INDIAN INSTITUTE OF SCIENCE, BENGALURU

DEPARTMENT OF ELECTRONIC SYSTEMS ENGINEERING

DESIGN FOR ANALOG CIRCUITS LABORATORY REPORT

ASSIGNMENT 8

OSCILLATORS

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1.1 Aim

To design and perform transient simulation of Relaxation Oscillator.

1.2 Schematic

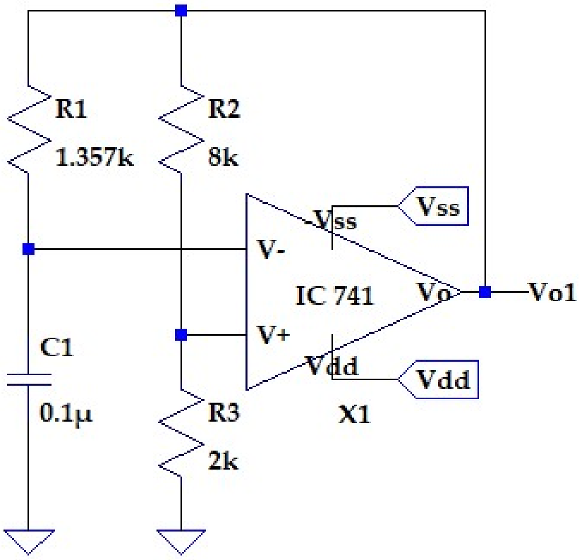

Figure 1: LTSpice schematic of Relaxation Oscillator

1.3 Component Selection

The transfer characteristics of the schmidt trigger in the circuit is given by

$$V_o = \begin{cases} -V_{sat} & \text{, if } V_i \geq \frac{+V_{sat}R_3}{R_2+R_3} \\ +V_{sat} & \text{, if } V_i \leq \frac{-V_{sat}R_3}{R_2+R_3} \end{cases}$$

In the simulation setup $\pm 10V$ supply is used. To set the threshold points as $\pm 2V$, $R_2 = 8k\Omega, R_3 = 2k\Omega$ is chosen. The time period of the oscillator in this case is given by

$$\delta t = 2R_1C_1 \ln\left(\frac{V_{sat}+2}{V_{sat}-2}\right)$$

For getting $f = 4545Hz$, $R_1 = 1.357k\Omega, C = 0.1\mu F$ is chosen.

1.4 Transient simulation waveforms

The figure 2 shows the output and the schmidt trigger input voltage waveforms, and figure 3 shows the FFT of the output voltage. The obtained frequency is 5kHz.

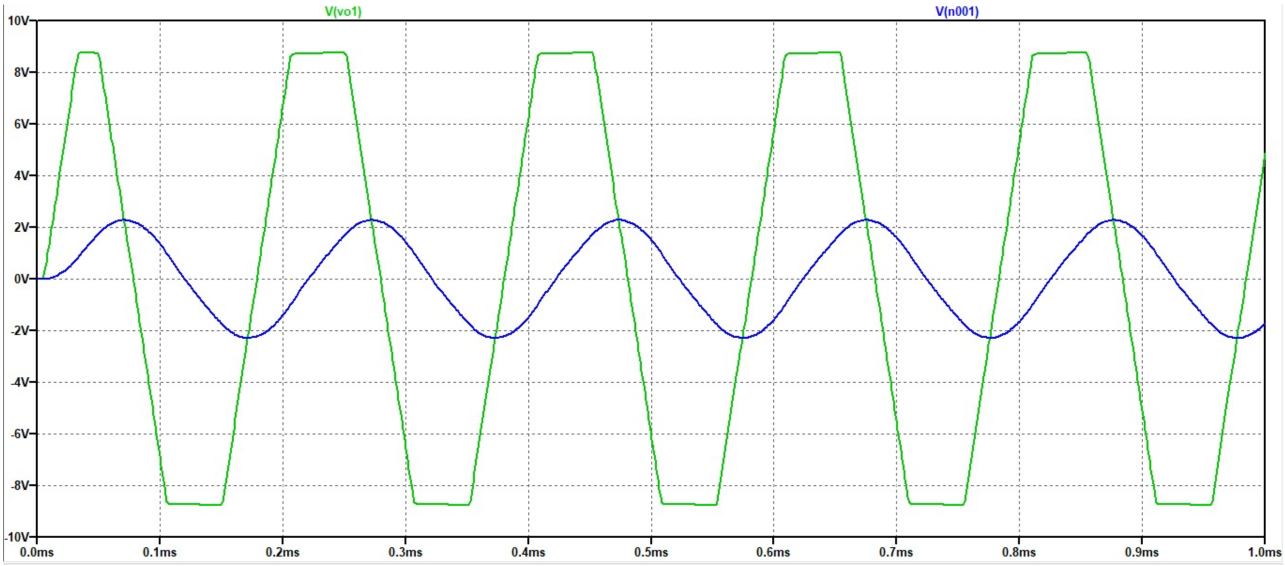

Figure 2: Transient Simulation of Relaxation Oscillator

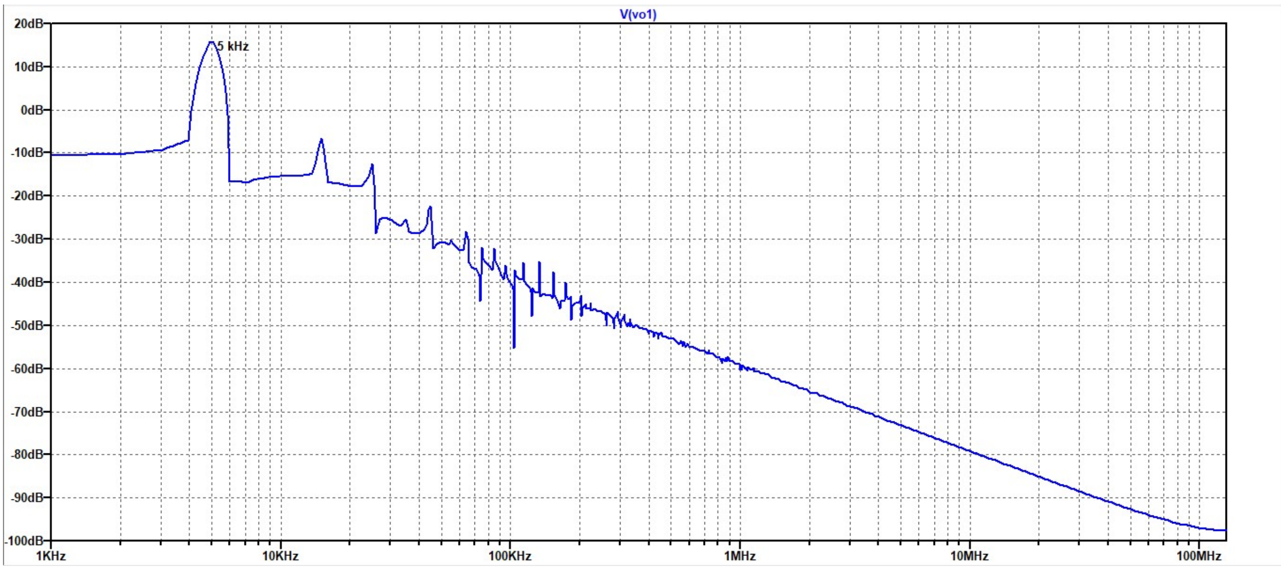

Figure 3: FFT of Relaxation Oscillator output

2 Phase Shift Oscillator

2.1 Aim

To design and perform transient simulation of Phase Shift Oscillator.

2.2 Schematic

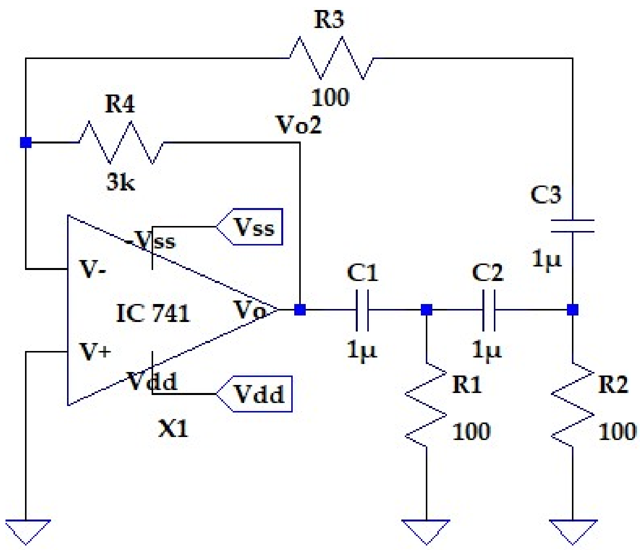

Figure 4: LTSpice schematic of Phase Shift Oscillator

2.3 Component Selection

The frequency of oscillation of the phase shift oscillator is given by

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

Where $R_1 = R_2 = R_3 = R$, and $C_1 = C_2 = C_3 = C$. For obtaining a frequency of 650 Hz, $R = 100\Omega, C = 1\mu F$ is chosen. R_4 is chosen to be $3k\Omega$ to obtain a loop gain slightly greater than 1.

2.4 Transient simulation waveforms

Figure 5 shows the transient simulation waveforms of the phase shift oscillator after amplitude stabilisation, and figure 6 shows the FFT of the oscillator output. The oscillation frequency obtained is 632 Hz.

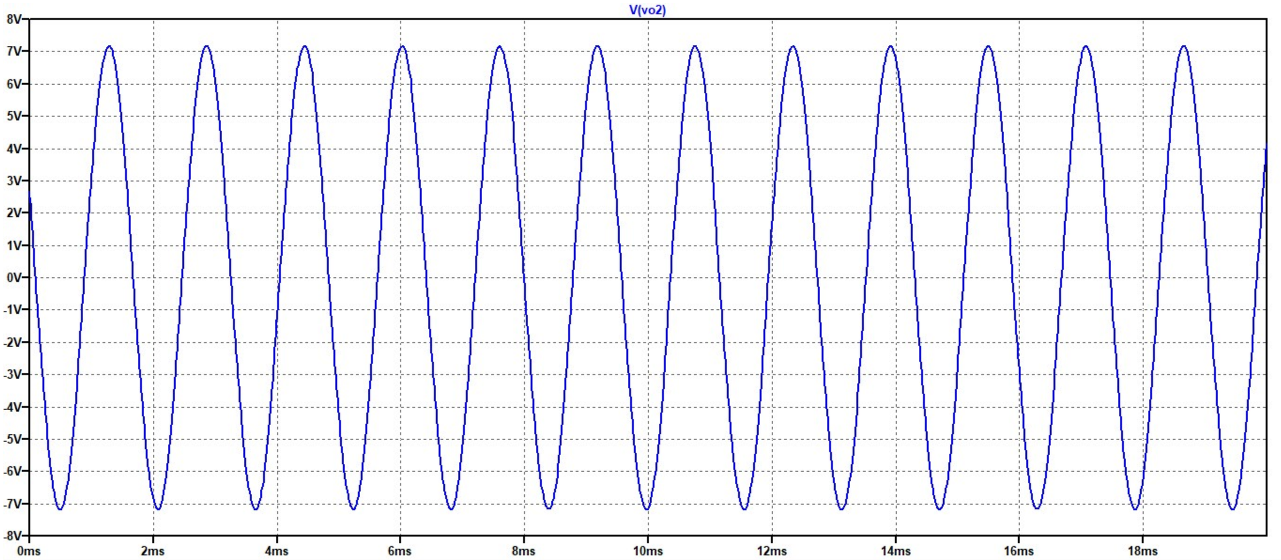

Figure 5: Transient Simulation of Phase Shift Oscillator

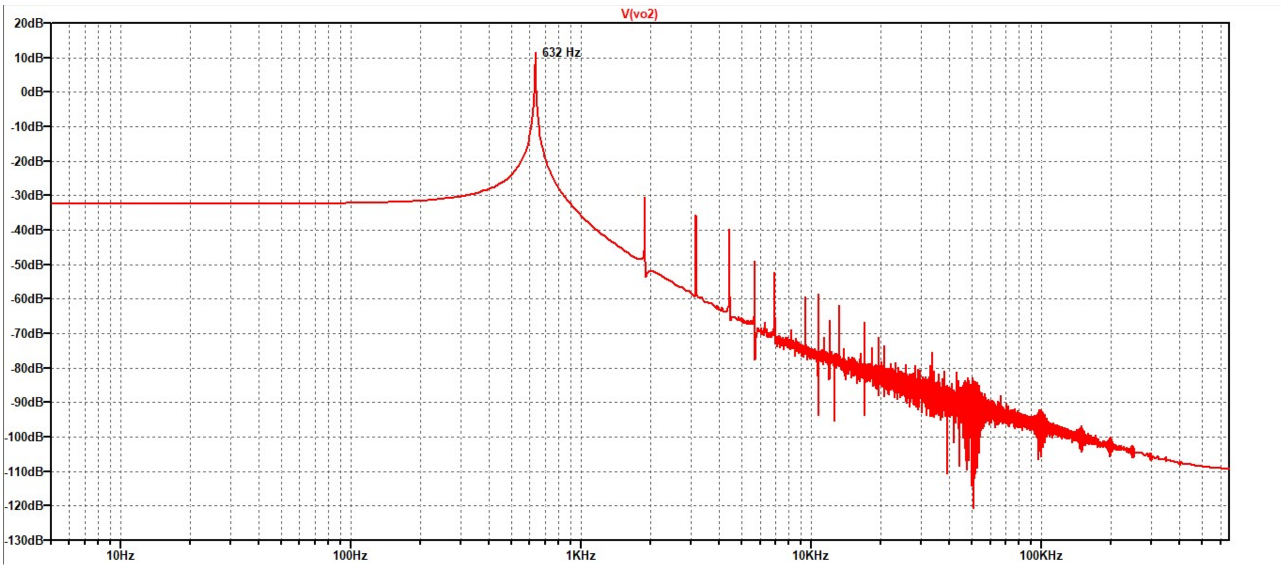

Figure 6: FFT of Phase Shift Oscillator output

3 Three Phase Oscillator

3.1 Aim

To design and perform transient simulation of Three Phase Oscillator.

3.2 Schematic

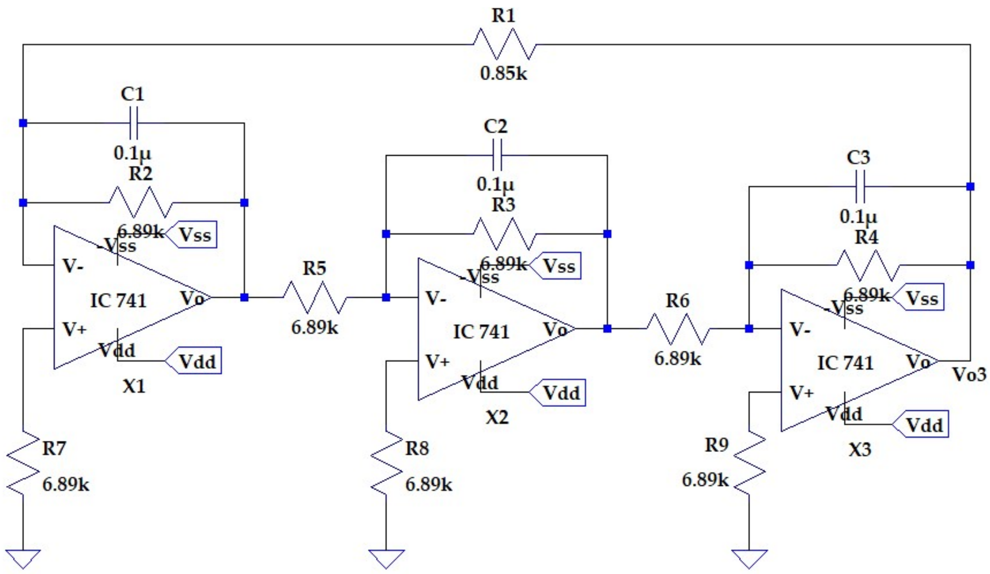

Figure 7: LTSpice schematic of Three Phase Oscillator

3.3 Component Selection

The oscillation frequency is given by

$$f = \frac{1}{2\pi\sqrt{3}RC}$$

Where $R_2 = R_3 = R_4 = R, C_1 = C_2 = C_3 = C$. For obtaining oscillation frequency of 400 Hz, $R = 6.89k\Omega, C = 0.1\mu F$ is chosen. For obtaining sustained oscillations, $R_1 = 850\Omega$ is chosen to set loop gain of 8.

3.4 Transient simulation waveforms

Figure 8 shows the transient simulation waveforms of the three phase oscillator after amplitude stabilisation , and figure 9 shows the FFT of the oscillator output. The oscillation frequency obtained is 401 Hz.

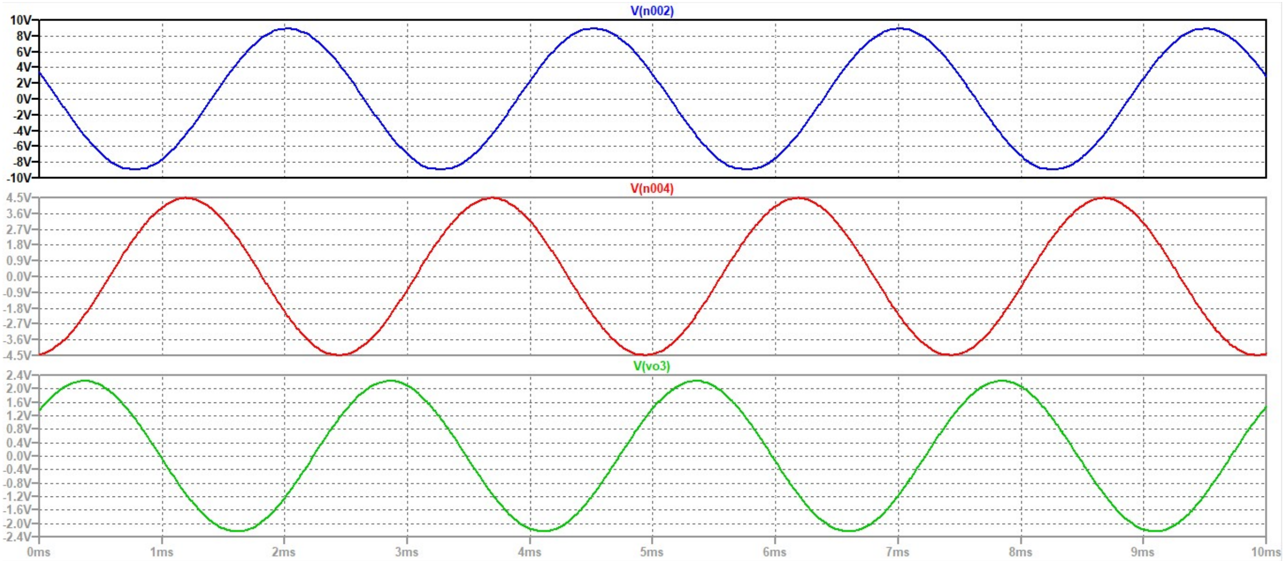

Figure 8: Transient Simulation of Three Phase Oscillator

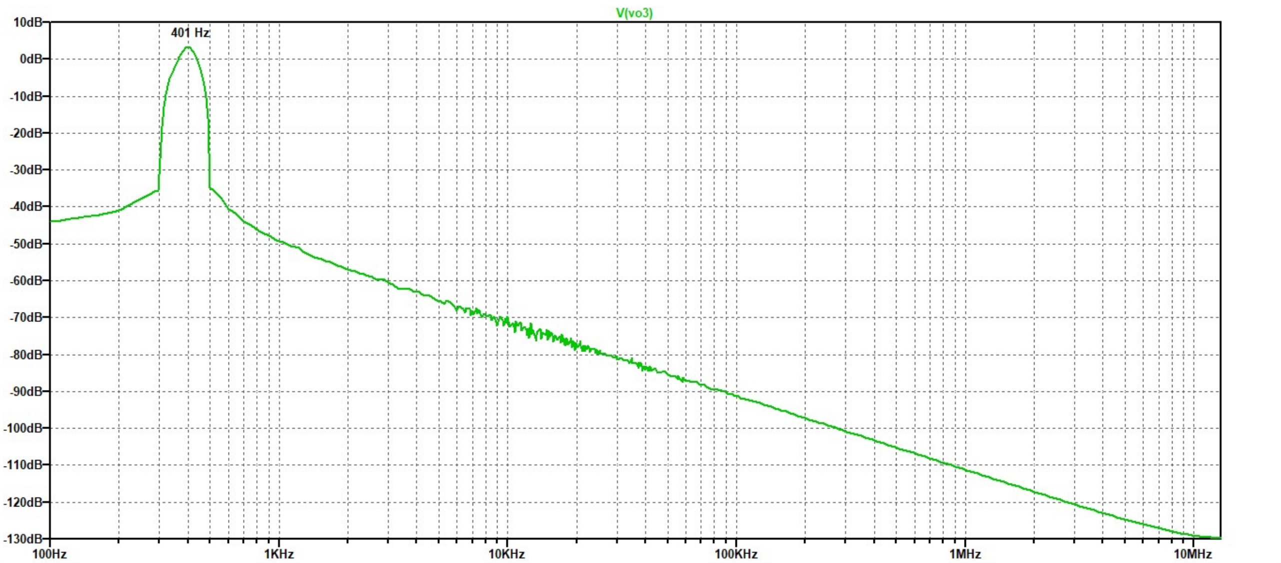

Figure 9: FFT of Three Phase Oscillator output

4 Wein Bridge Oscillator

4.1 Aim

To design and perform transient simulation of Wein Bridge Oscillator.

4.2 Schematic

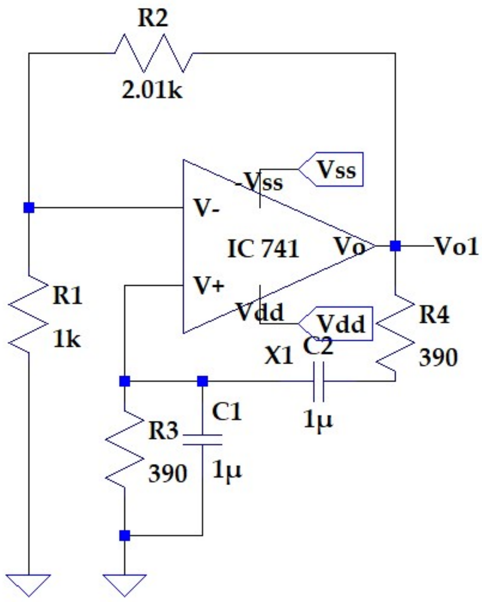

Figure 10: LTSpice schematic of Wein Bridge Oscillator

4.3 Component Selection

The frequency of oscillations is given by

$$f = \frac{1}{2\pi RC}$$

where $R_3 = R_4 = R$, $C_1 = C_2 = C$. For getting sustained oscillations $R_2/R_1 = 2$, so $R_2 = 2k\Omega, R_1 = 1k\Omega$ is chosen. $R = 390\Omega, C = 1\mu F$ is chosen for obtaining a frequency of 408 Hz.

4.4 Transient simulation waveforms

Figure 11 shows the transient simulation waveforms of the wein bridge oscillator after amplitude stabilisation , and figure 12 shows the FFT of the oscillator output. The oscillation frequency obtained is 399 Hz.

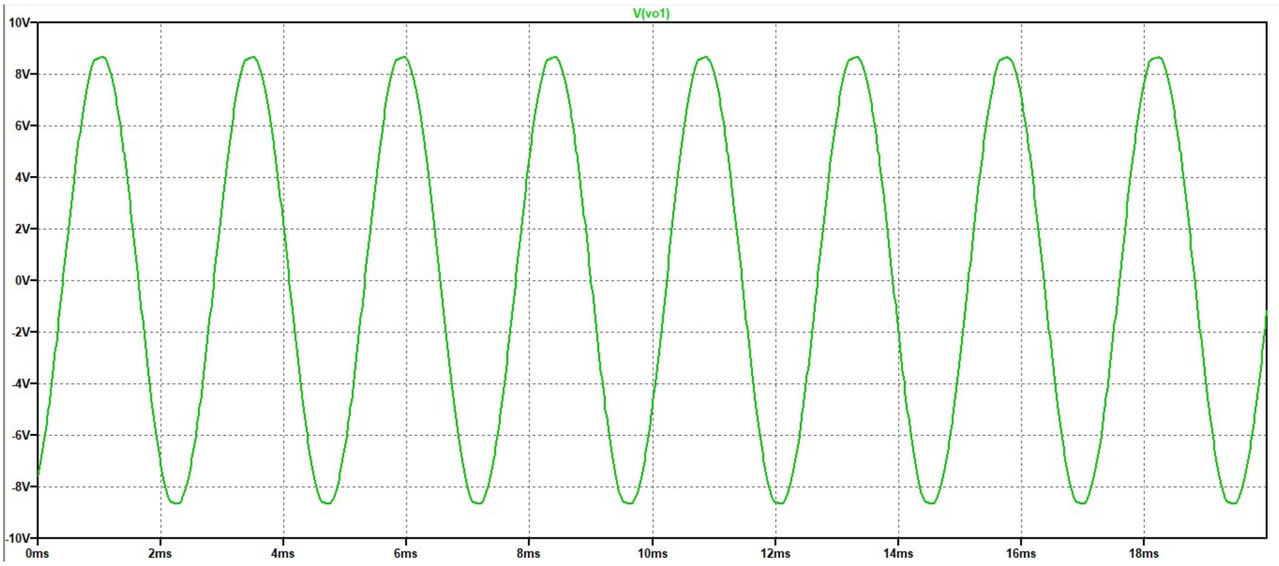

Figure 11: Transient Simulation of Wein Bridge Oscillator

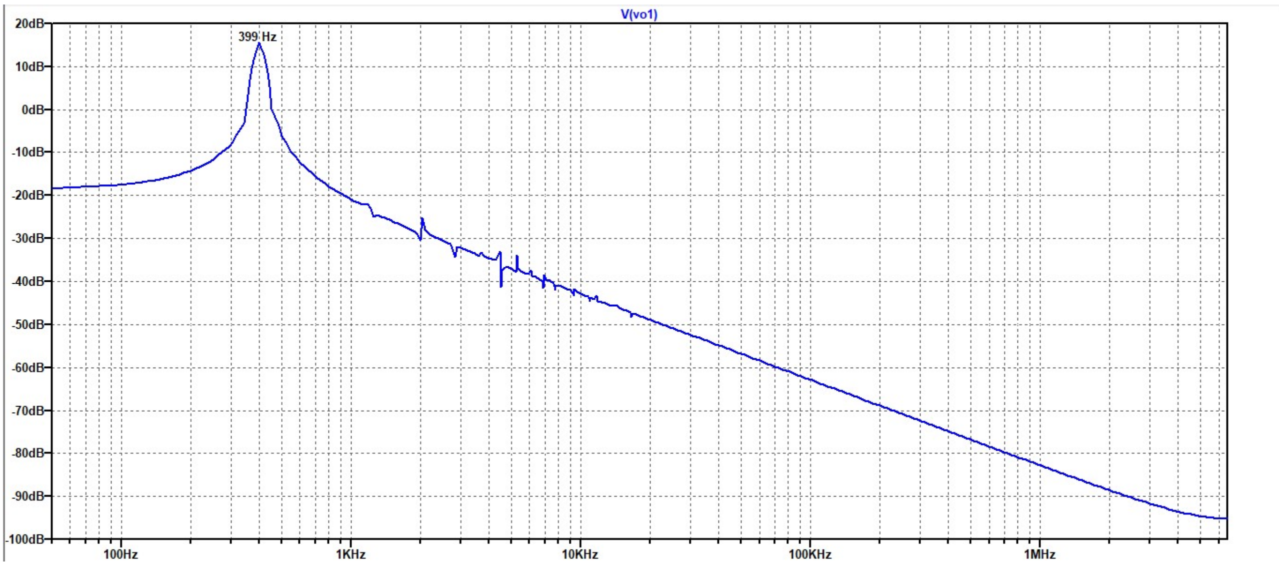

Figure 12: FFT of Wein Bridge Oscillator output

5 Conclusion

(1). The phase shift, 3 phase and wein bridge oscillators work at the condition when barkhausen criterion is satisfied and the phase shift caused in the loop is 360^o.

(2). The oscillator being a marginally stable system, it may become unstable or it might not oscillate at slight change in component values. Tuning the frequency and obtaining stable sustained oscillations over a long period of time is a challenge.

(3). The relaxation oscillator's frequency range is limited by the slew rate of the op-amp, as the schmidt trigger .