Pre Lab - Lillian Tucker

Saturday, February 25, 2023 12:21 AM

Simulate both schematics (Figure 1 and Figure 2) in LT Spice. In total, you should submit a *.PDF containing at least 8 plots (6+ transient and AC Sweep). Plots should contain a caption which states Vs settings and peak or peak-to-peak values of signals of interest (VLC and VR).

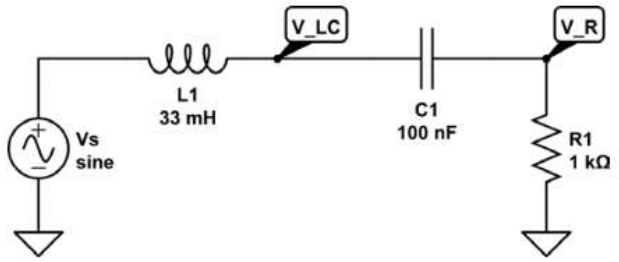


Figure 1. The default set-up for Experiment 25.

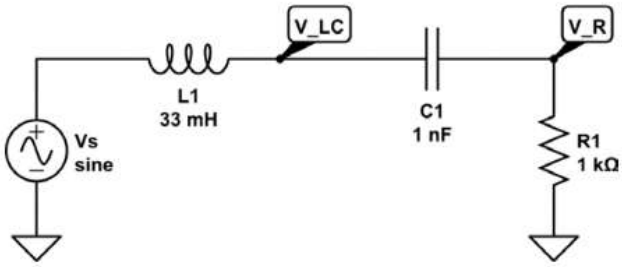
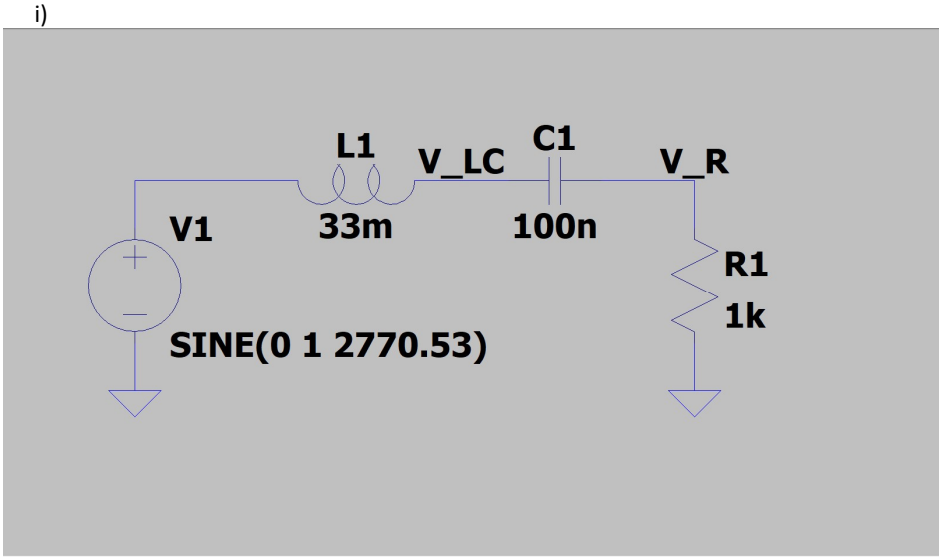


Figure 2. The additional set-up for Experiment 25.

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Figure 25-1:

i)



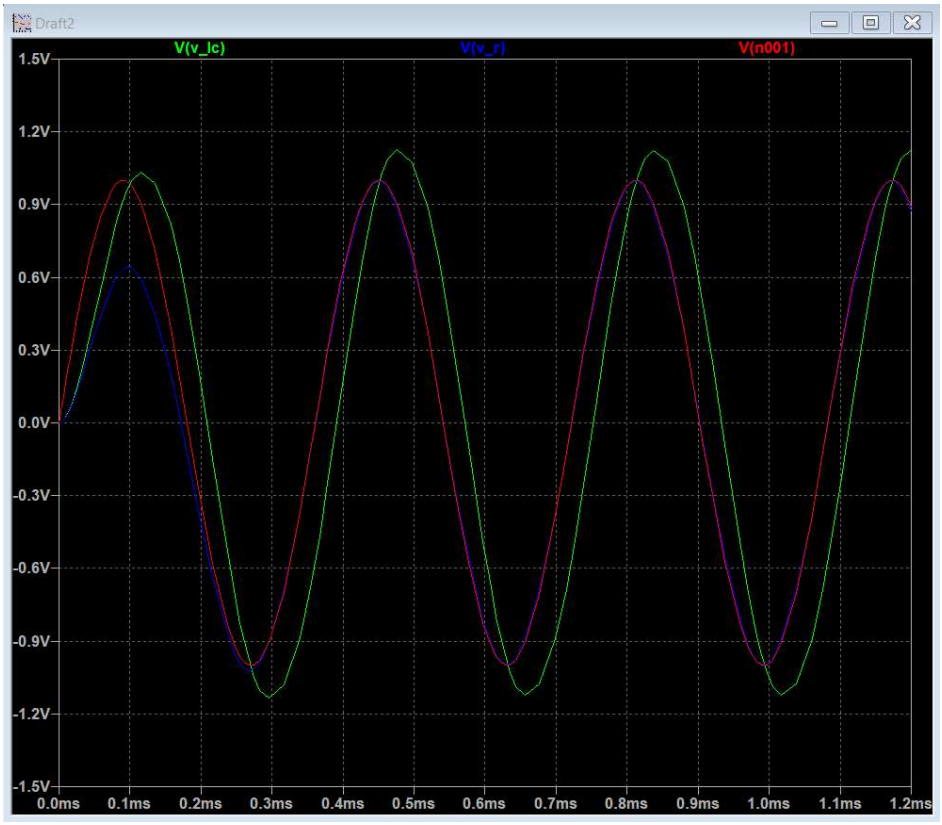


Figure 3: Figure 1 at 2770.53 Hz

Table 1	Vin	VR	VLC
Voltage (steady state) [Vp]	1	0.996	1.13
Phase Shift (degrees)	0	0	20
Frequency [Hz]	2770.53	2770.53	2772.2

Vin is set to a sine function with an amplitude of 1 Vp and 2770.53 Hz.

Figure 3 and Table 1 is at the resonance frequency of 2770.53 Hz. The voltage across the resistor is in phase and amplitude of Vin. VR starts at 0.65 Vp and takes 1 cycle to reach a steady state of 1 Vp. The voltage across the inductor and capacitor starts at a voltage of 1.03 Vp and takes one cycle to reach a steady state of 1.13 Vp and is lagging the voltage source by about 20 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

ii)

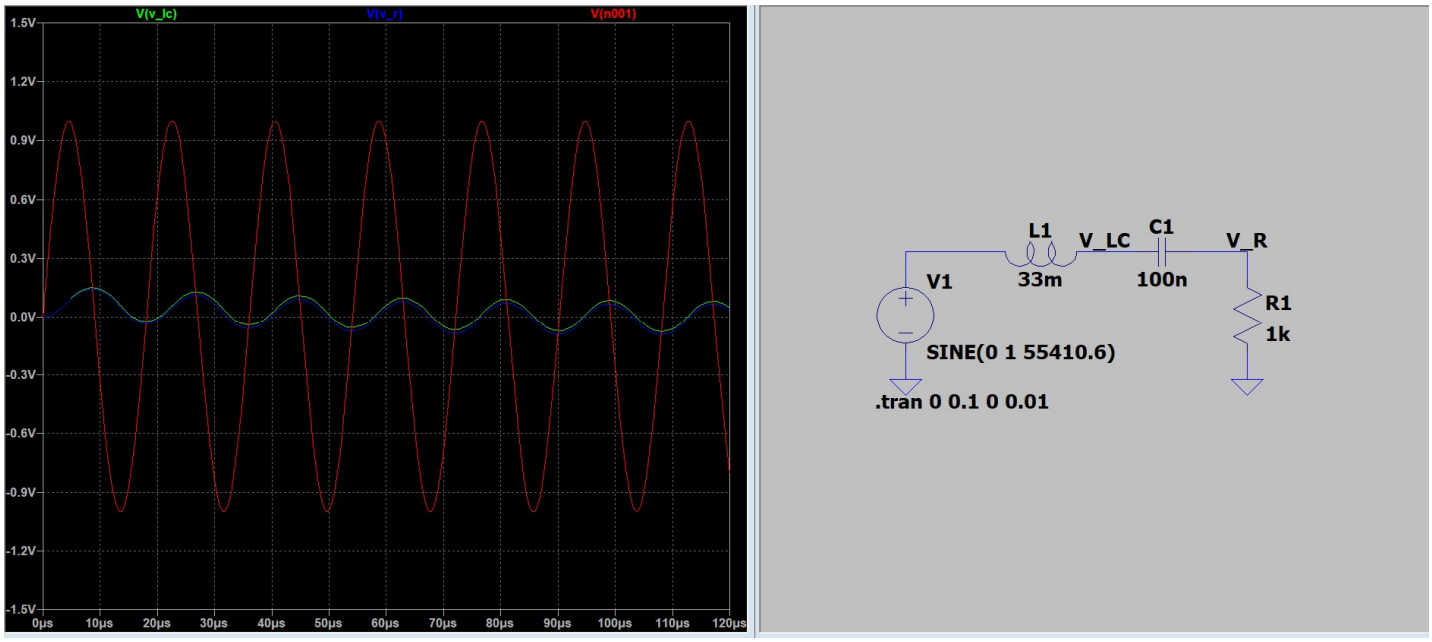


Figure 4: Figure 1 at 55410.6 Hz

Table 2	Vin	VR	VLC
Voltage (steady state) [Vp]	1	0.24	0.25
Phase Shift (degrees)	0	45	45
Frequency [Hz]	55410.6	55555.6	55493.9

Vin is set to a sine function with an amplitude of 1 Vp and 55410.6 Hz.

Figure 4 and Table 2 is at 20x the resonance frequency of 55410.6 Hz. The voltage across the resistor is in phase and amplitude of VLC. VR starts and remains at 0.24 Vp but shifts down 30 mV per cycle in the scope of 120us. This suggests there is another frequency on top of the smaller amplitude sine wave of VR. VLC starts and remains at 0.25 Vp but shifts down 25 mV per cycle in the scope of 120us. This suggests there is another frequency on top of the smaller amplitude sine wave of VLC. VR and VLC are in phase of each other but lag Vin by 45 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

iii)

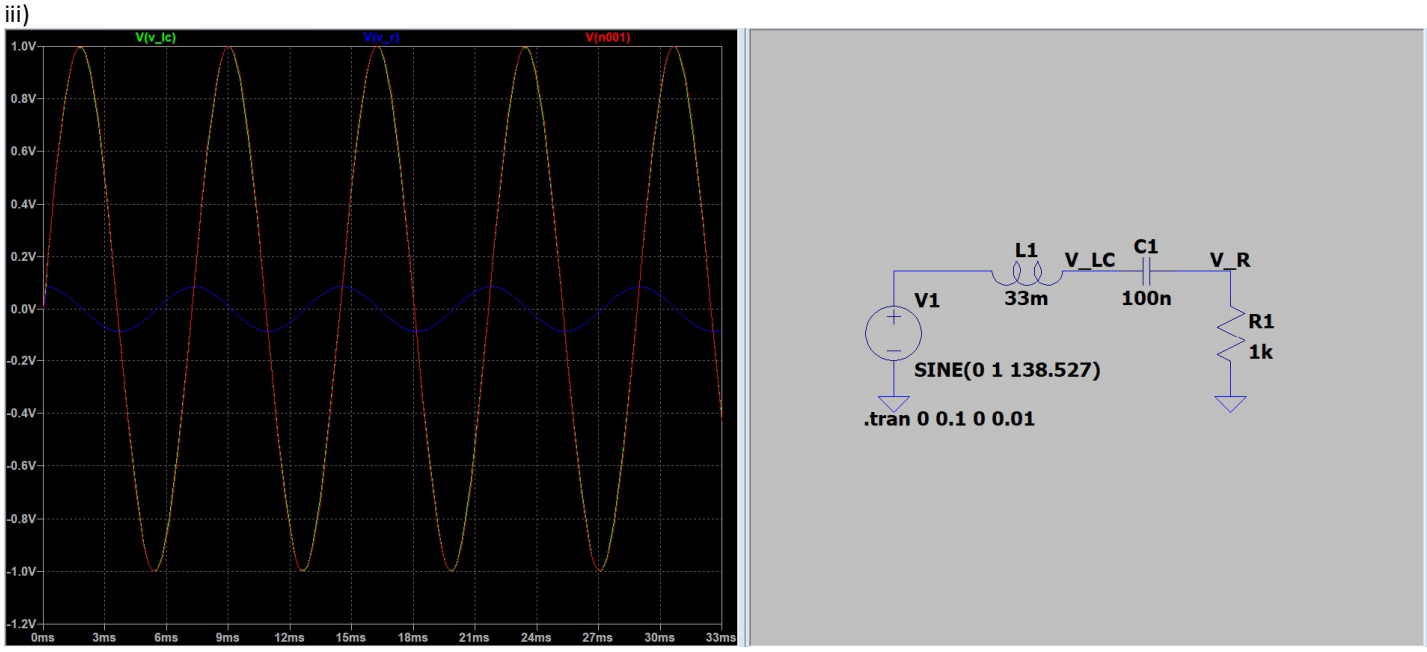


Figure 5: Figure 1 at 138.53 Hz

Table 3	Vin	VR	VLC

Voltage (steady state) [mVp]	1000	85.46	999.23
Phase Shift (degrees)	0	45	0
Frequency [Hz]	138.53	143.68	138.53

Vin is set to a sine function with an amplitude of 1 Vp and 138.53 Hz.

Figure 5 and Table 3 is at 1/20x the resonance frequency of 138.53 Hz. The voltage across the inductor is in phase and amplitude of Vin. The voltage across the inductor and capacitor starts in a steady state at 999.23 mVp. The voltage across the resistor starts in a steady state of 85.46 mVp and is lagging Vin and VLC by 45 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

2)

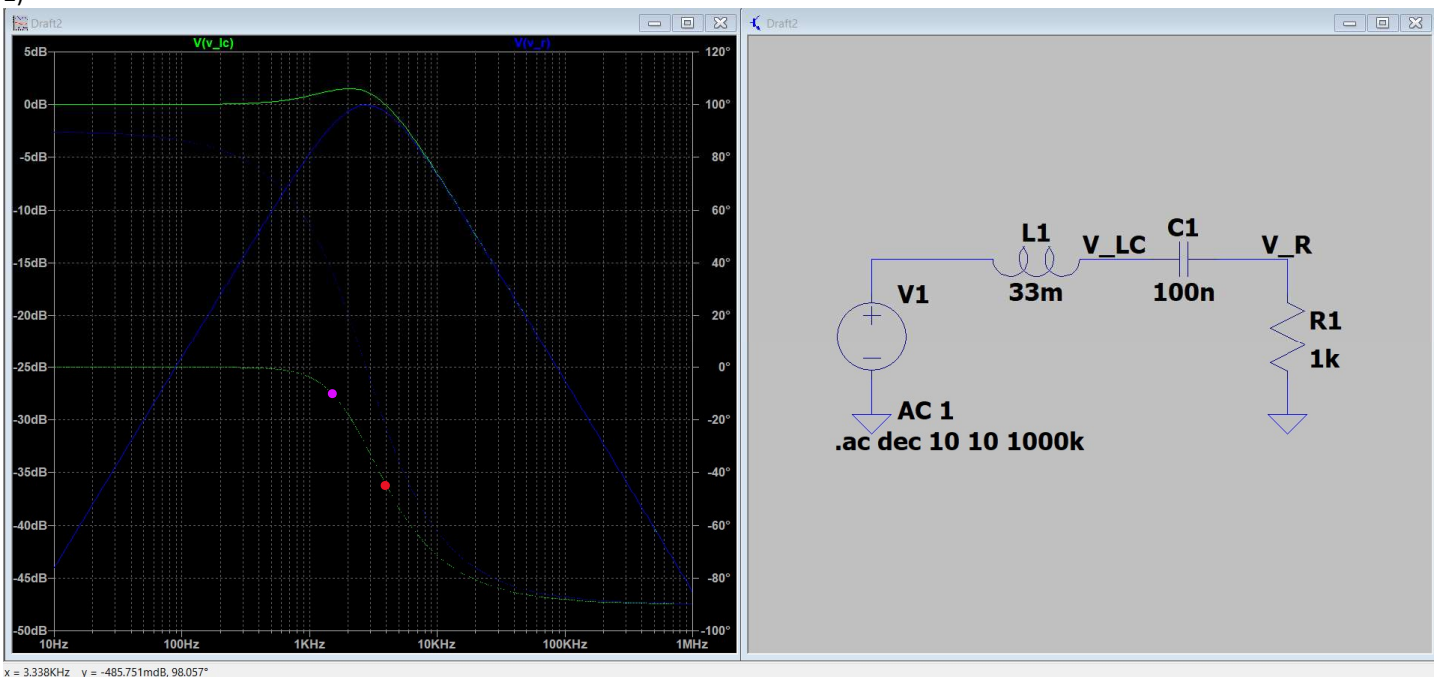


Figure 6: Figure 1 Bode Plot

- Center Frequency = $w_o = -45\ degrees = 4\ kHz$
- Corner Frequency = $f_C = \frac{1}{2\pi * RC} = \frac{1}{2\pi * 1k * 100n} = 1591.55\ Hz$

  Quality Factor = Q = $\frac{1}{wo * RC} = \frac{1}{4k * 1k * 100n} = 2.5$

Vin is set to no voltage signal type with an amplitude of 1 Vp in a small AC signal. The AC analysis was set to measure 10 points very decade from 10 Hz to 1 MHz.

Figure 25-2:

i)

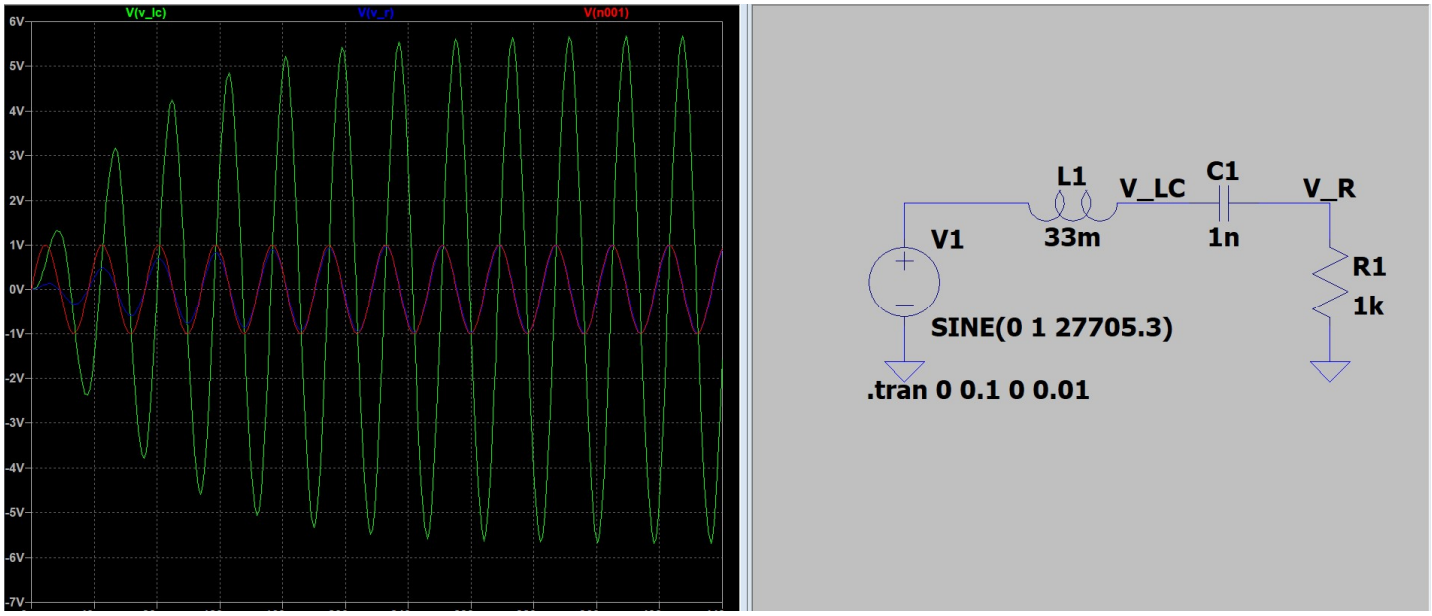


Figure 7: Figure 2 at 27705.3 Hz

Table 4	Vin	VR	VLC
Voltage (steady state) [Vp]	1	0.987	5.66
Phase Shift (degrees)	0	0	45
Frequency [Hz]	27705.3	27705.3	27705.3

Vin is set to a sine function with an amplitude of 1 Vp and 27705.3 Hz.

Figure 7 and Table 4 is at the resonance frequency of 27705.3 Hz. The voltage across the resistor is in phase and amplitude of Vin. VR starts at 0.134 Vp and takes 5 cycles to reach a steady state of 0.987 Vp. The voltage across the inductor and capacitor starts at a voltage of 1.32 Vp and takes 5 cycles to reach a steady state of 5.66 Vp and is lagging the voltage source by 45 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

ii)

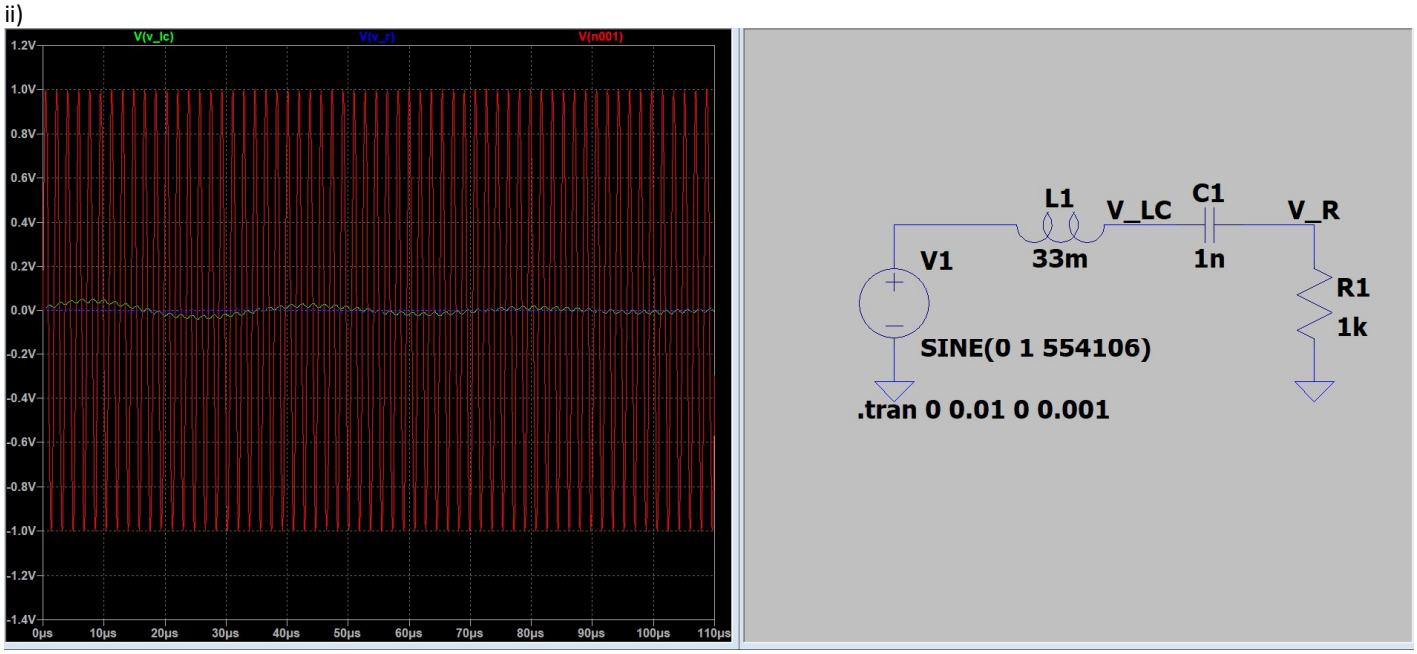


Figure 8: Figure 2 at 554106 Hz (zoomed out to 110us)

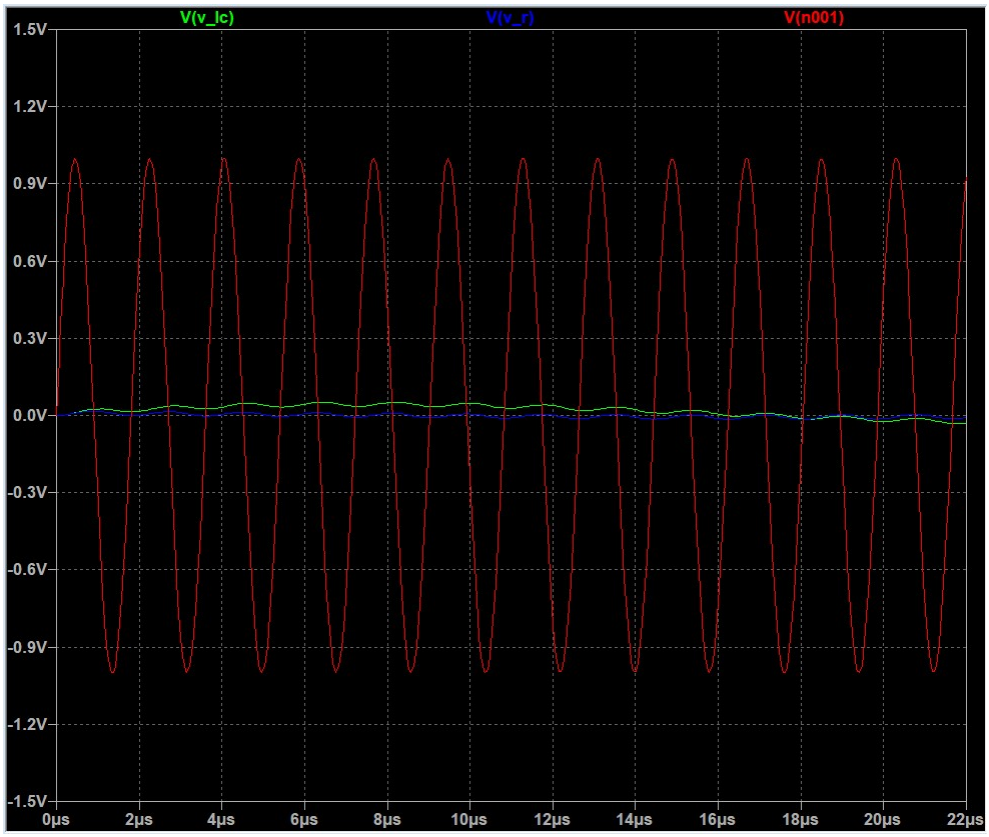


Figure 9: Figure 2 at 554106 Hz (zoomed into 22us)

Table 5	Vin	VR	VR (large initial)	VLC (small)	VLC (large initial)
Voltage (steady state) [mVp]	1000	10.31	10.31	9.95	20.25
Phase Shift (degrees)	0	45	0	45	0
Frequency [Hz]	554106	552486	27708	540541	27708

Vin is set to a sine function with an amplitude of 1 Vp and 554106 Hz.

Figure 8 and 9 and Table 5 is at 20x the resonance frequency of 554106 Hz. The voltage across the resistor is in phase with VLC. VR starts and remains at 10.31 mVp but oscillates between -5 mVp and 10 mVp in the scope of 22us in figure 9. This suggests there is another frequency on top of the smaller amplitude sine wave of VR. In figure 8, it can be noted that there is an additional VR frequency of 10.3 mVp and 27708 Hz which is close to the resonance frequency. It takes 5 cycles for this additional frequency to diffuse and reach a steady state. VLC starts and remains at 9.95 mVp but oscillates between -7.46 mVp and 9.95 mVp in the scope of 22us in figure 9. This suggests there is another frequency on top of the smaller amplitude sine wave of VLC. In figure 8, it can be noted that there is an additional VLC frequency of 9.95 mVp and 27708 Hz which is close to the resonance frequency. It takes 5 cycles for this additional frequency to diffuse and reach a steady state. VR and VLC are in phase of each other but lag Vin by 45 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

iii)

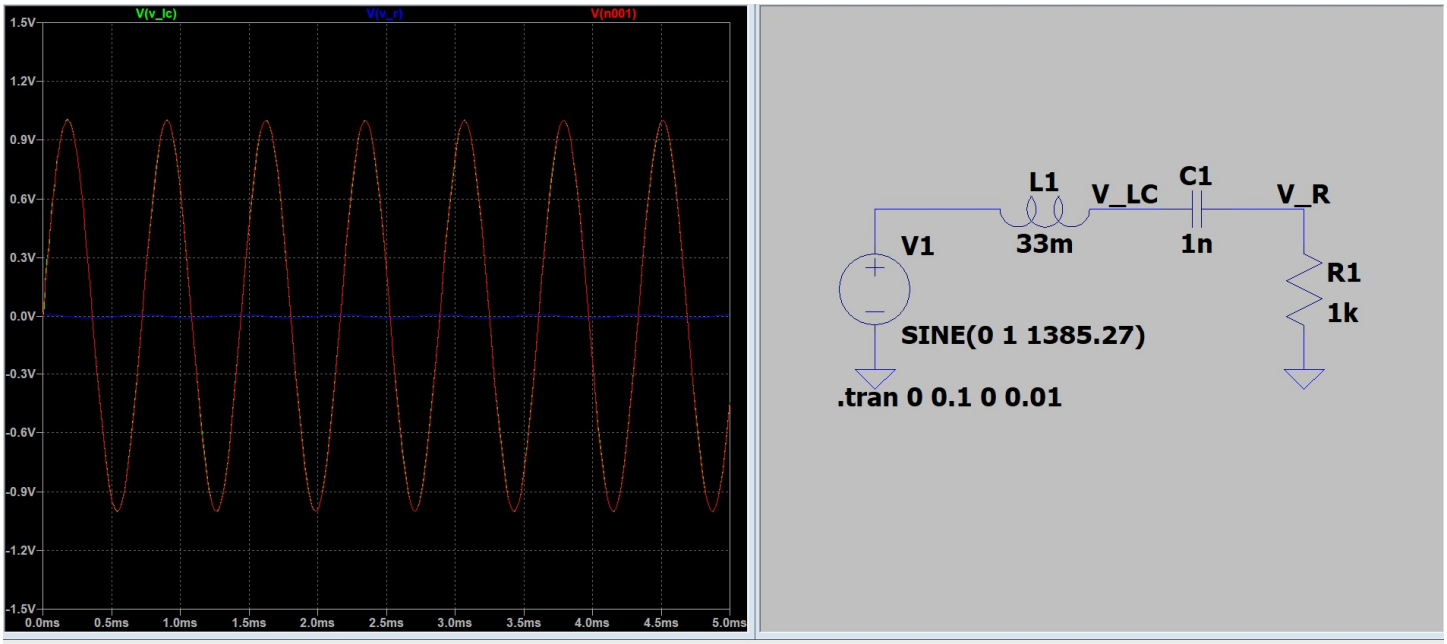


Figure 10: Figure 2 at 1385.27 Hz

Table 6	Vin	VR	VLC
Voltage (steady state) [mVp]	1000	8.60	1006
Phase Shift (degrees)	0	45	0
Frequency [Hz]	1385.27	1369.86	1382.09

Vin is set to a sine function with an amplitude of 1 Vp and 1382.09 Hz.

Figure 10 and Table 6 is at 1/20x the resonance frequency of 1385.3 Hz. The voltage across the inductor is in phase and amplitude of Vin. The voltage across the inductor and capacitor starts in a steady state at 1006 mVp. The voltage across the resistor starts in a steady state of 8.60 mVp and is lagging Vin and VLC by 45 degrees. The frequencies of all 3 voltage signals are approximately equivalent.

2)

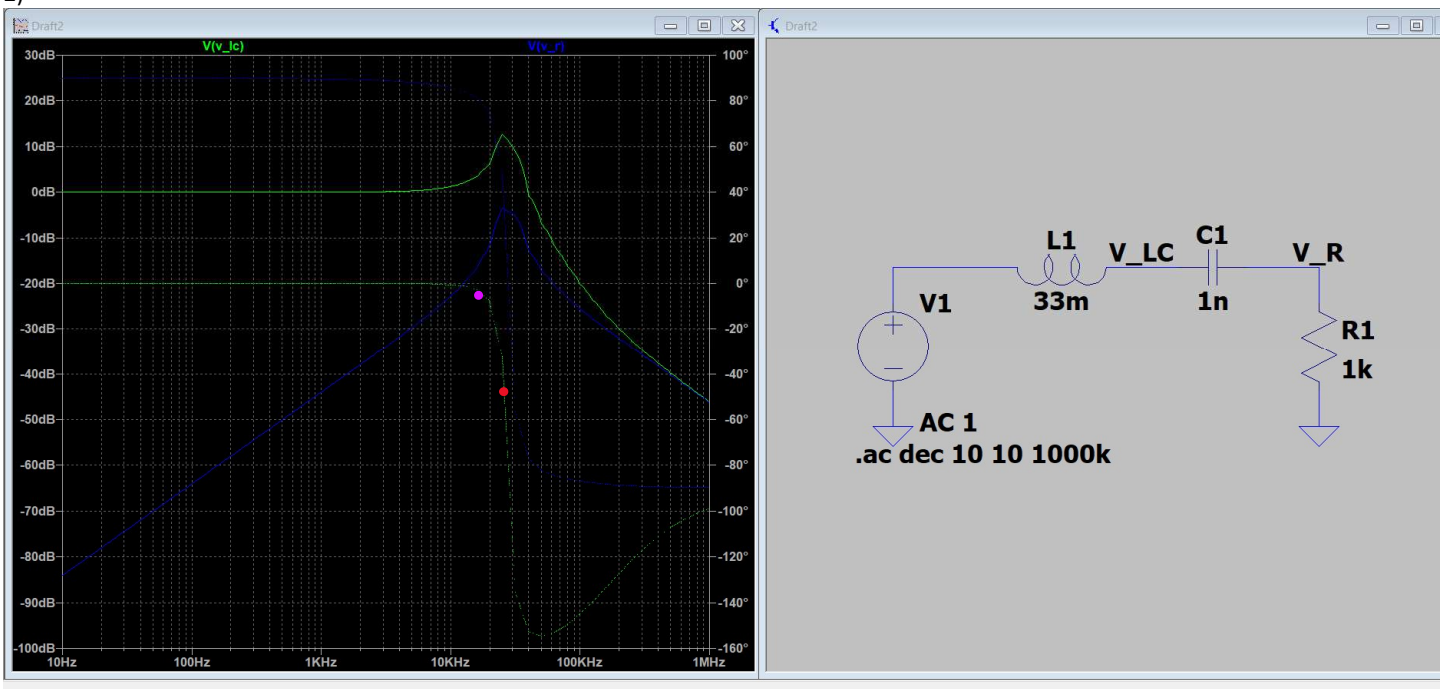


Figure 11: Figure 2 Bode Plot

- Center Frequency = $w_o = -45\ degrees = 27\ kHz$

Figure 11: Figure 2 Bode Plot

- Center Frequency = $w_o = -45\ degrees = 27\ kHz$
- Corner Frequency = $f_C = \frac{1}{2\pi * RC} = \frac{1}{2\pi * 1k * 1n} = 15.9\ Hz$

  Quality Factor = Q = $\frac{1}{wo * RC} = \frac{1}{27k * 1k * 100n} = 37.4$

  Vin is set to no voltage signal type with an amplitude of 1 Vp in a small AC signal. The AC analysis was set to measure 10 points very decade from 10 Hz to 1 MHz.