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DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
Oscillator Circuits

16^{th} **July, 2020** **Numericals**

Numerical 1: In a colpitt's Oscillator, amplifier components are $R_1 = 100k$, $R_2 = 18k$, $R_C = 12k$, $R_E = 1k$, $C_{C1} = 1\mu F$, $C_E = 150\mu F$, $C_{C2} = 1\mu F$, $V_{CC} = 10V$. Select the LC tank circuit such that frequency of oscillations is close to 90kHz.
BJT transistor: 2N2222
Also comment on the phase shift offered by LC Tank circuit.

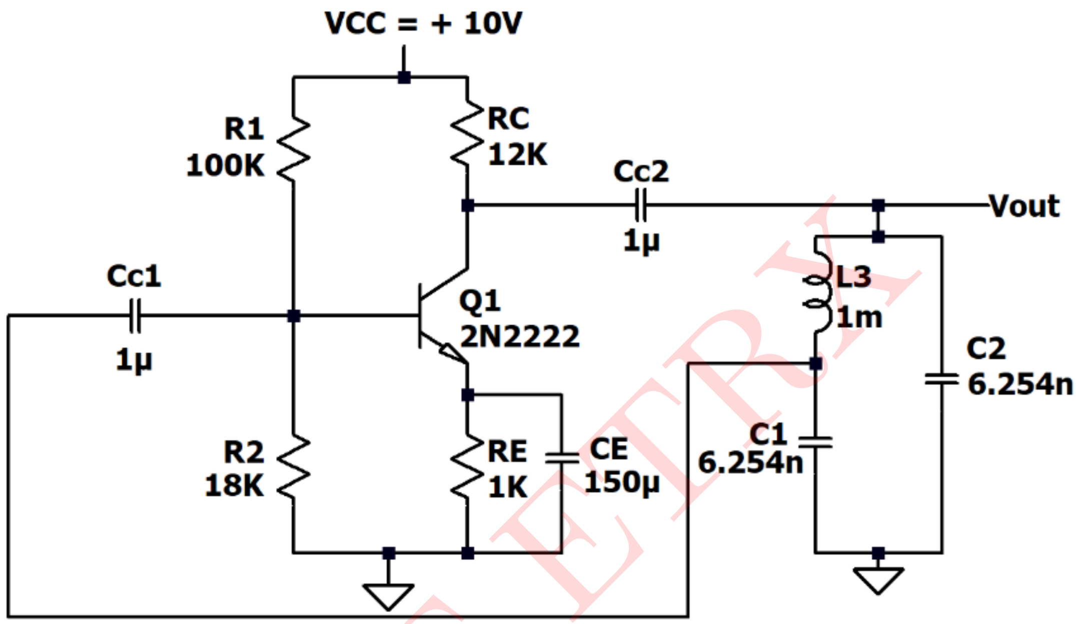

Figure 1: Circuit 1

Solution:

Frequency of oscillations for a Colpitt's Oscillator is given as:
$$f_o = \frac{1}{2\pi\sqrt{C_{eq}L_3}}$$

Where, $C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2}$

Let $L_3 = 1mH$

Since we want the frequency of oscillations to be close to 90kHz

$f_o \approx 90kHz$

$$\therefore 90 \times 10^3 = \frac{1}{2\pi\sqrt{10^{-3} \times C_{eq}}}$$

$$\therefore 10^{-3} \times C_{eq} = \frac{1}{(90 \times 10^3 \times 2\pi)^2}$$

$$\therefore C_{eq} = \frac{10^3}{(90 \times 10^3 \times 2\pi)} = \mathbf{3.127nF}$$

Let $C_1 = C_2$

$$\therefore C_1 = C_2 = 2 \times 3.127nF = \mathbf{6.254nF}$$

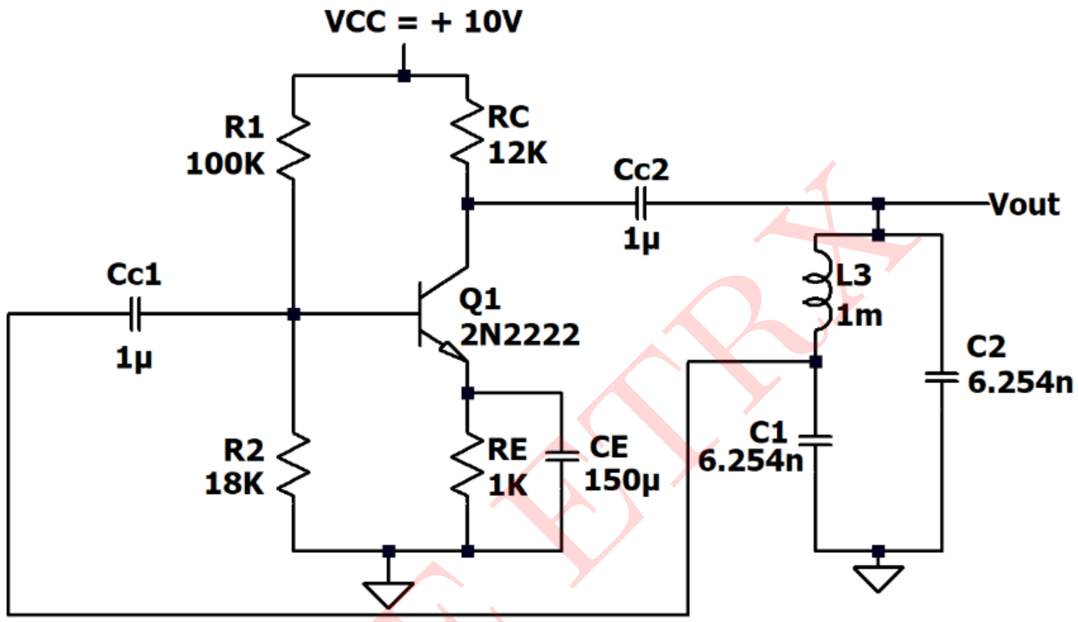

Figure 2: Colpitt's Oscillator

Frequency of oscillations = **90kHz**

$$\therefore \text{Time period of oscillations} = \frac{1}{f_o} = \frac{1}{90 \times 10^3} = \mathbf{11.11\mu sec}$$

$$\text{Feedback fraction (K)} = \frac{V_f}{V_o} = \frac{IX_{C2}}{IX_{C1}} = \frac{C_1}{C_2} = \frac{6.254 \times 10^{-9}}{6.254 \times 10^{-9}} = \mathbf{1}$$

Feedback fraction = 1
Phase shift provided by common emitter amplifier is 180°
Phase shift provided by the LC tank circuit is 180°
So the total phase shift of the entire circuit is 360°(or 0°)
Thus, the total phase shift = 360°(or 0°)

SIMULATED RESULTS:
Above circuit is simulated in LTspice and the result is as follows:

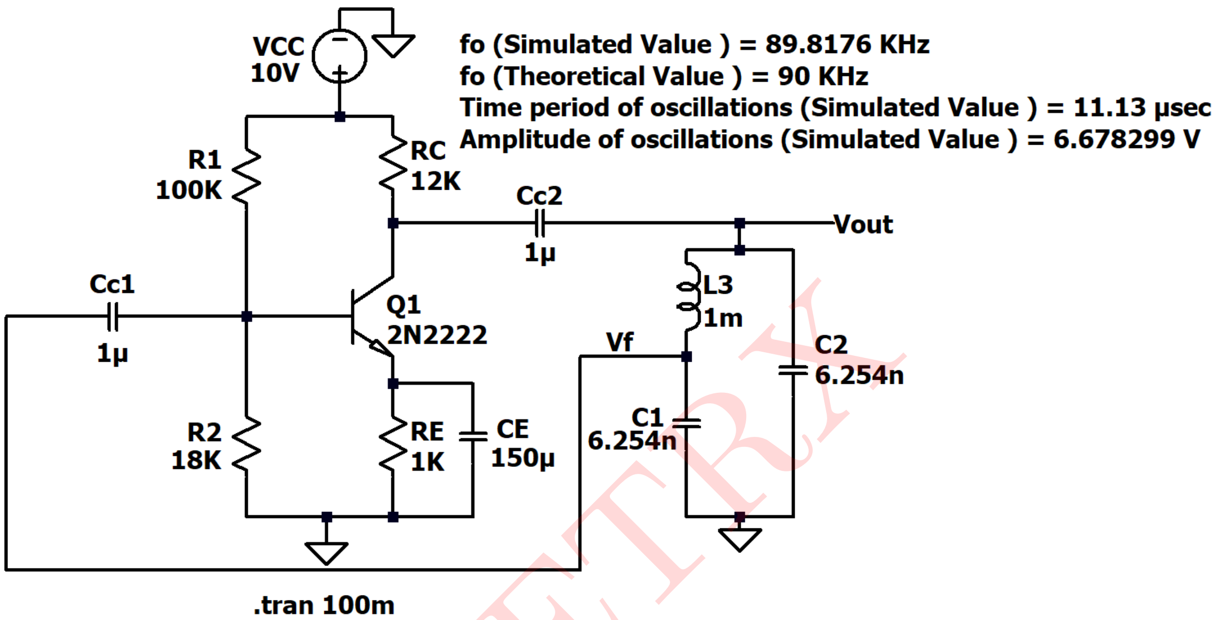

Figure 3: Circuit Schematic

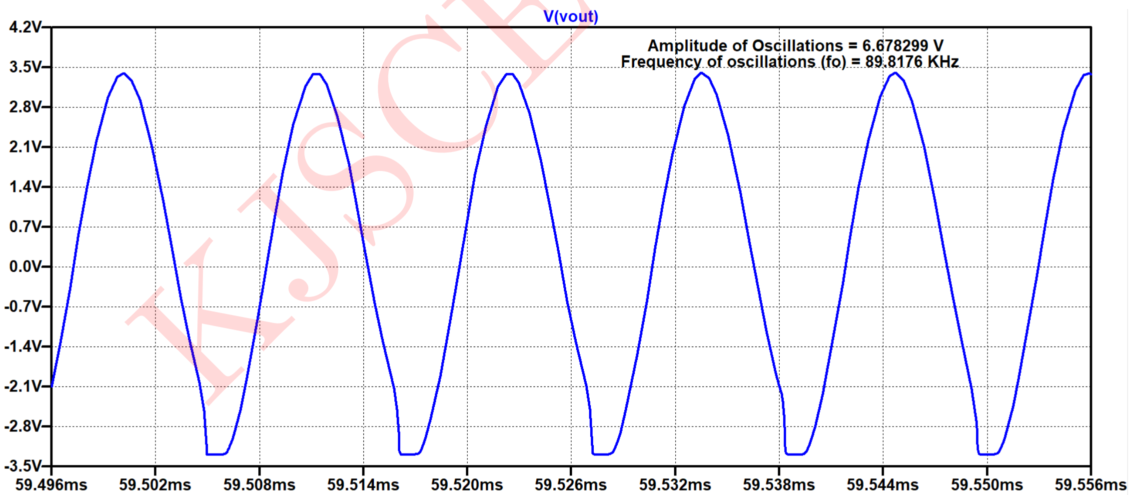

Figure 4: Output voltage waveform

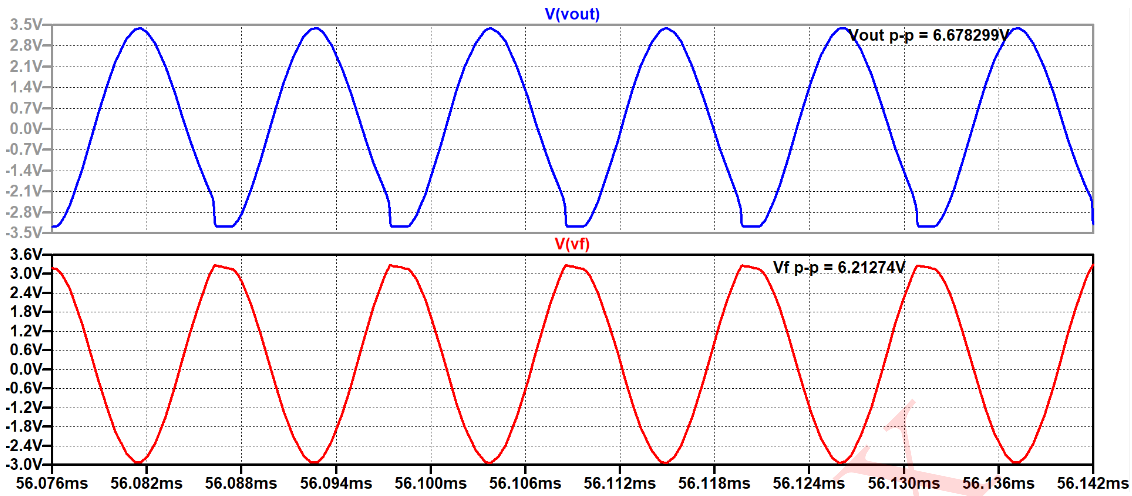

Figure 5: Phase shift between output voltage and feedback voltage

Comparison between Theoretical and Simulated values :-

Parameters	Theoretical	Simulated
Frequency of oscillations (f_o)	90kHz	89.8176kHz
Time period of oscillations	11.11μsec	11.13μsec
Amplitude of oscillations	–	6.6783V
Feedback signal V_f amplitude	–	6.21274V
Feedback fraction	1	0.93
Phase shift offered by tank circuit	180°	180°

Table 1: Numerical 1

Numerical 2: In a colpitt's Oscillator, amplifier components are $R_1 = 100k$, $R_2 = 18k$, $R_C = 12k$, $R_E = 1k$, $C_{C1} = 1\mu F$, $C_E = 150\mu F$, $C_{C2} = 1\mu F$, $V_{CC} = 10V$. Select the LC tank circuit such that frequency of oscillations is close to 550kHz.
BJT transistor: 2N2222
Also comment on the phase shift offered by LC Tank circuit.

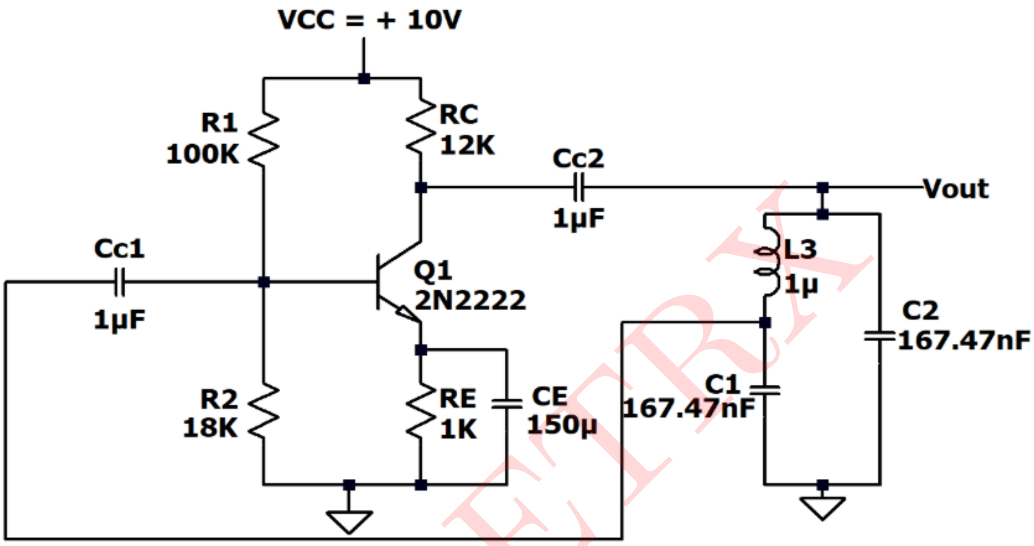

Figure 6: Circuit 2

Solution:

Frequency of oscillations for a Colpitt's Oscillator is given as:

$$f_o = \frac{1}{2\pi\sqrt{C_{eq}L_3}}$$

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

Let $L_3 = 1\mu H$

Since we want the frequency of oscillations to be close to 90kHz

$f_o \approx 550kHz$

$$\therefore 550 \times 10^3 = \frac{1}{2\pi\sqrt{10^{-6} \times C_{eq}}}$$

$$\therefore 10^{-6} \times C_{eq} = \frac{1}{(550 \times 10^3 \times 2\pi)^2}$$

$$\therefore C_{eq} = \frac{10^6}{(90 \times 10^3 \times 2\pi)} = \mathbf{83.73nF}$$

Let $C_1 = C_2$

$\therefore C_1 = C_2 = 2 \times 83.73nF = \mathbf{167.47nF}$

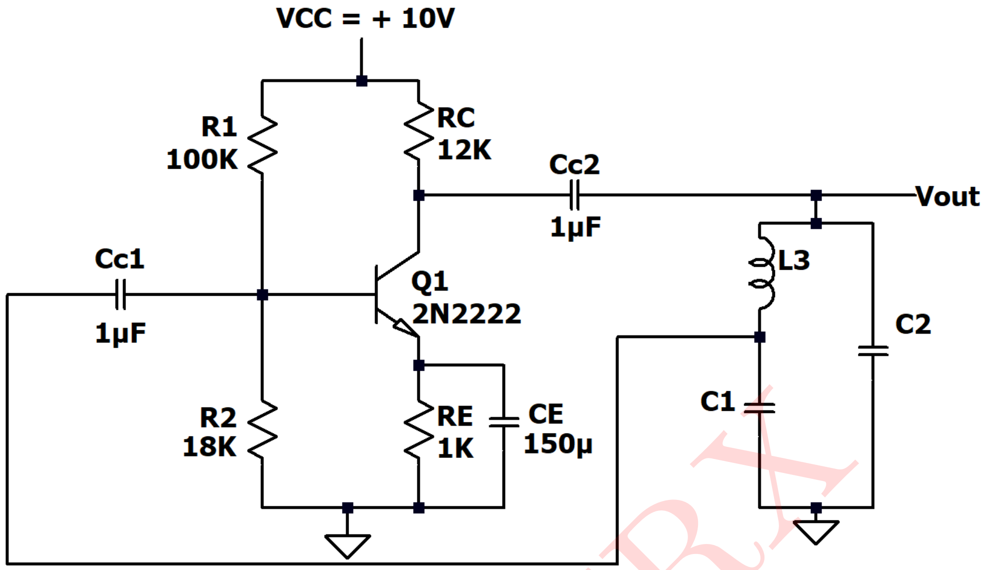

Figure 7: Colpitt's Oscillator

Frequency of oscillations = **550kHz**

$$\therefore \text{Time period of oscillations} = \frac{1}{f_o} = \frac{1}{550 \times 10^3} = \mathbf{1.818\mu sec}$$

$$\text{Feedback fraction (K)} = \frac{V_f}{V_o} = \frac{IX_{C2}}{IX_{C1}} = \frac{C_1}{C_2} = \frac{167.47 \times 10^{-9}}{167.47 \times 10^{-9}} = \mathbf{1}$$

Feedback fraction = 1
Phase shift provided by common emitter amplifier is 180°
Phase shift provided by the LC tank circuit is 180°
So the total phase shift of the entire circuit is 360°(or 0°)
Thus, the total phase shift = 360°(or 0°)

SIMULATED RESULTS:

Above circuit is simulated in LTspice and the result is as follows:

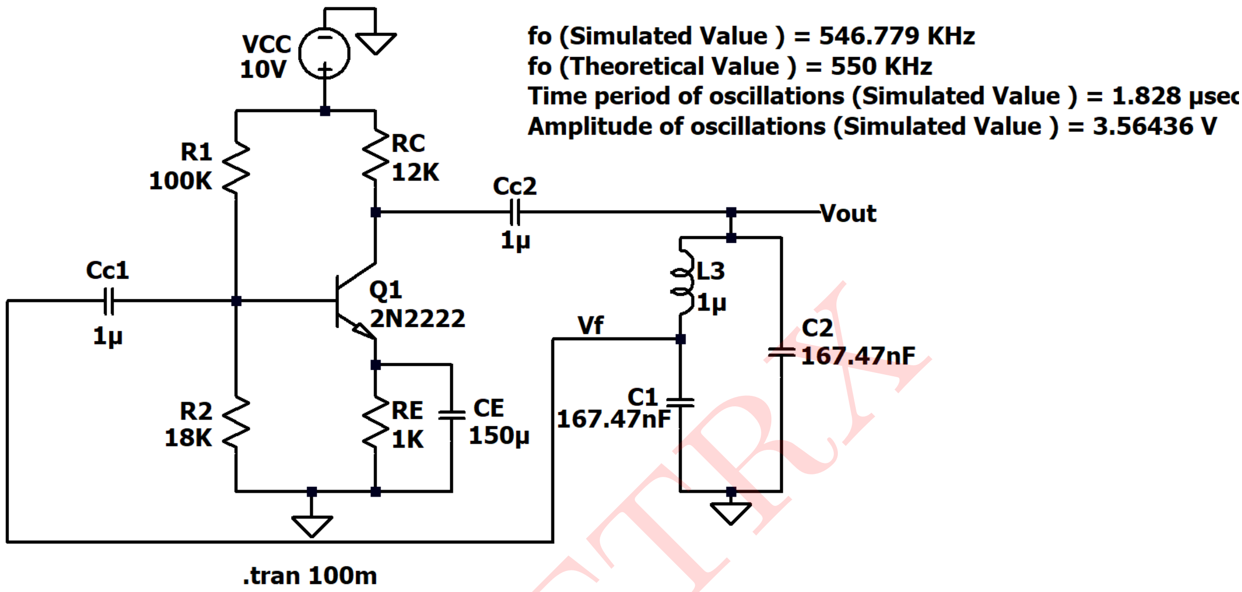

Figure 8: Circuit Schematic

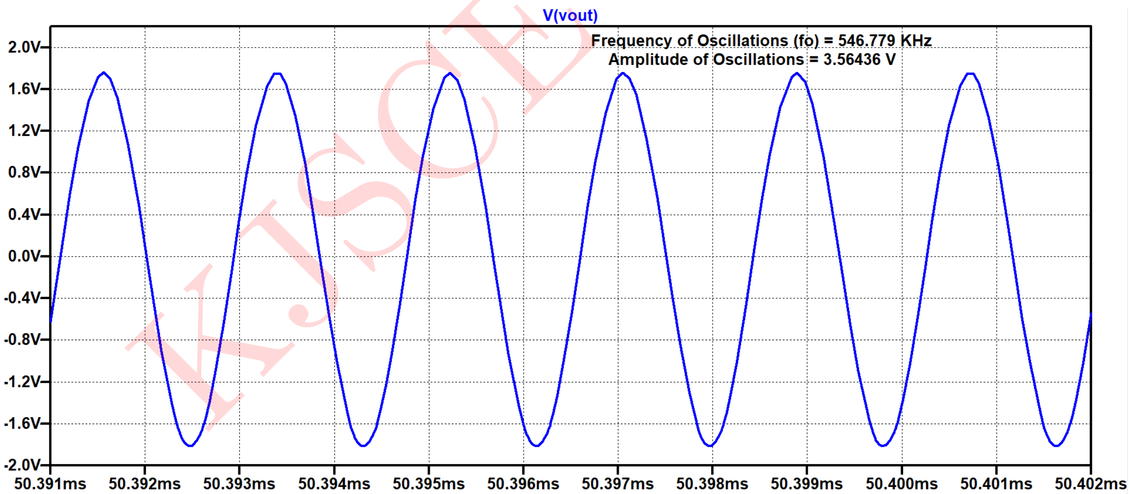

Figure 9: Output voltage waveform

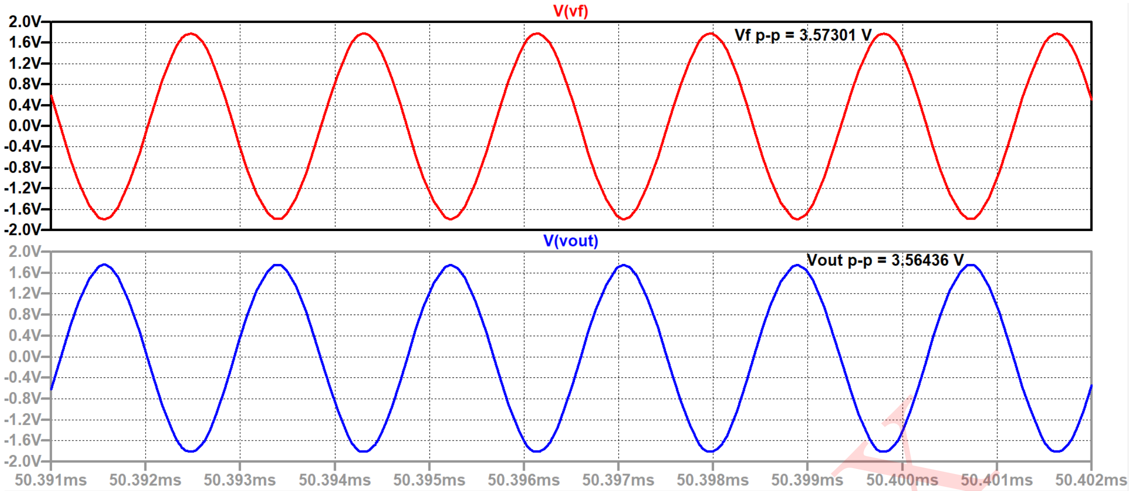

Figure 10: Phase shift between output voltage and feedback voltage

Comparison between Theoretical and Simulated values :-

Parameters	Theoretical	Simulated
Frequency of oscillations (f_o)	550kHz	546.779kHz
Time period of oscillations	1.818μsec	1.828μsec
Amplitude of oscillations	—	3.5644V
Feedback signal V_f amplitude	—	3.5730V
Feedback fraction	1	1
Phase shift offered by tank circuit	180°	180°

Table 2: Numerical 2

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