Faculty of Engineering and Technology

Electrical and Computer Engineering Department

ENEE2103

Circuits and Electronics Lab

Experiment No.3 - Pre Lab No.2

First and Second Order Circuits

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Section: 5.

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1. Part A: RC Circuit

- **RC Circuit simulation using PSpice software:**

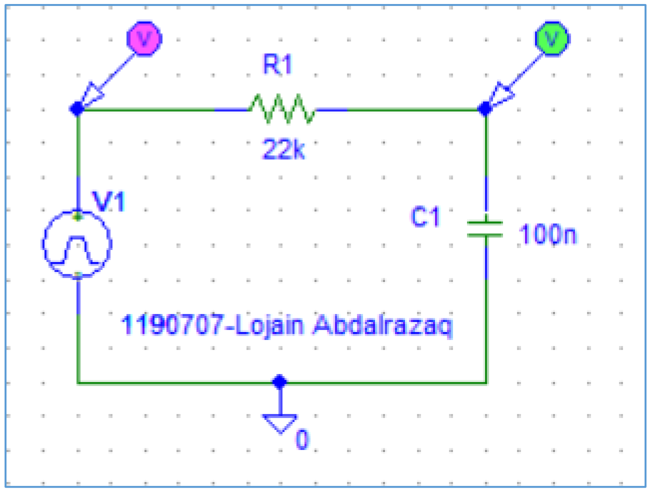


Fig1.1: Circuit simulation using Pspice.

- **Plotting the voltage across the capacitor:**

The following figure shows the voltage across the capacitor (charging and discharging) and the pulse voltage source:

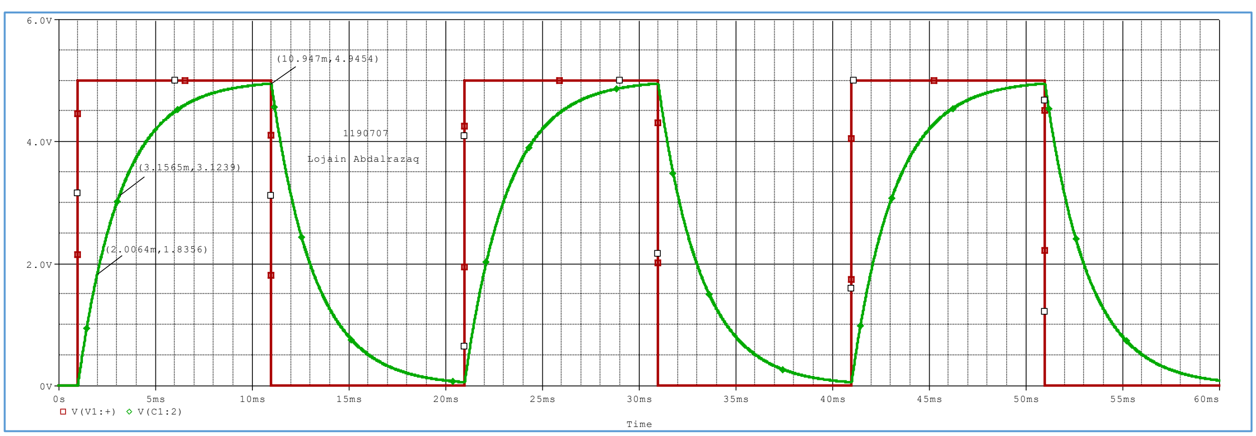
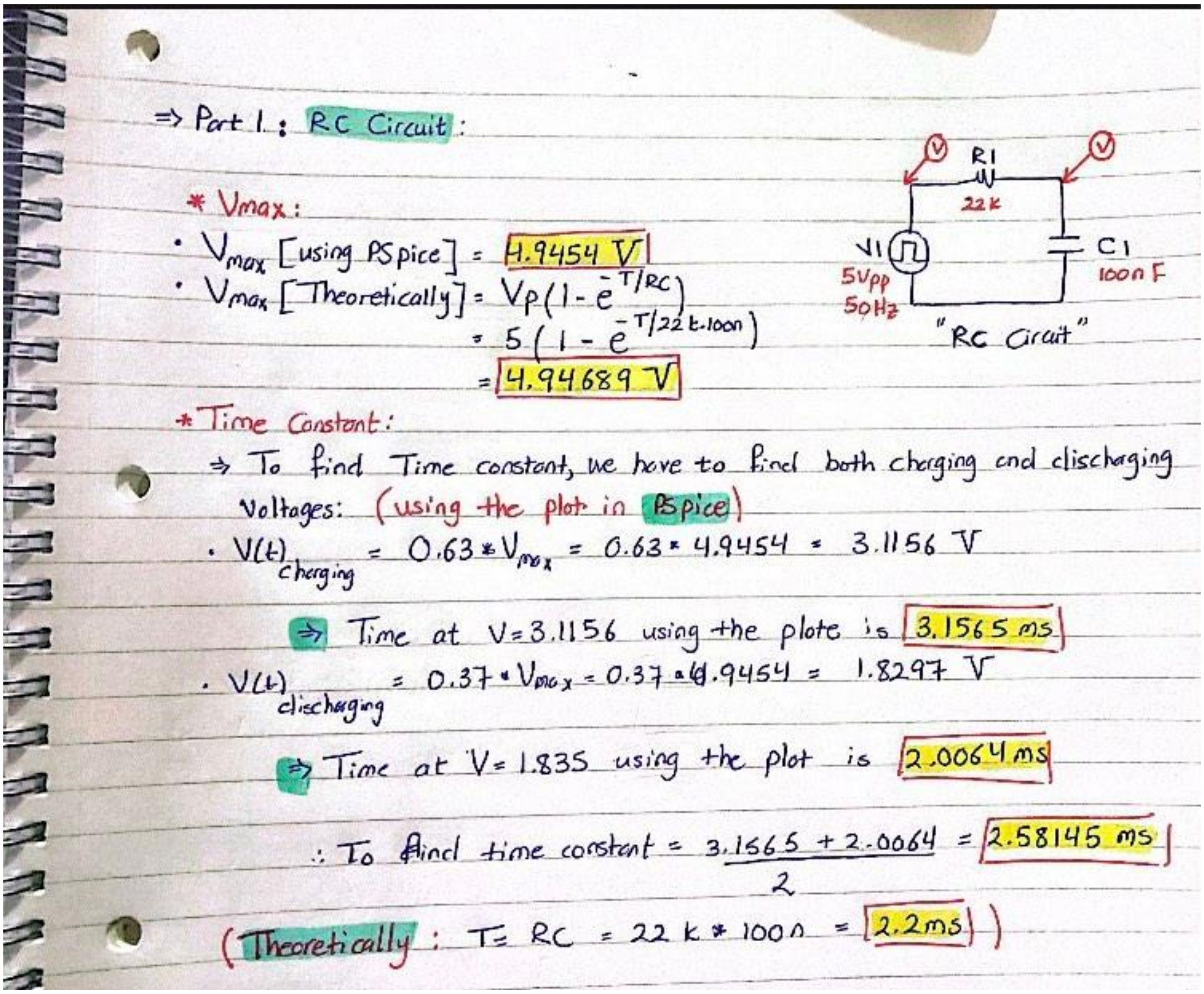


Fig1.2: The voltage across the capacitor.

- **RC Circuit Calculations:**

  From the previous plot, we can find and measure the value of the **Vmax** and **time constant** using the plotting in PSpice software and theoretically, and results were **too close as shown:**



⇒ Part 1 : RC Circuit :

* Vmax :

- V_{max} [using PSpice] = $\boxed{4.9454\ V}$
- V_{max} [Theoretically] = $V_P(1-e^{-T/RC})$

$= 5(1-e^{-T/22k \cdot 100n})$

$= \boxed{4.94689\ V}$

* Time Constant :

⇒ To find Time constant, we have to find both charging and discharging Voltages: (using the plot in PSpice)

- $V(t)_{charging} = 0.63 * V_{max} = 0.63 * 4.9454 = 3.1156\ V$

⇒ Time at V=3.1156 using the plote is $\boxed{3.1565\ ms}$

- $V(t)_{discharging} = 0.37 * V_{max} = 0.37 * 4.9454 = 1.8297\ V$

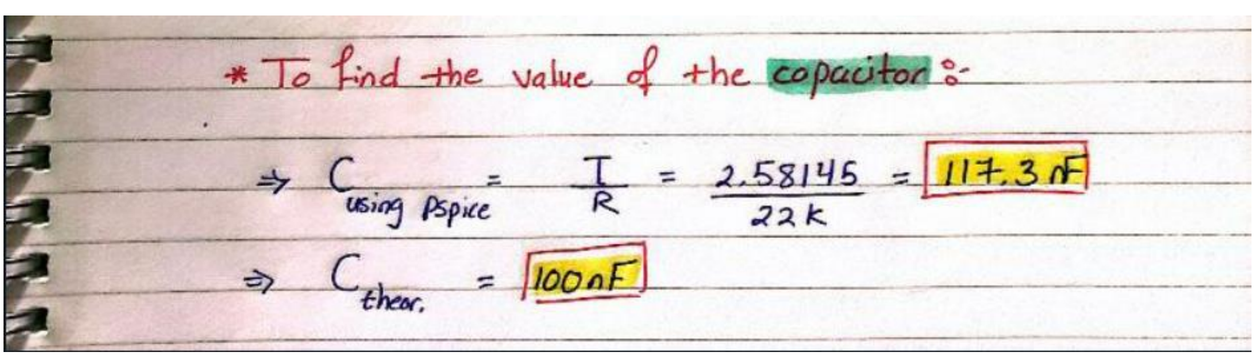
⇒ Time at V=1.835 using the plot is $\boxed{2.0064\ ms}$

∴ To find time constant $= \frac{3.1565 + 2.0064}{2} = \boxed{2.58145\ ms}$

(Theoretically : $T = RC = 22k * 100n = \boxed{2.2ms}$)

Fig1.3: Finding Vmax and time constant using the plot in PSpice for the capacitor.

Also, to find the value of the capacitor using PSpice:



* To find the value of the capacitor :-

⇒ $C_{using\ PSpice} = \frac{T}{R} = \frac{2.58145}{22k} = \boxed{117.3\ nF}$

⇒ $C_{theor.} = \boxed{100nF}$

Fig1.4: Finding the capacitor value using PSpice results.

2. Part B: RL Circuit

- **RL Circuit simulation using PSpice software:**

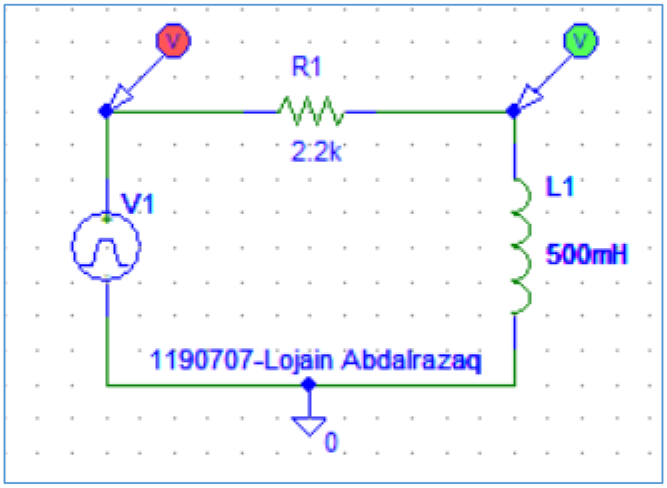


Fig1.5: Circuit simulation using PSpice when f=500Hz.

- **Plotting the voltage across the inductor:**

The following figure shows the voltage across the inductor when the **f=500Hz** and **Vp-p=10V**.

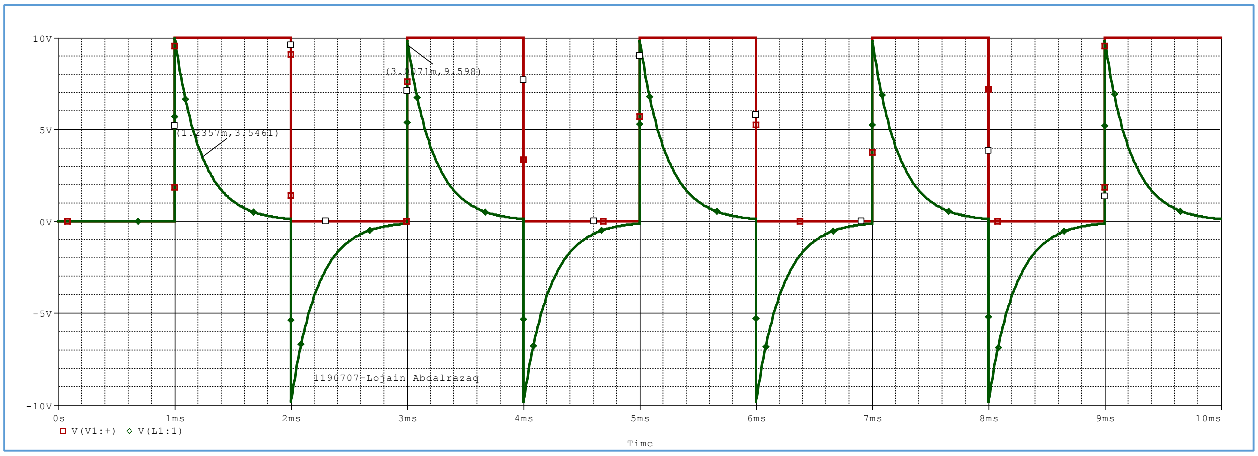
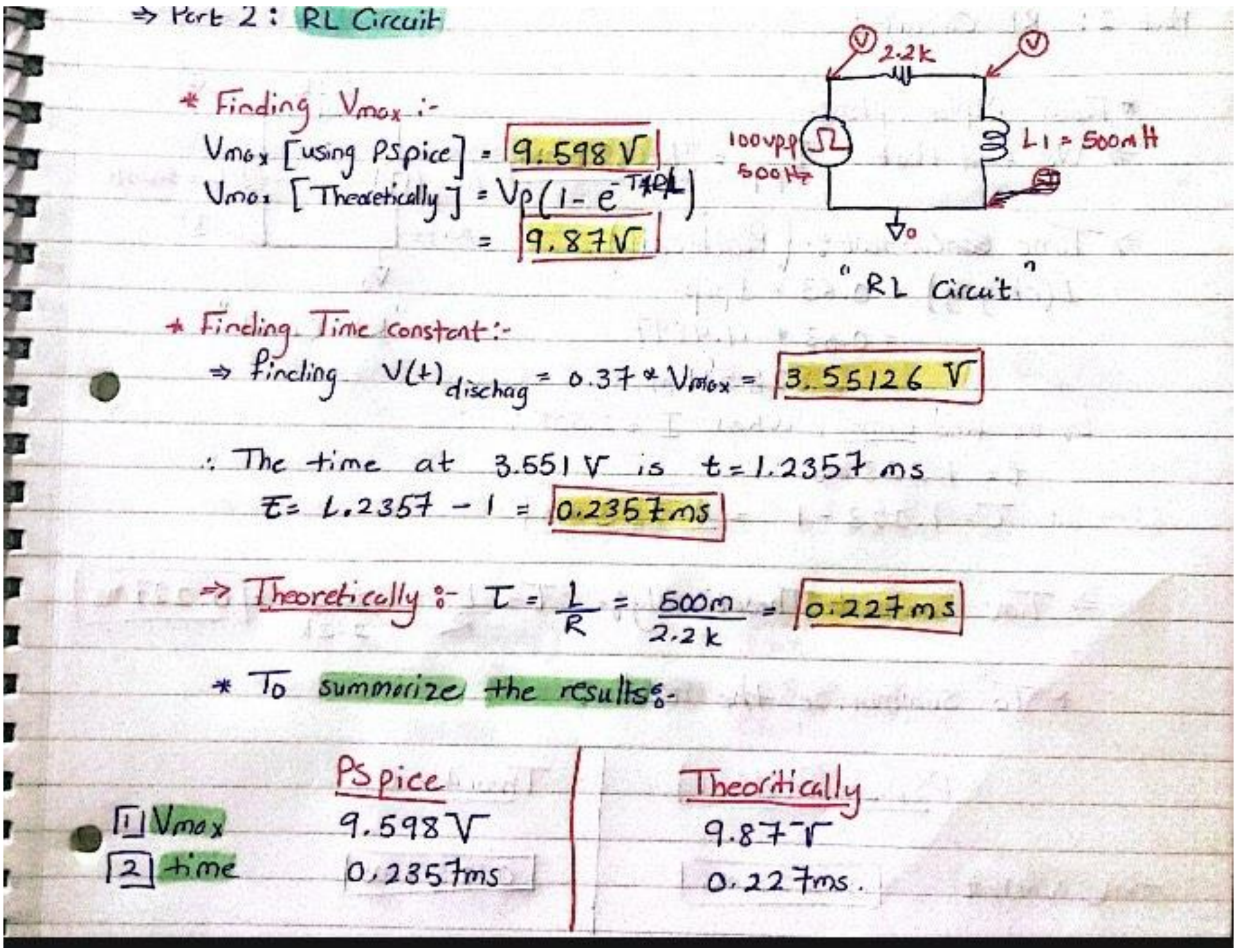


Fig1.6: The voltage response of the inductor.

- ✓ From the figure(1.6),which is the voltage response of the inductor, we can find the value of **Vmax** and **time constant**, the results was so close to the theoretical ones as shown in the following:



⇒ Part 2 : RL Circuit

* Finding V_{max} :-

V_{max} [using PSpice] = $\boxed{9.598\ V}$

V_{max} [Theoretically] = $V_p(1-e^{-T/2\tau})$ = $\boxed{9.87V}$

* Finding Time constant :-

⇒ finding $V(t)_{dischag} = 0.37 * V_{max} = \boxed{3.55126\ V}$

∴ The time at 3.551 V is t = 1.2357 ms

$\tau = 1.2357 - 1 = \boxed{0.2357ms}$

⇒ Theoretically :- $\tau = \frac{L}{R} = \frac{500m}{2.2k} = \boxed{0.227ms}$

* To summarize the results :-

	PSpice	Theoritically
[1] Vmax	9.598 V	9.87 V
[2] time	0.2357ms	0.227ms.

Fig1.7: Finding Vmax and time constant using the plot of the voltage across the inductor.

- **RL Circuit simulation using PSpice software:**

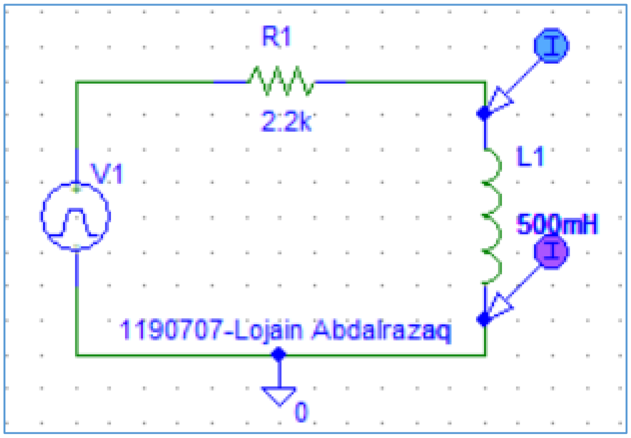


Fig1.8: Circuit simulation using PSpice when f=500Hz.

- **Plotting the current across the inductor:**

The following figure shows the current across the inductor when the **f=500Hz** and **Vp-p=10V**.

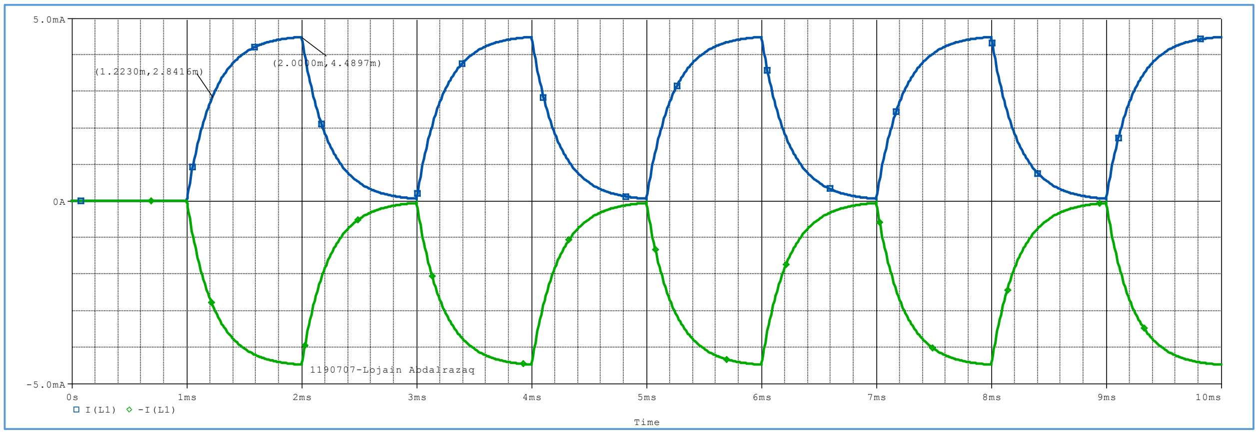


Fig1.9: The current response of the inductor.

- ✓ From the figure(1.9),which is the current response of the inductor, we can find the value of **time constant**, the results was so close to the theoretical ones as shown in the following:

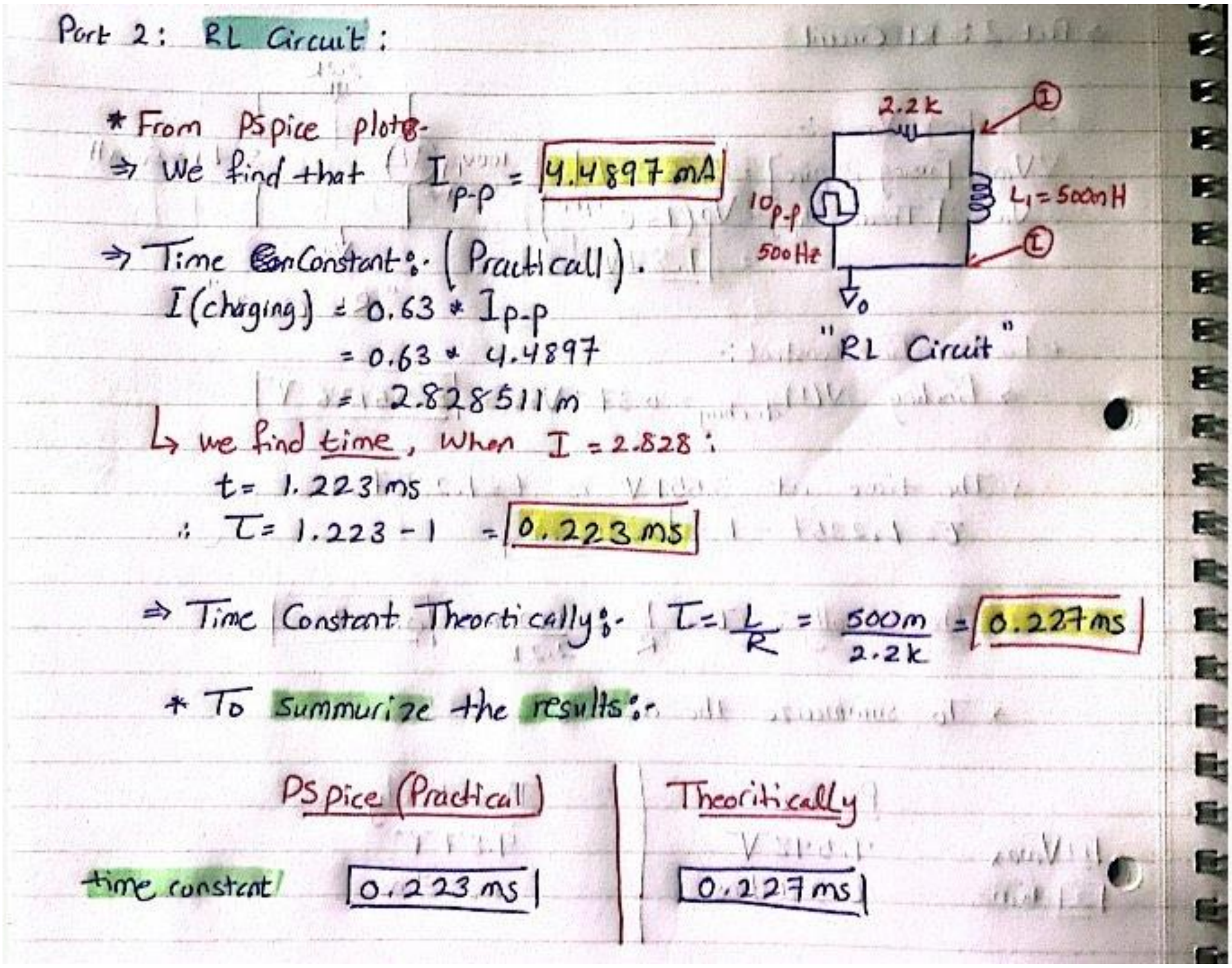


Fig1.10: Time Constant calculations using the plot of the current across the inductor.

- <u>**RL circuit after the period changed to T=2τ_L:**</u>

- ✓ **T = 2 ∗ *L*/*R* =2*(500m/2.2k) = 0.454** msec.
- ✓ **F=1/T = 2.2 KHz.**

Which means that:

- ✓ PER=T=0.454m.
- ✓ PW= pulse width=0.5T=0.5*0.454=0.227m.

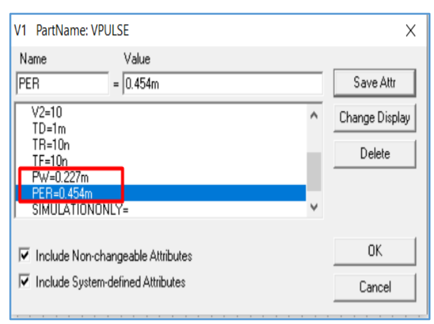


Fig1.11: changing Pulse Voltage settings.

- **<u>Plotting the voltage across the inductor when T=2τL:</u>**

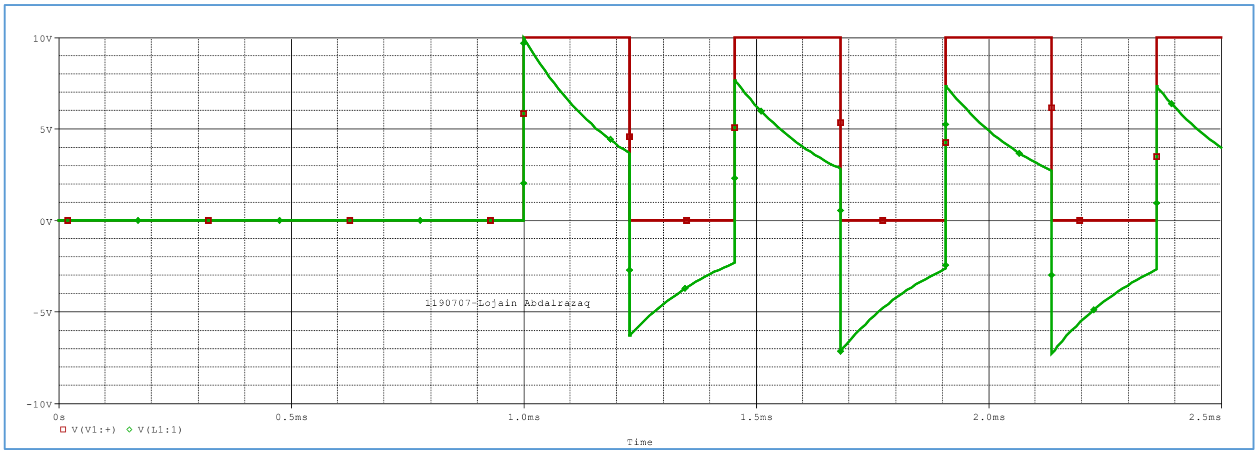


Fig1.12: The voltage response of the inductor when T=2τ.

- **<u>Plotting the current across the inductor when T=2τL:</u>**

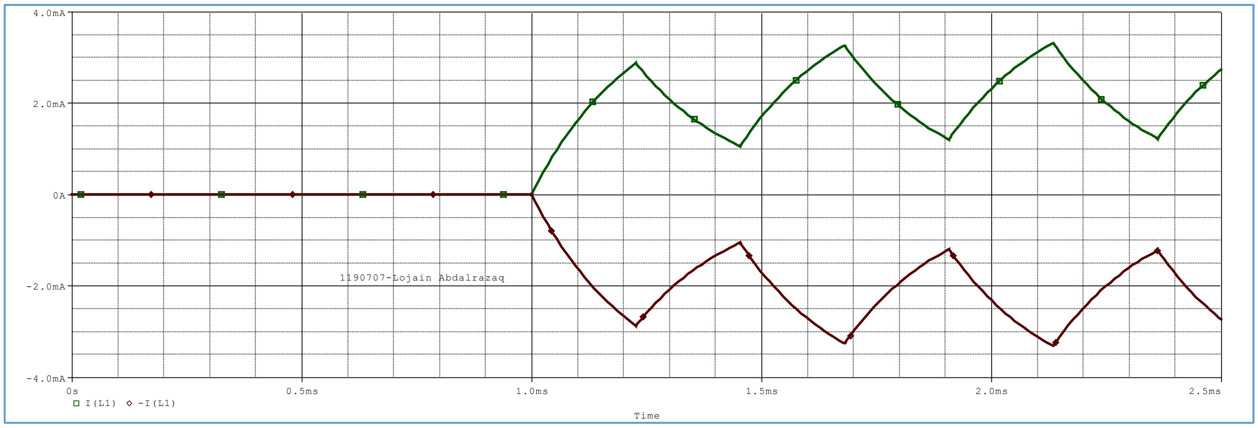


Fig1.13: The current response of the inductor when T=2τ.

3. Part C: RLC Circuit

- **RLC Circuit simulation using PSpice software:**

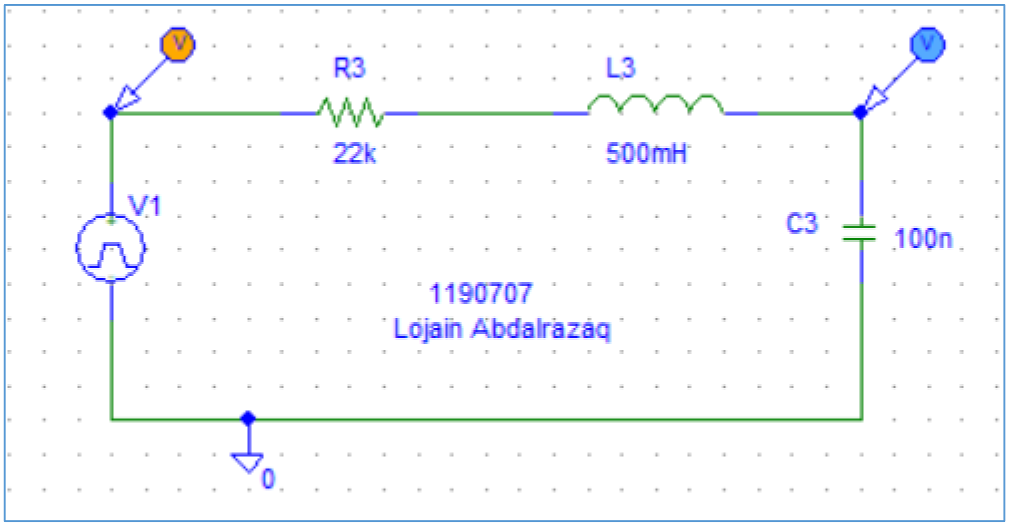


Fig1.14: Circuit simulation using PSpice.

- **Plotting the voltage across the capacitor:**

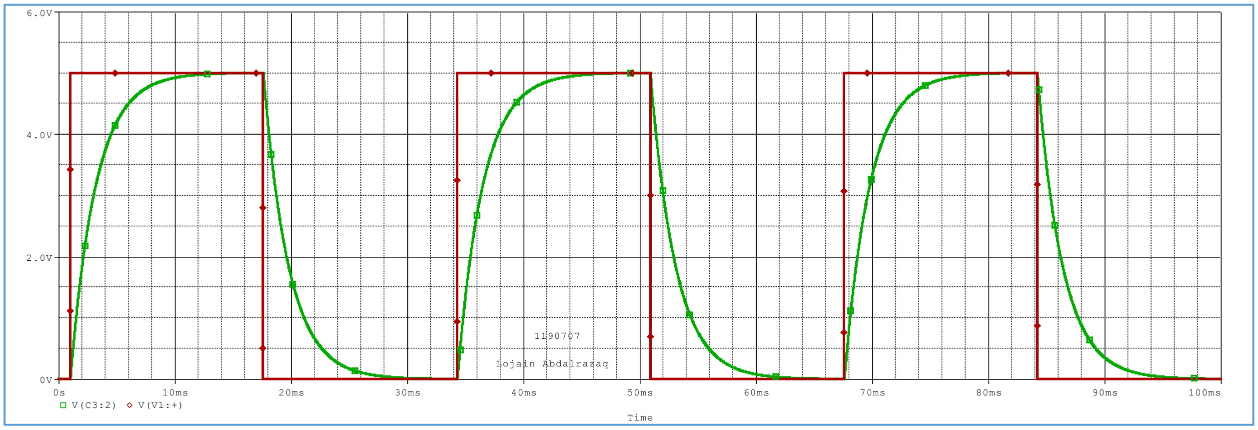


Fig1.15: The voltage response of the capacitor.

✓ Calculating R3 to give critically damped response:

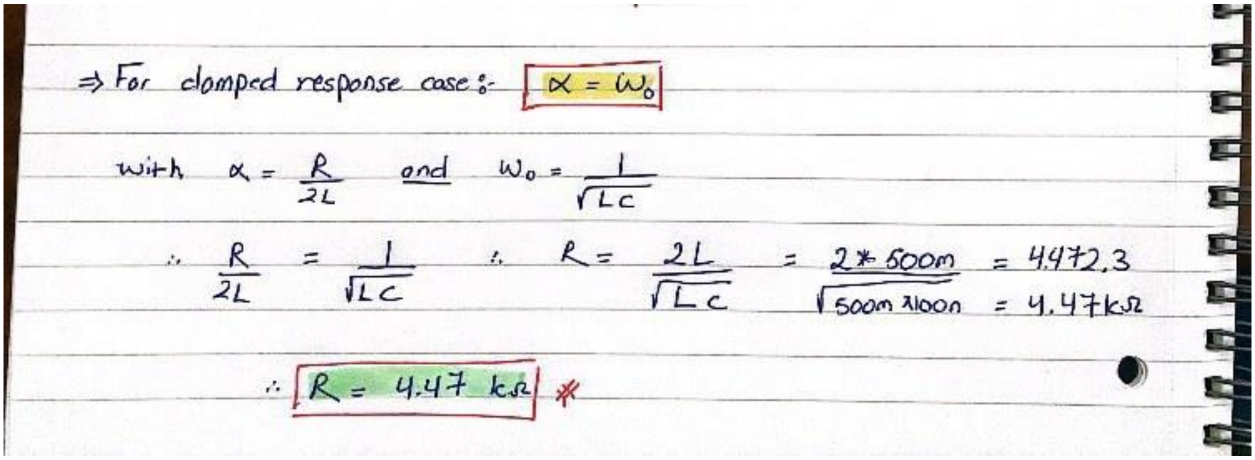


Fig1.16: Finding R3 in critically damped case.

✓ Plotting the voltage across the capacitor when R3=4.47k:

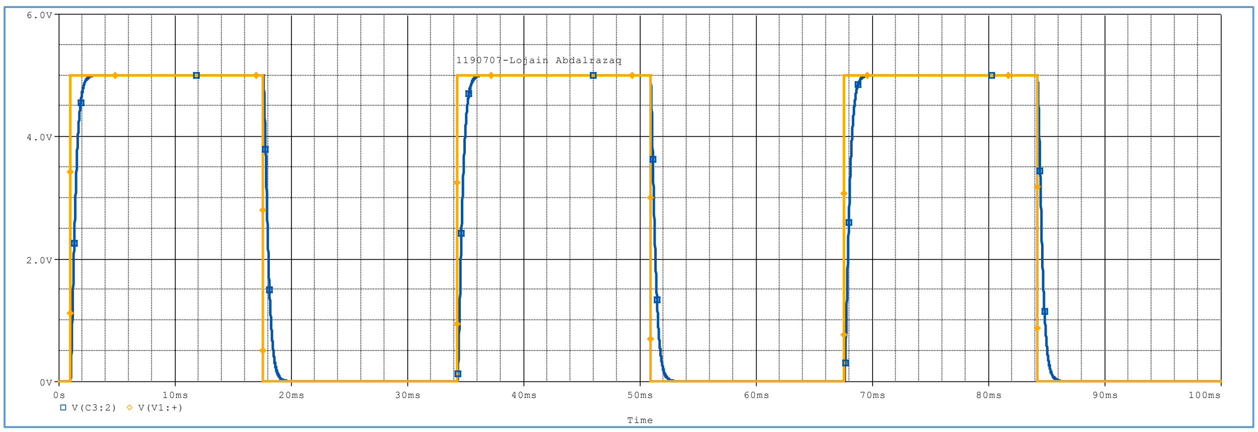
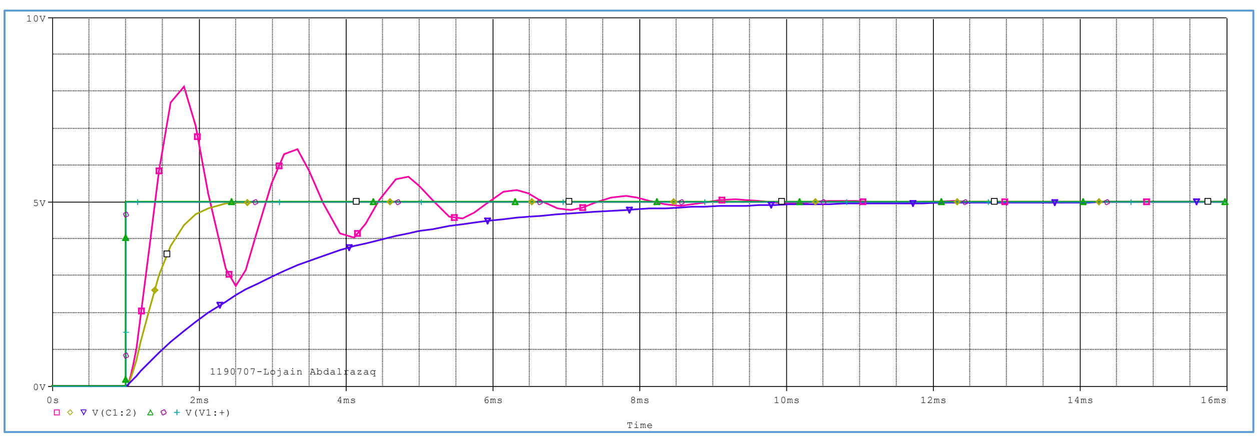


Fig1.17: Voltage across the capacitor when R3=4.47k.

✓ Run parametric + transient analysis with varying R3 with 3 values:



✓ *Fig1.18: Voltage across the capacitor when R3 varying.*

Note:

When **R=4.47k** which is Critical Damping the output voltage is **close** to the input one.

- **Response parameters:**

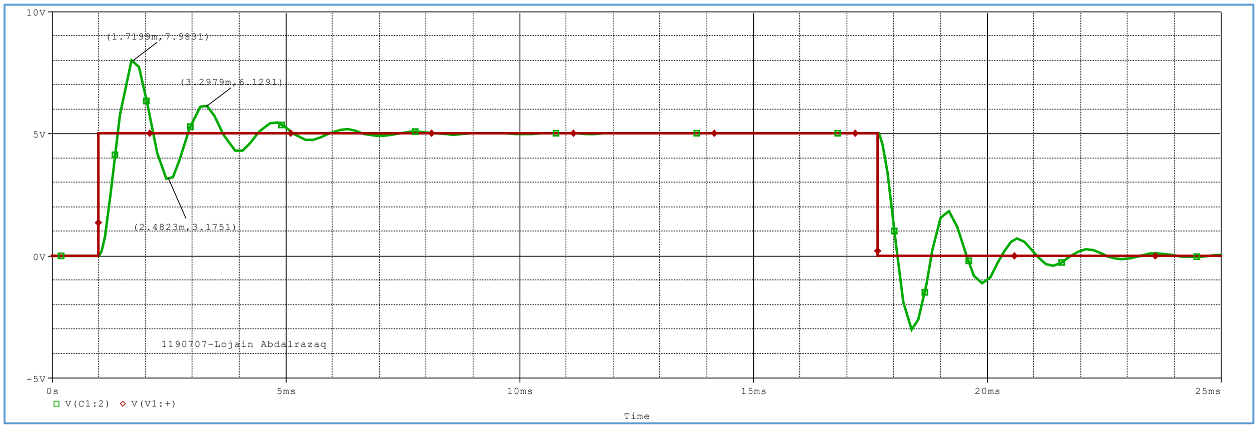


Fig1.19: Response Parameter when R=750.

* From the graph, we can find the following:-

$\boxed{- V_a = 7.9831\ V}$ $\boxed{- V_b = 6.129\ V}$ Note: $V_0(\infty) = 5V$

$\boxed{- t_a = 1.7199m}$ $\boxed{- t_b = 3.2927m}$

$$\rightarrow \tau = \frac{t_b - t_a}{\ln\left(\frac{V_a - V_0(\infty)}{V_b - V_0(\infty)}\right)} = \frac{3.29 - 1.7199}{\ln\left(\frac{7.98 - 5}{6.129 - 5}\right)} = \frac{1.5728}{\ln(2.639)} = \boxed{1.62m}$$

$\rightarrow$ damping coefficient: $\alpha = \frac{1}{\tau} = \boxed{0.617\ rad/sec}$ (wd)

$\rightarrow$ damping radian frequency (theoritically) $= w = \frac{1}{\sqrt{LC}} = \boxed{4.5\ krad/sec}$ (wd)

$\rightarrow$ damping radian frequency (graph) $\omega = \frac{2\pi}{t_b - t_a} = \boxed{4\ krad/sec}$