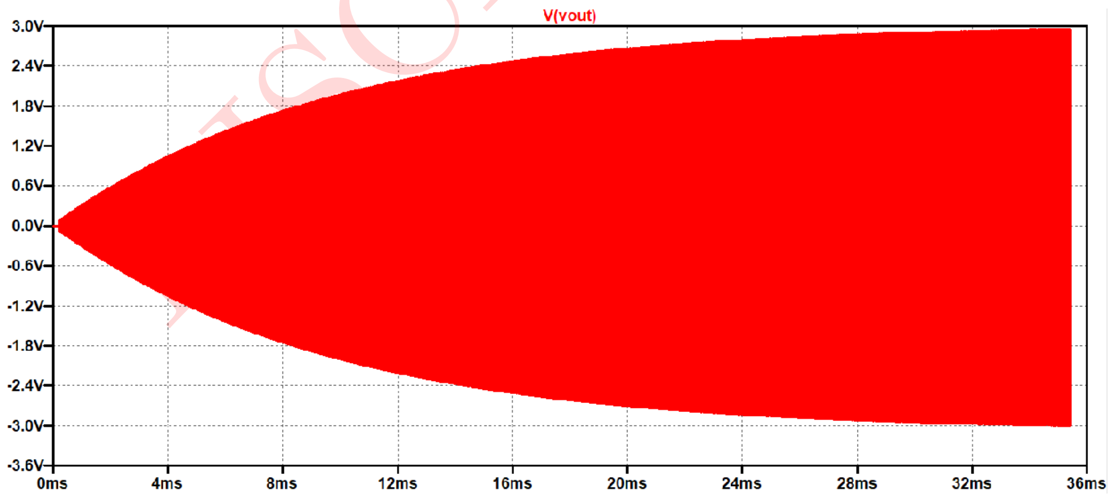

Figure 9: Output wave before zooming in

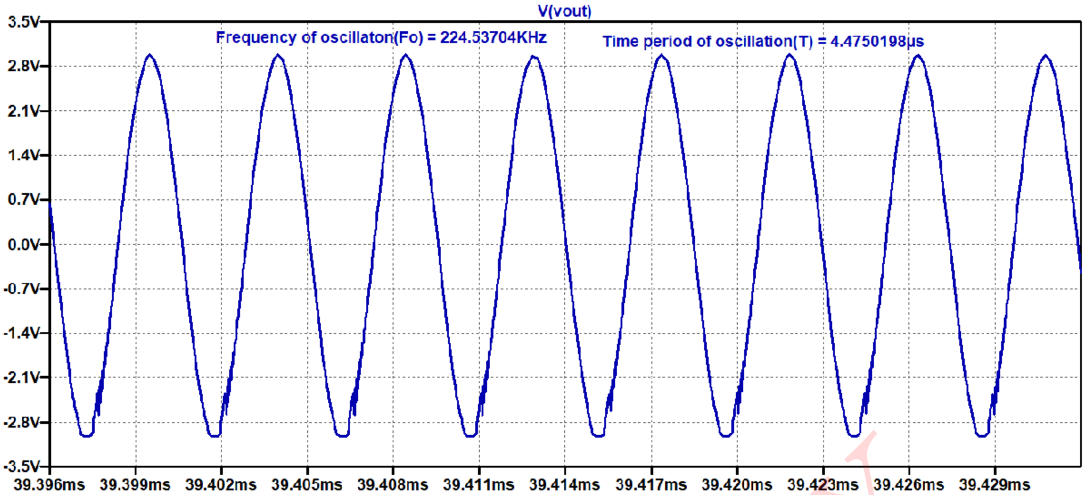

Figure 10: Output wave after zooming in

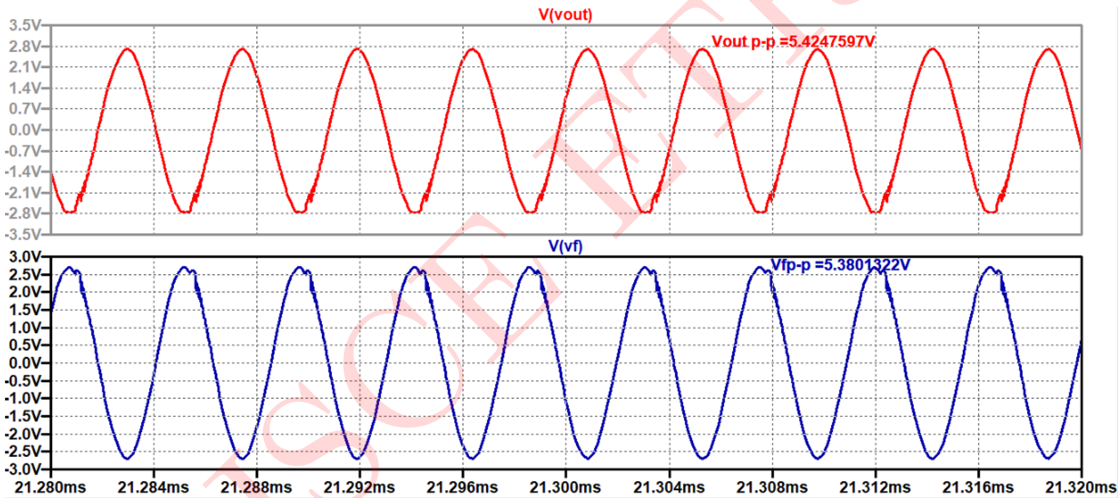

Figure 11: Peak to peak values of V_{out} and V_f

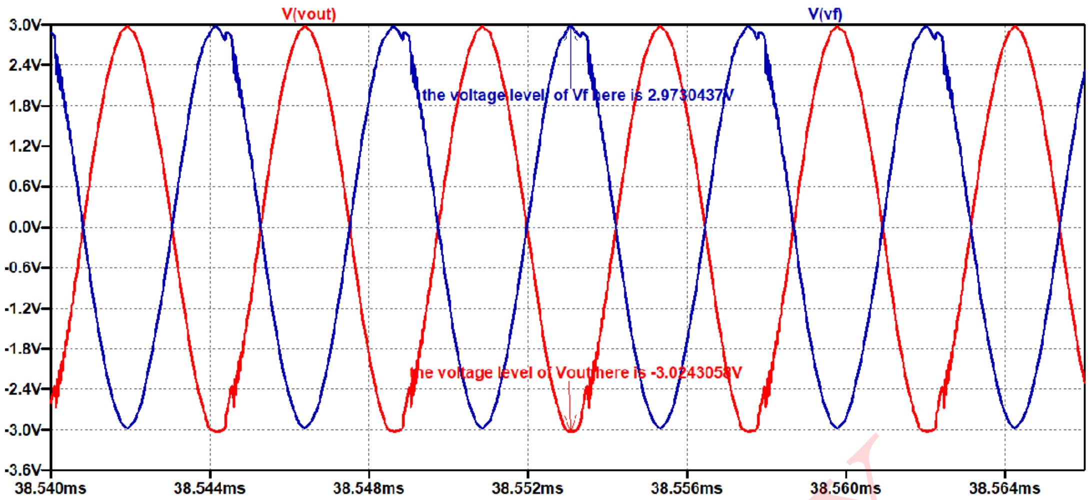

Figure 12: Phase difference between V_{out} and V_f

Comparison between theoretical and simulated values:

Parameters	Theoretical values	Simulated values
Frequency of oscillations(f_o)	620kHz	619.6560kHz
Timeperiod of oscillations(T)	1.61μs	1.6137μs
Amplitude of oscillations	–	3.7311V
Feedback signal VF amplitude and phase w.r.t V_{out}	–	3.7356V, 180°
Feedback fraction in dB	1	0.9917
Phase shift offered by LC tank circuit	180°	180°

Table 2: Numerical 2

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