ECE113|BASIC ELECTRONICS
Dr. S.S.Jamuar
Lab_4:
Student Name : Shivam Agarwal
Roll No. : 2020123
Date : 11/7/2021

AIM 1 : Observing the step response of the RLC circuit and obtaining the period of oscillation, time constant and peak overshoot and comparing it with theoretical value

Components Used : voltage source ,resistor ,inductor, capacitor , wires.

Software used : LTspice

Undamped natural frequency:

Undamped natural freq.

$$\omega_n = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{62nF \times 9.6mH}}$$

$$= 40989.11$$

Critical resistance :

Critical resistance →

So Damping factor = 1

$$\xi = \frac{R}{2}\sqrt{\frac{C}{L}}$$

$$1 = \frac{R}{2}\sqrt{\frac{62\,nF}{9.6\,mH}}$$

$$R = 2\sqrt{\frac{9.6\,mH}{62\,nF}}$$

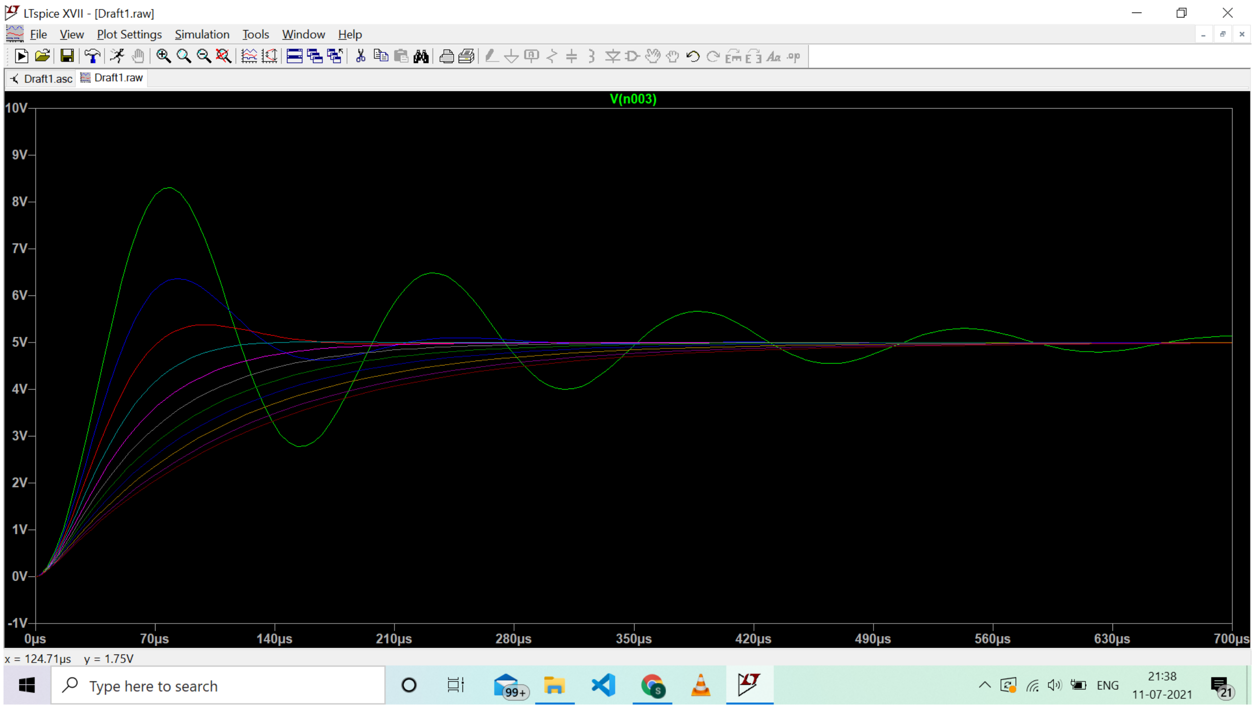
$$= 787\,\Omega$$

However $R = R_{resistor} + R_{inductor}$

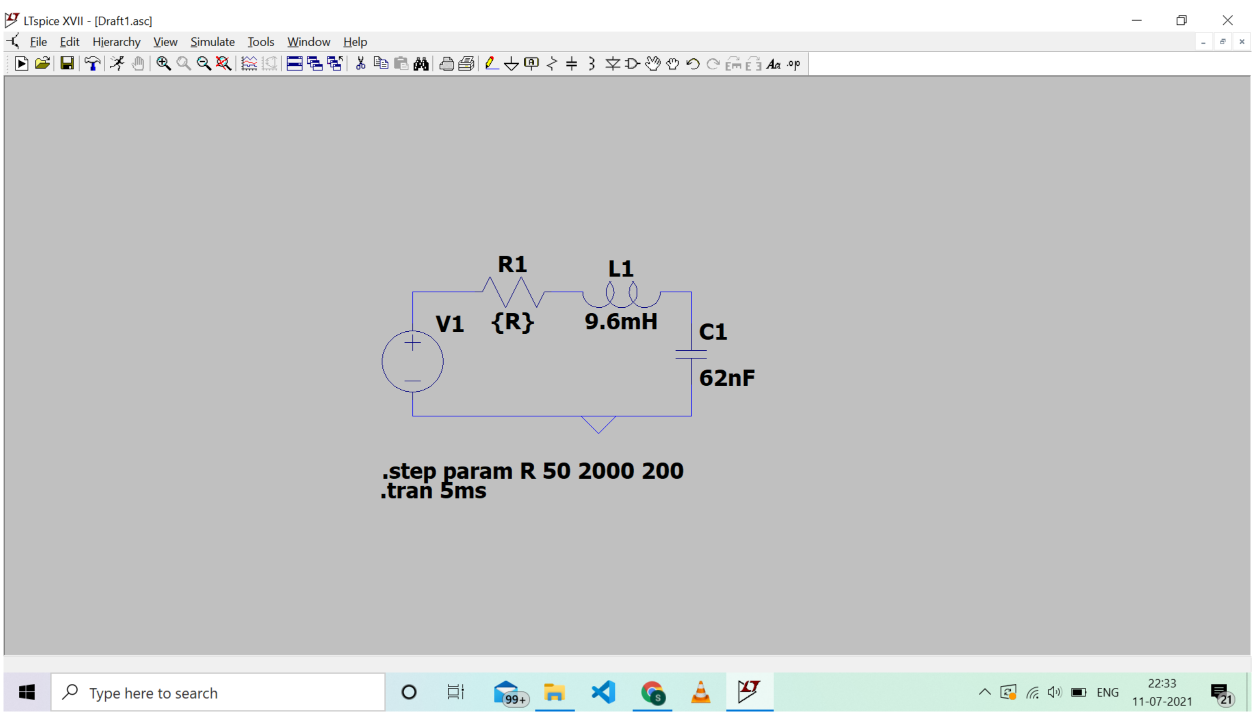
$$R_{resistor} = R - 50$$

$$= 737\,\Omega$$

Waveform :



Circuit Diagram



Theoretical calculations(for different values of R**) :**

1) For R = 50 ohm

For $R = 50\,\Omega$.

$R_{eq} = 50 + 50 = 100\,\Omega$.

Damping factor $= \frac{R_{eq}}{2}\sqrt{\frac{C}{L}}$

$= 0.127$.

Time Period $= \frac{2\pi}{\omega_n\sqrt{1-\xi^2}}$

$= \frac{2\pi}{40989.11\sqrt{1-0.127^2}}$

$= 154.54\,\mu s$.

Peak overshoot $= e^{-\frac{\pi\xi}{\sqrt{1-\xi^2}}}$

$M_p = e^{-\frac{\pi(0.127)}{\sqrt{1-0.127^2}}}$

$= 0.6688$

$M_p\% = 66.88\,\%$

Time constant $= \frac{2L}{R_{eq}}$

$= \frac{2 \times 9.6 \times 1}{100}$

$= 192\,\mu s$

2) For R = 250 ohm

For $R = 250\,\Omega$.

$R_{eq} = 300\,\Omega$

$$\xi_e = \frac{300}{2}\sqrt{\frac{C}{L}}$$

$$= 0.381$$

$$\text{Time period} = \frac{2\pi}{\omega_n\sqrt{1-\xi_e^2}}$$

$$= \frac{2\pi}{40989.11\sqrt{1-0.381^2}}$$

$$= 165\,\mu s$$

$$\text{Peak overshoot} = e^{-\frac{\xi_e \pi}{\sqrt{1-\xi_e^2}}}$$

$$= 0.274$$

$$M_p\% = 27.4\%$$

$$\text{Time constant} = \frac{2L}{R_{eq}}$$

$$= \frac{2\times 9.6\times 10^{-3}}{300}$$

$$= 64\,\mu s$$

3) For R = 450 ohm

For R = 450 Ω

$R_{eq} = 500\ \Omega$.

$$\xi_e = \frac{500}{2}\sqrt{\frac{C}{L}}$$

$$= 0.635$$

$$\text{Time period} = \frac{2\pi}{\omega_n\sqrt{1-\xi_e^2}}$$

$$= \frac{2\pi}{40889.11\sqrt{1-0.635^2}}$$

$$= 198.42\ \mu s$$

$$\text{Peak overshoot} = e^{-\frac{\pi \xi_e}{\sqrt{1-\xi_e^2}}}$$

$$= 0.0756$$

$$M_p\% = 7.56\ \%$$

$$\text{Time constant} = \frac{2L}{R_{eq}}$$

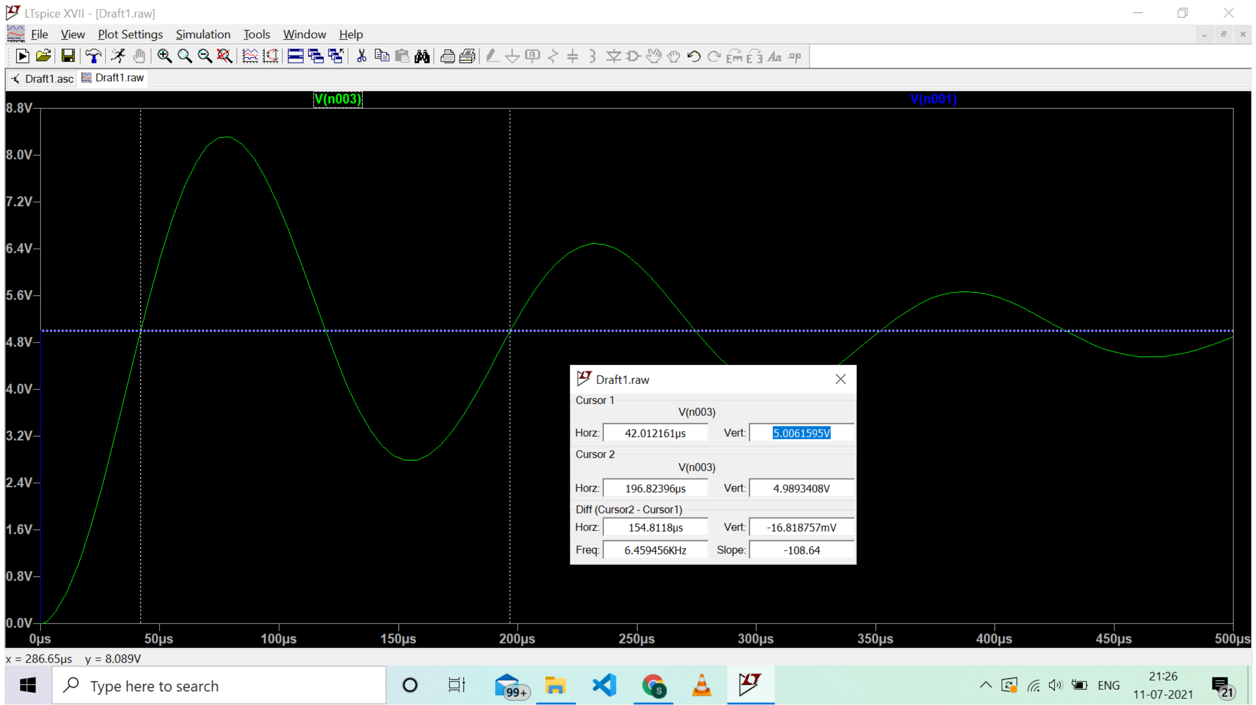
$$= \frac{2\times 9.6\times 10^{-3}}{500}$$

$$= \frac{192}{5}\ \mu s$$

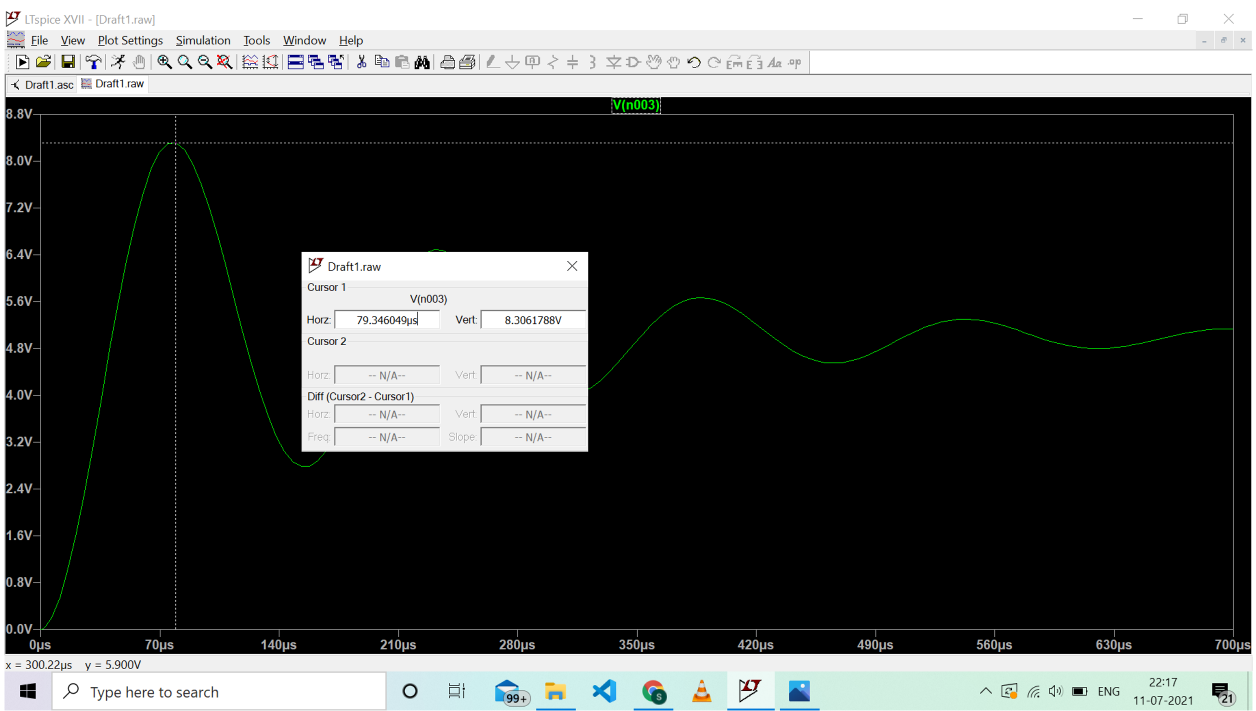
$$= 38.4\ \mu s.$$

Practical observations:

1) For 50 ohm resistance:



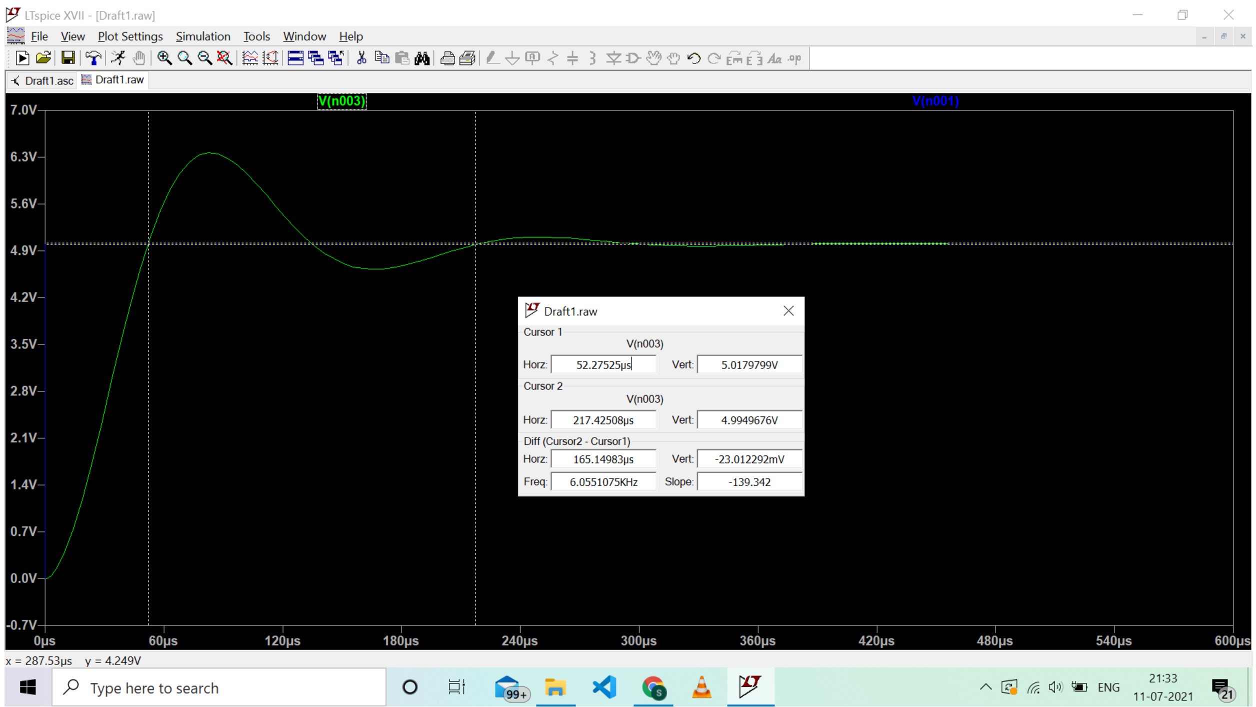
Time period = 154.81µs



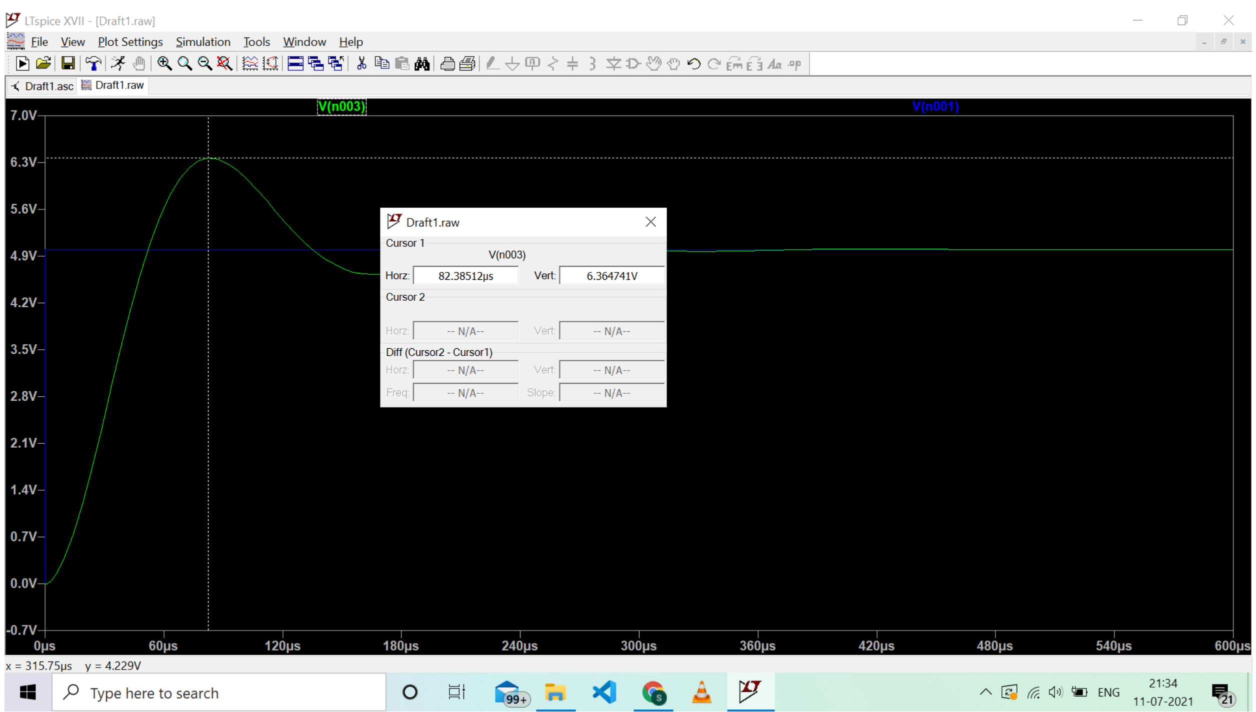
Peak overshoot = (8.306-5)/5

= 66.12%

2) For R = 250 ohm



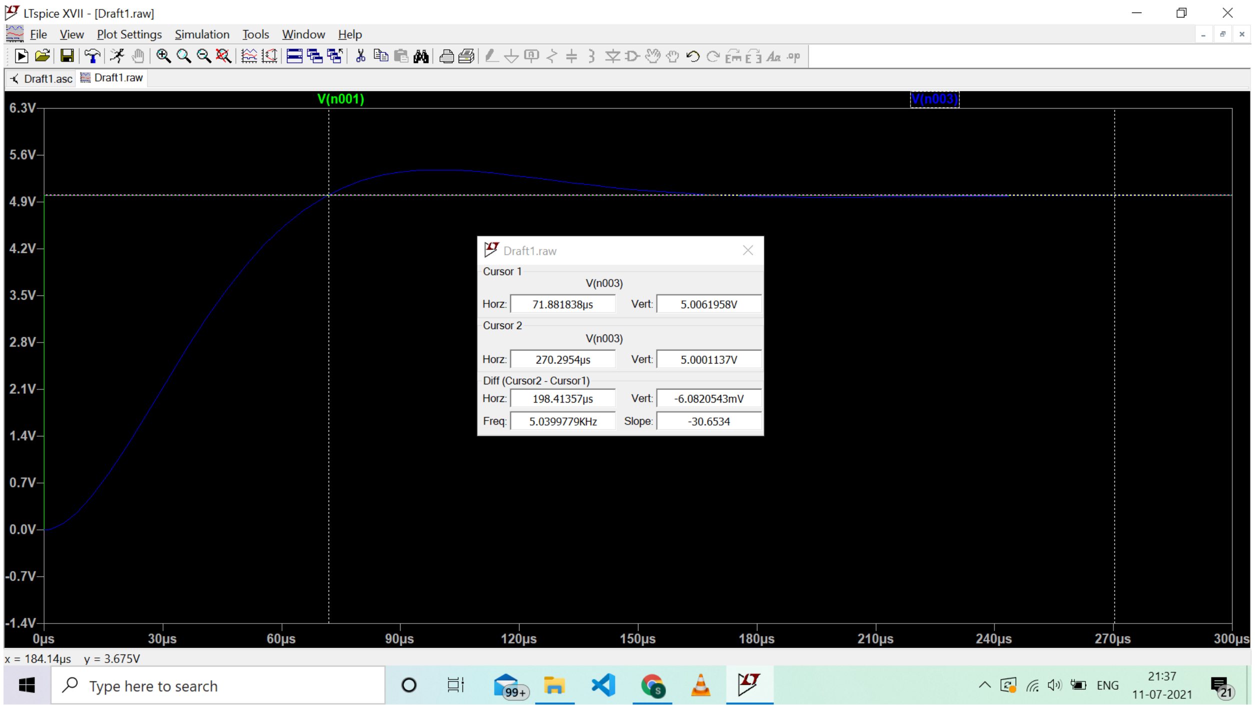
Time period = 165.14µs



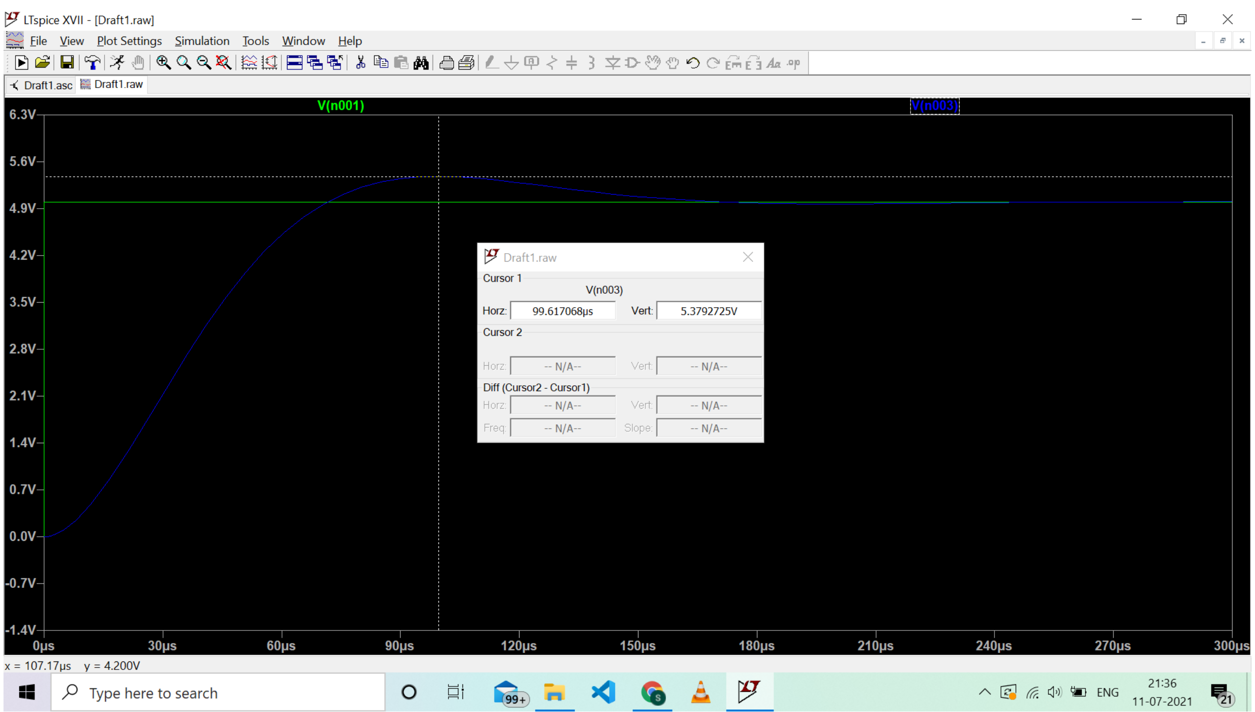
Peak overshoot = (6.364-5)/5

= 27.28%

3) For R = 450 ohm



Time period = 198.41µs



Peak overshoot = (5.379 -5)/5

= 7.58%

Observations :

S. No.	R (ohm)	R_{eq} (ohm)	Theoretical values			Experimental values	
			Time Period (μs)	Peak Oversh- -oot (in %)	Time constan t(μs)	Time Period (μs)	Peak Oversh- -oot (in %)
1	50	100	154.54	66.88	192	154.81	66.12
2	250	300	165	27.4	64	165.14	27.28
3	450	500	198.42	7.56	38.4	198.41	7.58

Applications :

1. RLC circuits have many applications as oscillator circuits.
2. They are used in television sets and radio receivers for tuning purposes.