BIRZEIT UNIVERSITY

Faculty of Engineering & Technology
Electrical & Computer Engineering Department

Circuit Analysis – ENEE2304

Pspice Project

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Section(3)

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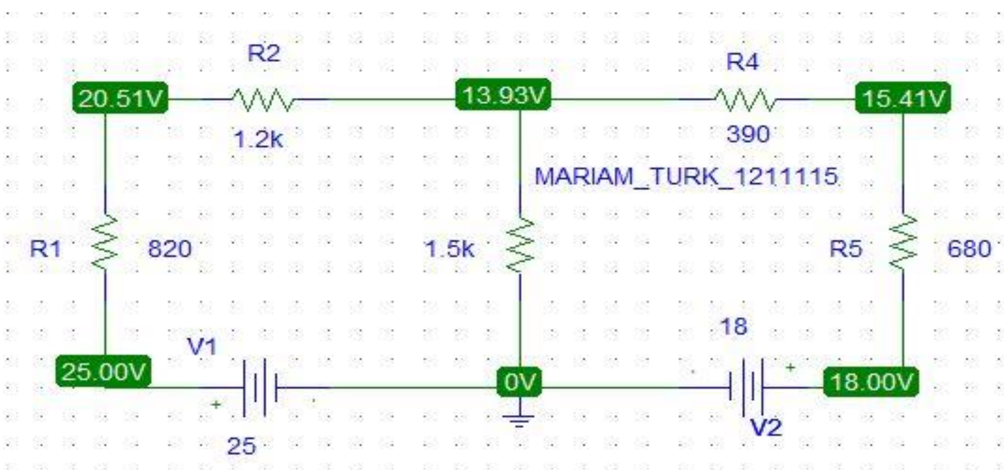
Contents:

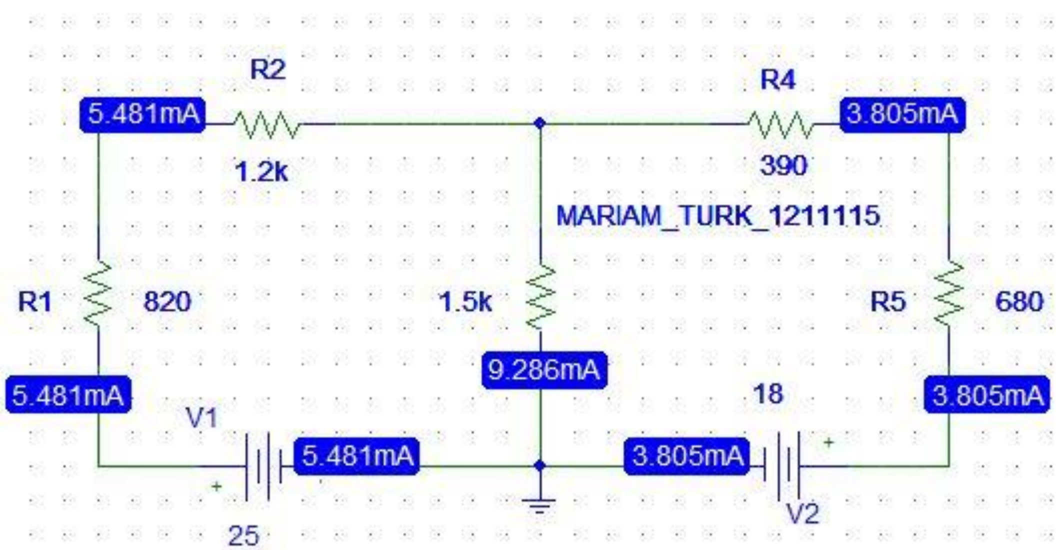
Question 1: Superposition Technique

1-find the voltage and current on R_3:

The voltage on the R_3 equal 13.93 – 0 = 13.93 V



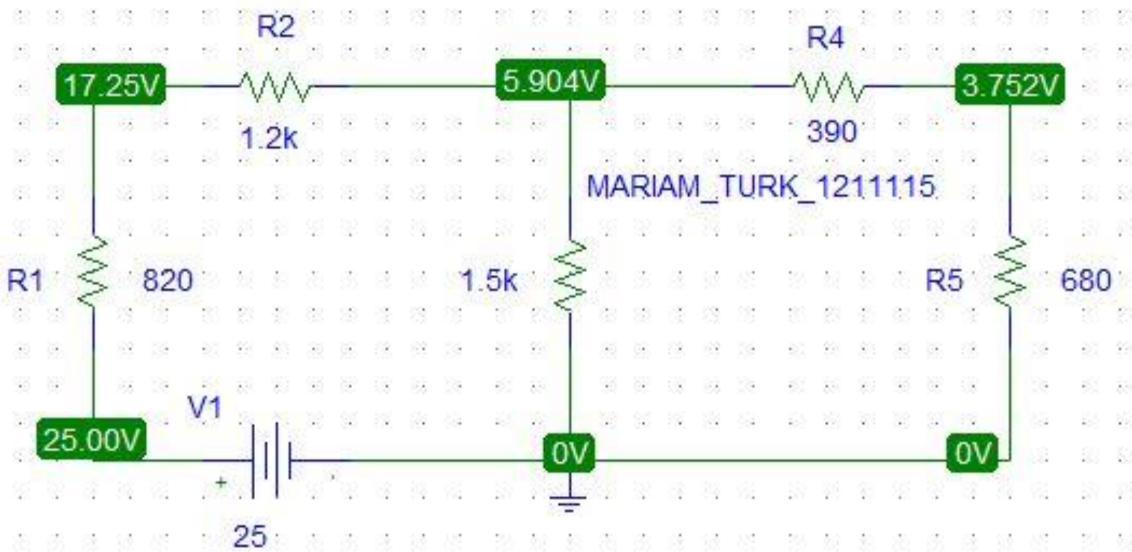
Then the current across R_3 = 9.286 mA

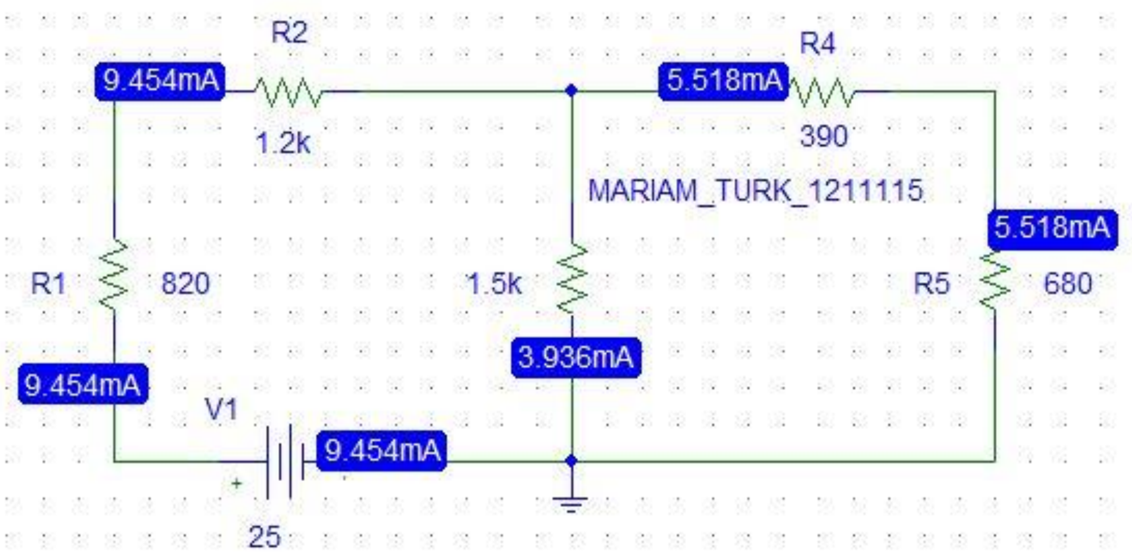


2- Apply Superposition theorem :

By source V1: The voltage on R_3 equal 5.904 volt.

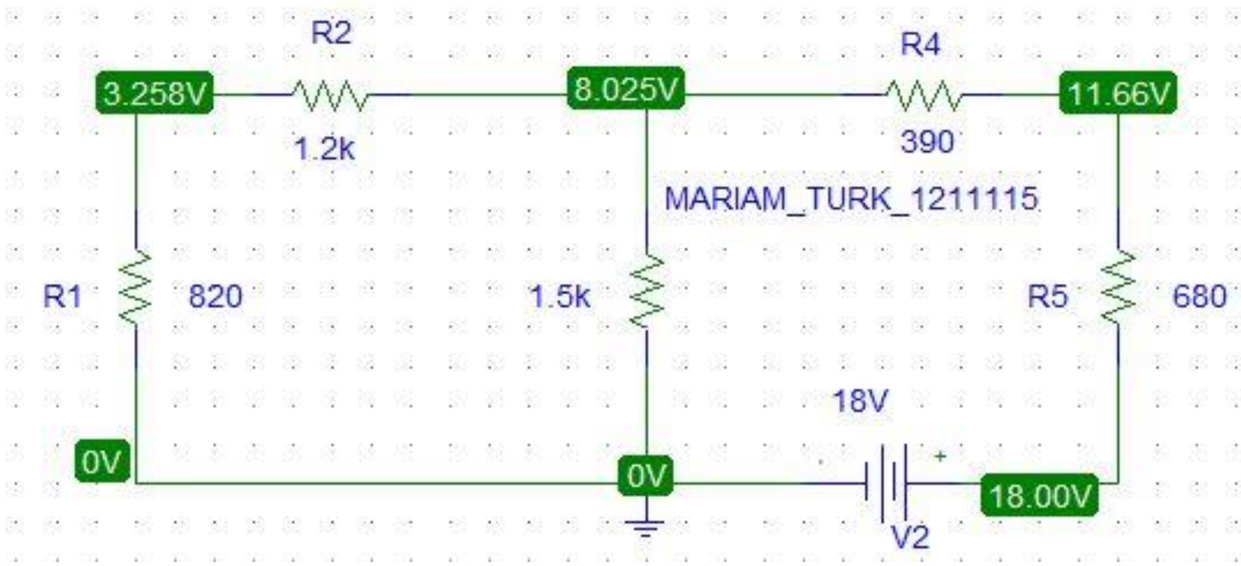
The current across R_3 equal 3.936 mA (down).

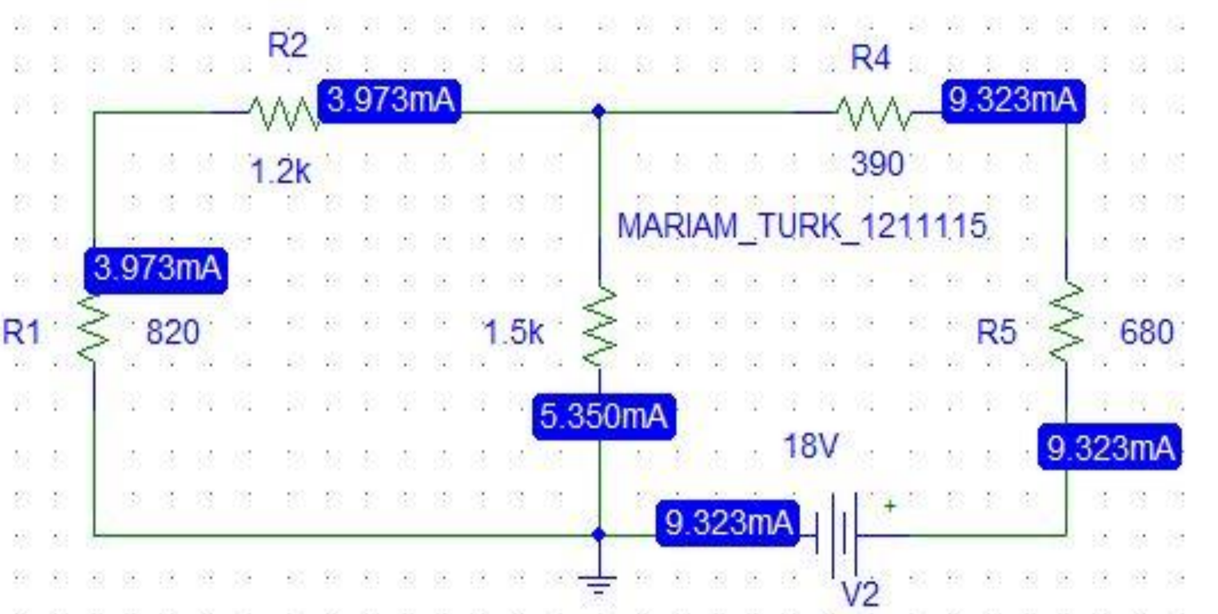




By source V2: The voltage on R_3 equal 8.025 volt.

The current across R_3 equal 5.350 mA (down).





By Superposition theorem:

Voltage on R_3 = Voltage on R_3 from V_1+ Voltage on R_3 from V_2

Voltage on R_3 = 5.904 + 8.025 = 13.929 volt

Current across R_3 = Current across R_3 from V_1+ Current across R_3 from V_2

Current across R_3 =3.936 (down) + 5.350 (down) = 9.286 mA (down)

3- Compare the result:

Voltage on R_3 in part 1= 13.93 V

Voltage on R_3 in part 2 = 13.929 V

Current across R_3 in part 1 = 9.286 mA

Current across R_3 in part 2 = 9.286 mA

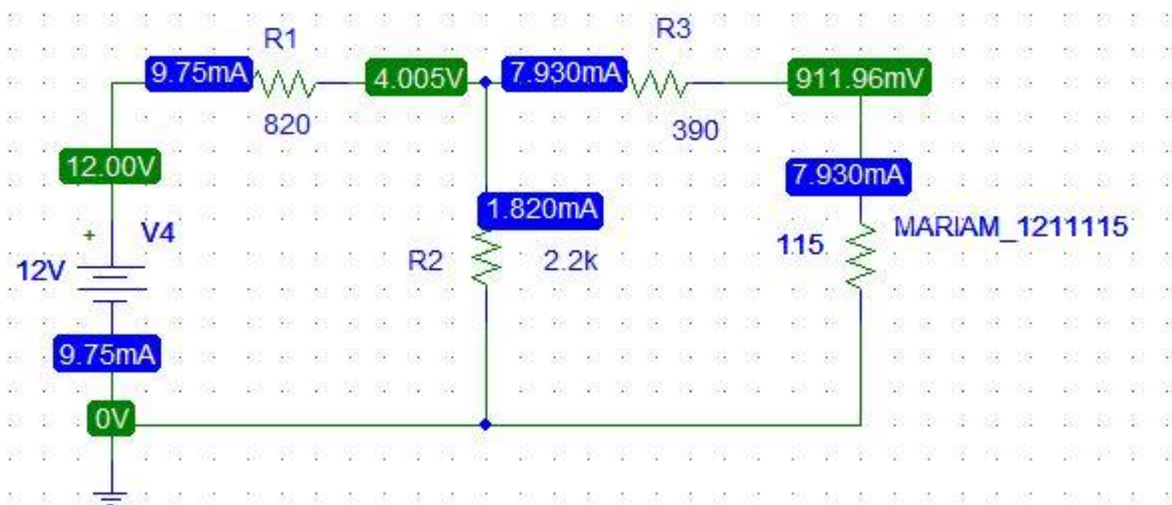
The results in each step are equal and this proves the validity of the Superposition theorem which states that in a linear circuit, the response (voltage or current) in any branch is equal to the algebraic sum of the responses produced by each independent source acting alone, while all the other sources are turned off. This theorem allows us to simplify complex circuits by breaking them down into smaller, simpler components that can be analyzed and combined to find the overall response of the circuit.

Question 2: Thevenin's Theorem & Maximum Power Transfer

1- Find the voltage and current on R_L:

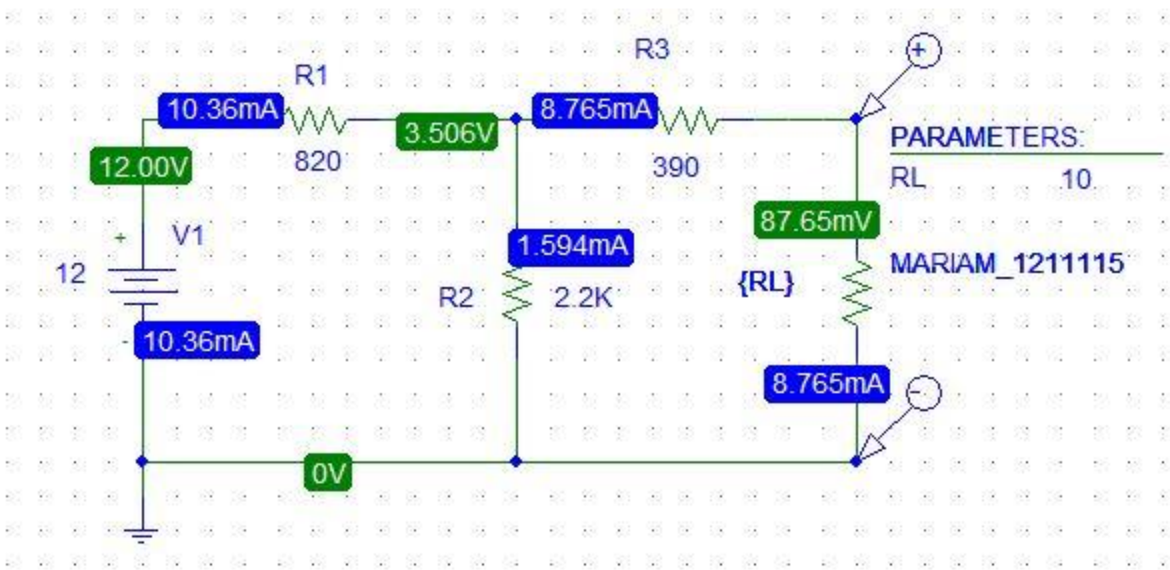
The voltage on R_L equal 911.96 – 0 = 911.96 mV.

The current across R_L 7.930 mA



2- Plot the power of R_L versus the value of R_L:

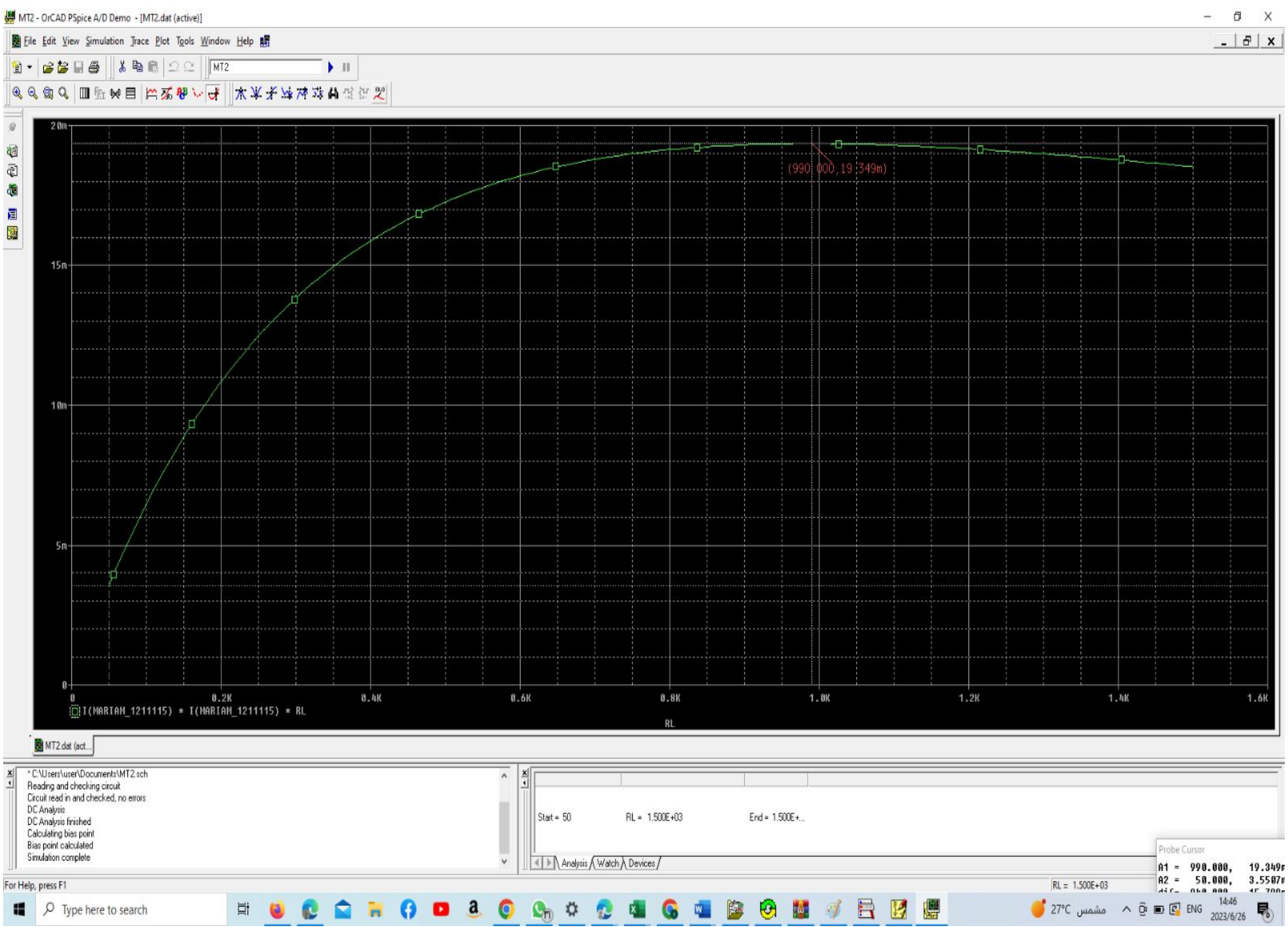
The circuit:



We will define R_L as parameter from 50 Ω to 1.5 kΩ then plot the power of R_L versus the value of R_L by using DC sweep.

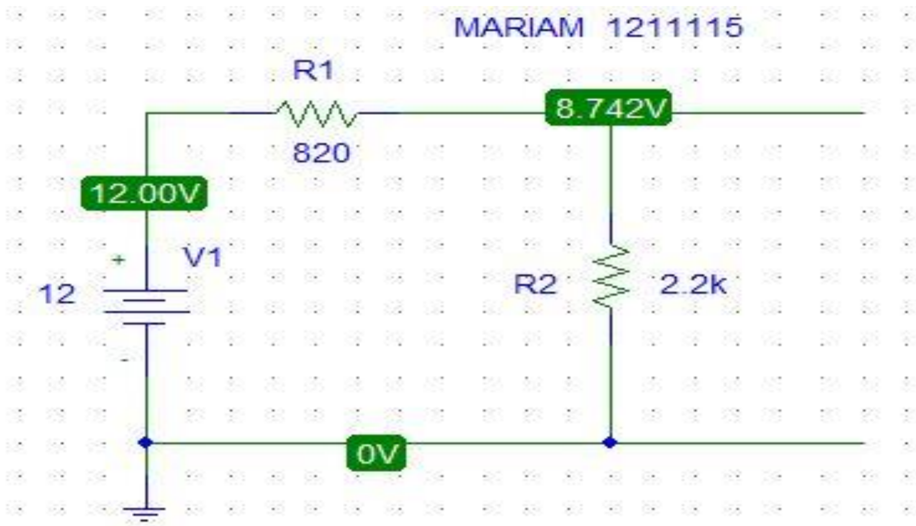
And from the graph we see R_L equal 990.000 Ω when the power be maximum

The graph :

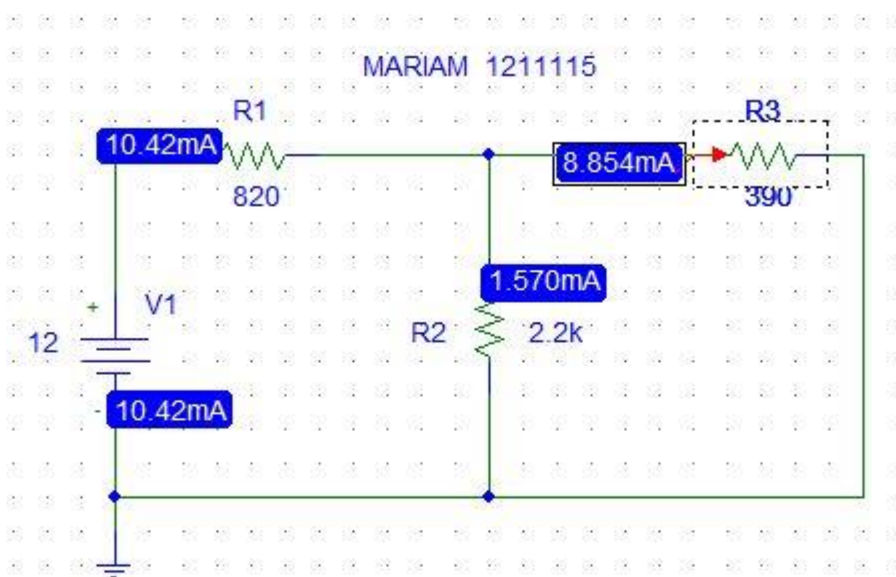


3-Calculate $R_{thevenin}$ seen by R_L :

From this simulation V_{OS} equal 8.742 – 0= 8.742



From this simulation I_{SC} equal 8.854 mA



Calculate $R_{Thevenin}$:

$$R_{Thevenin} = V_{OS} / I_{SC}$$

$$R_{Thevenin} = 8.742 / (8.854 * 10^{-3})$$

$$R_{Thevenin} = 987.35\ \Omega$$

4- Compare the result :

Result in step 1:

R_L equal 990.000 when the power be maximum.

Result in step 2:

$R_{Thevenin} = 987.35\ \Omega$

We see:

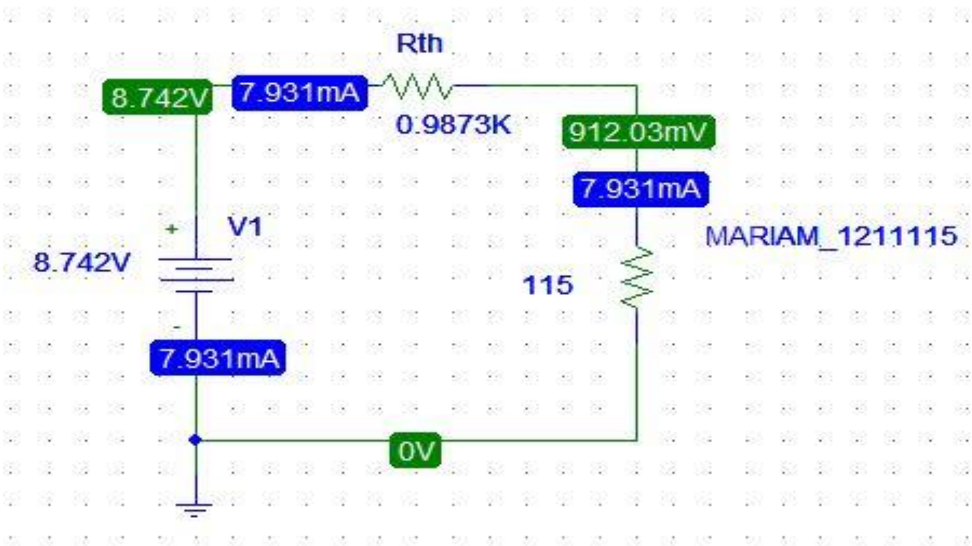
$R_{Thevenin}$ equal to R_L that has a maximum power

5- Thevenin equivalent circuit:

From the simulation for Thevenin equivalent circuit we see :

The voltage on R_L equal 912.03 – 0 = 912.03 mV

The current across R_L equal 7.931 mA



6- compare the result for step1 & step5 :

Step 1:

The voltage on R_L equal 911.96 – 0 = 911.96 mV

The current across R_L equal 7.930 mA

Step 2:

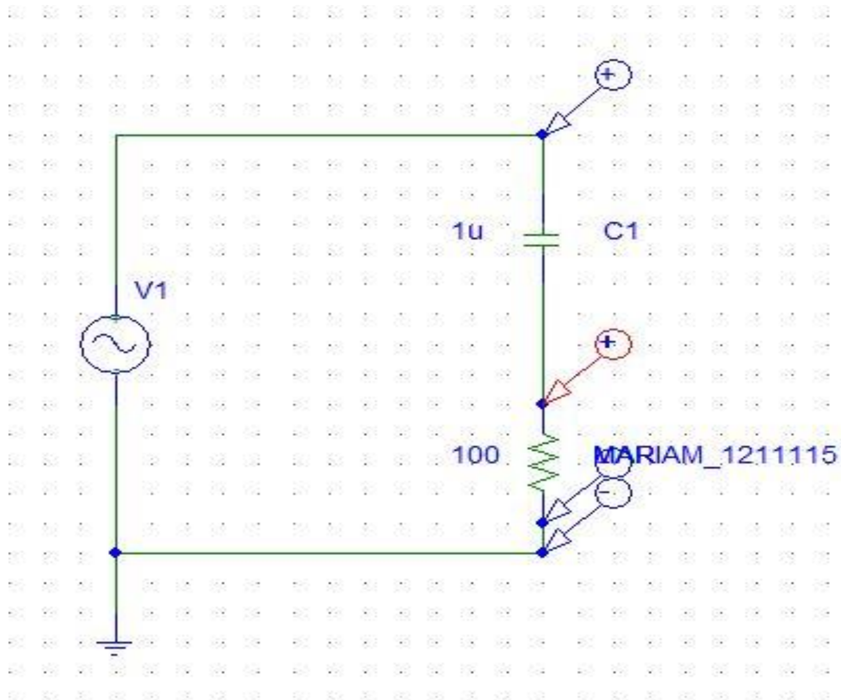
The voltage on R_L equal 912.03 – 0 = 912.03 mV

The current across R_L equal 7.931 mA

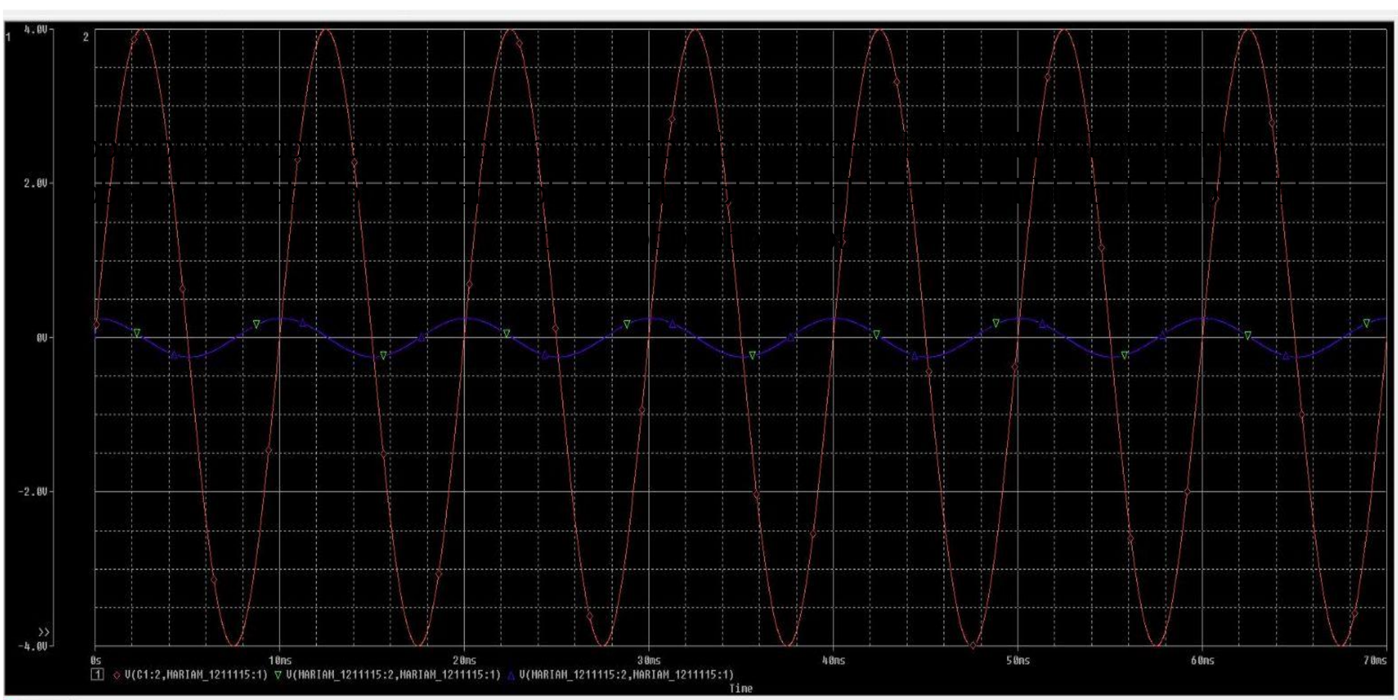
Result in step1 is equal result in step5 that mean, The Thevenin equivalent circuit is a way of representing a complex electrical network with a single voltage source and single impedance (resistor), to simplify analysis and design

Question 3: Sinusoidal Steady State Analysis:

1- show V(t) and V(t):

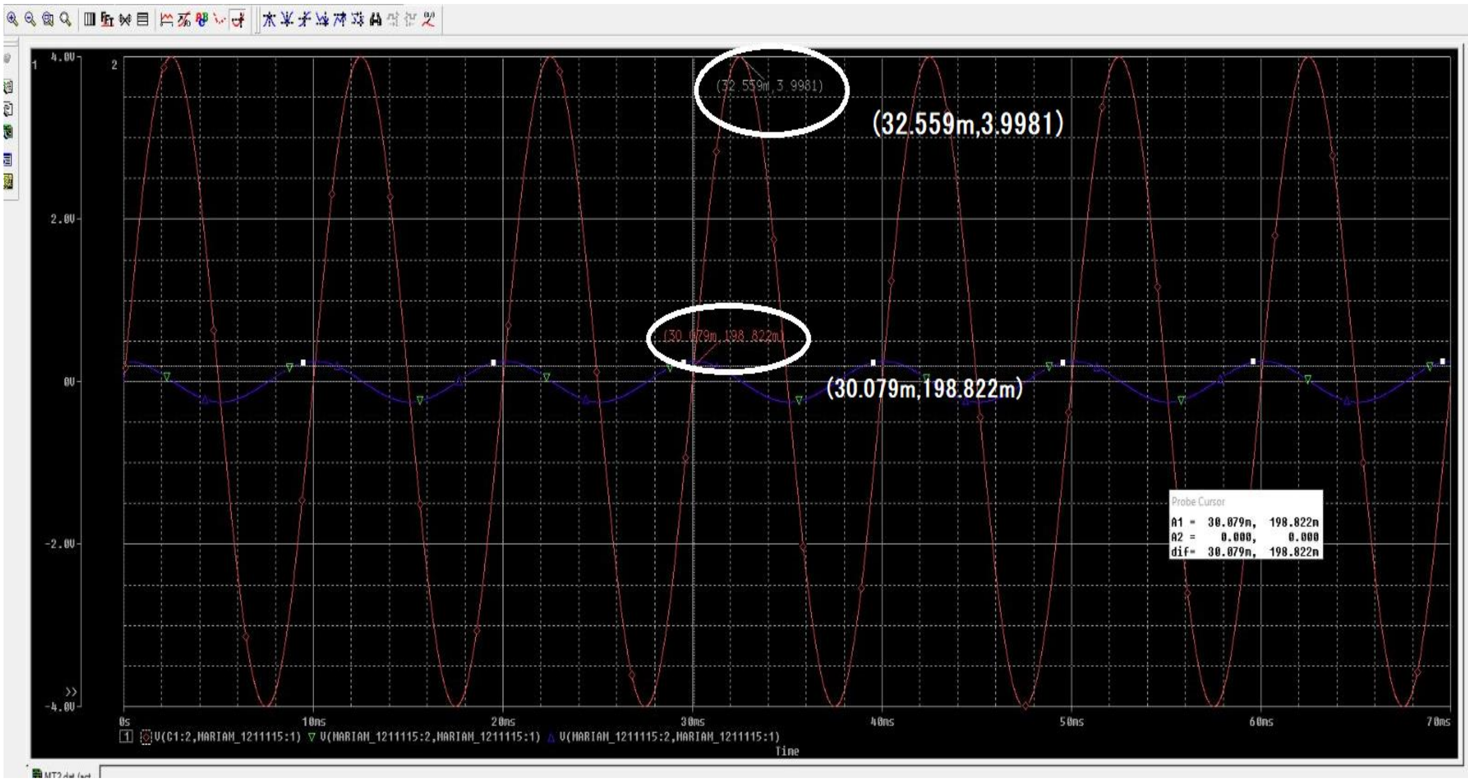


Red(V_{in}) **blue**(V_R)



2-calculate phase shift:

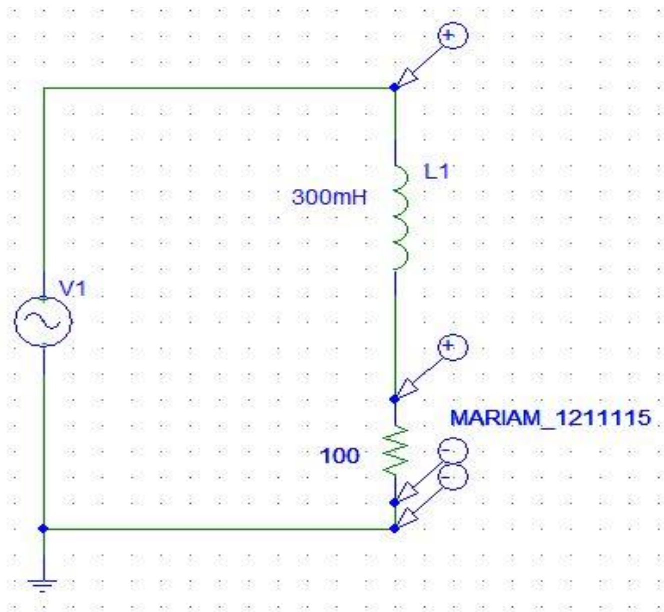
$\{\Delta\boldsymbol{\theta}=\mathbf{3}60° \mathbf{\ x\ f\ x\ } \Delta\mathbf{t}\}$



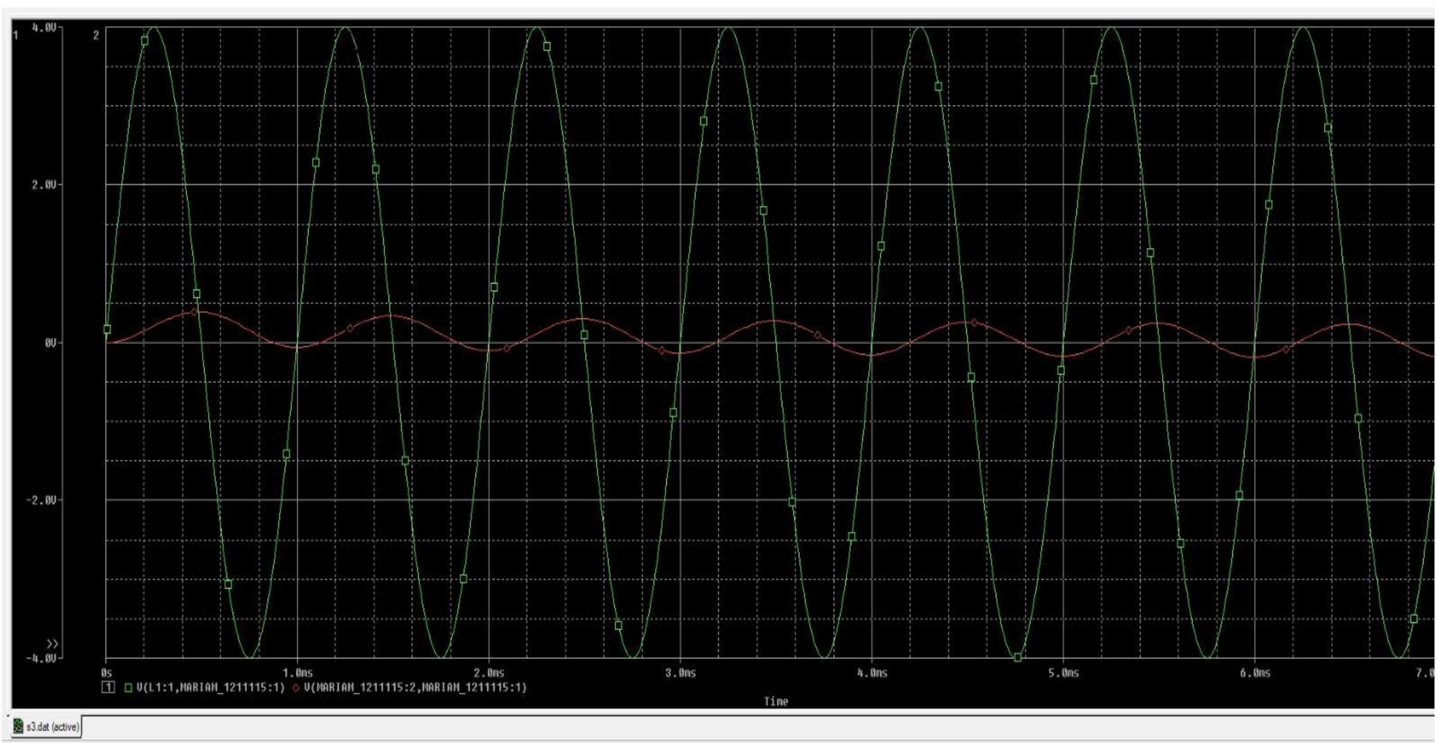
$\Delta\mathbf{t} = 32.559 - 30.079 = 2.48$

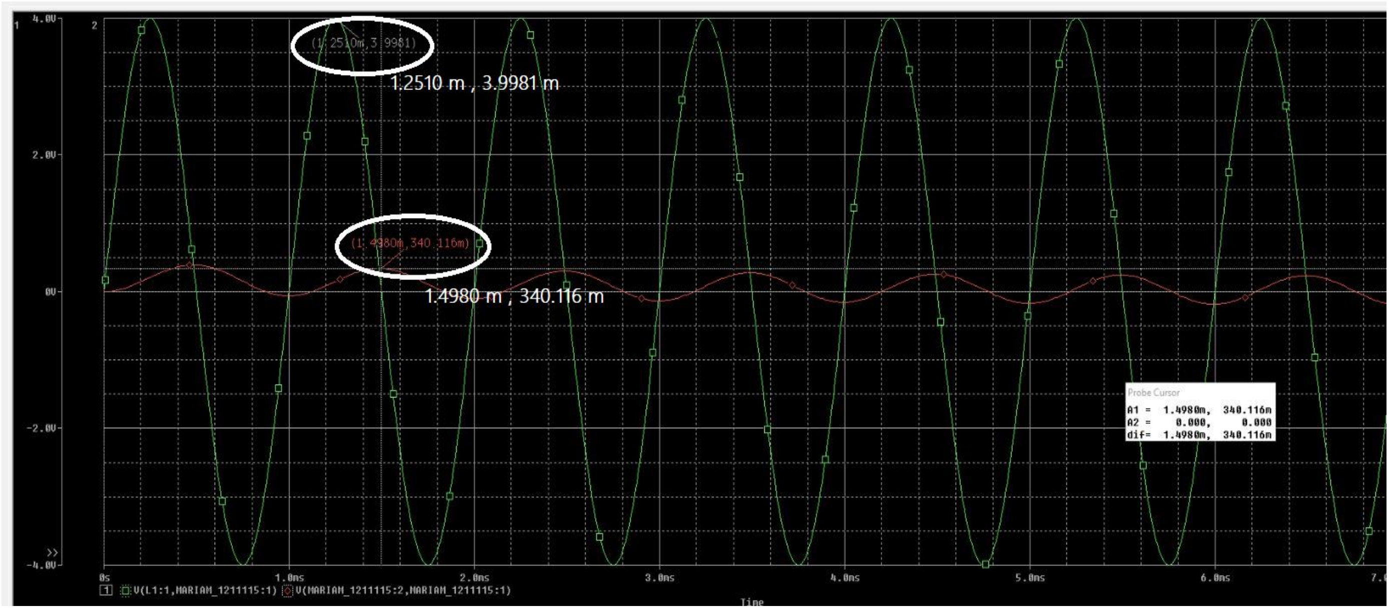
$\Delta\boldsymbol{\theta} = \mathbf{3}60° \mathbf{\ x\ } 100 \mathbf{\ x\ } 2.48 \mathbf{\ x\ } 10^{-3} = 89.28$

3-Repeat the same procedure in the step 1and 2 above for the circuit 2 :



Red(V_{in}) **blue**(V_R)





$\Delta \mathbf{t} = 1.4980 - 1.2510 = 0.247$

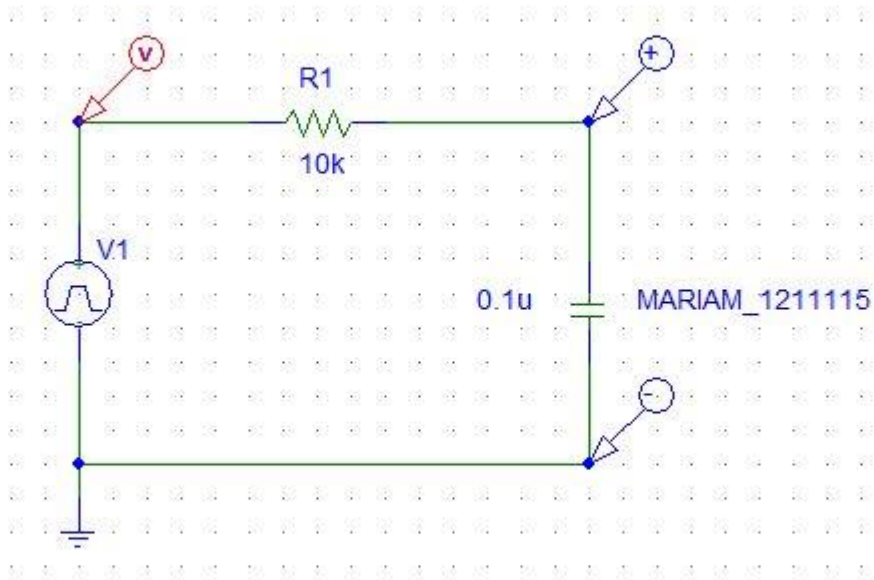
$\Delta \boldsymbol{\theta} = \mathbf{3}60° \; \mathbf{x} \; 100 \; \mathbf{x} \; 0.247 \; \mathbf{x} \; 10^{-3} = 88.92$

4. Compare and discuss the results obtained for the two circuits:

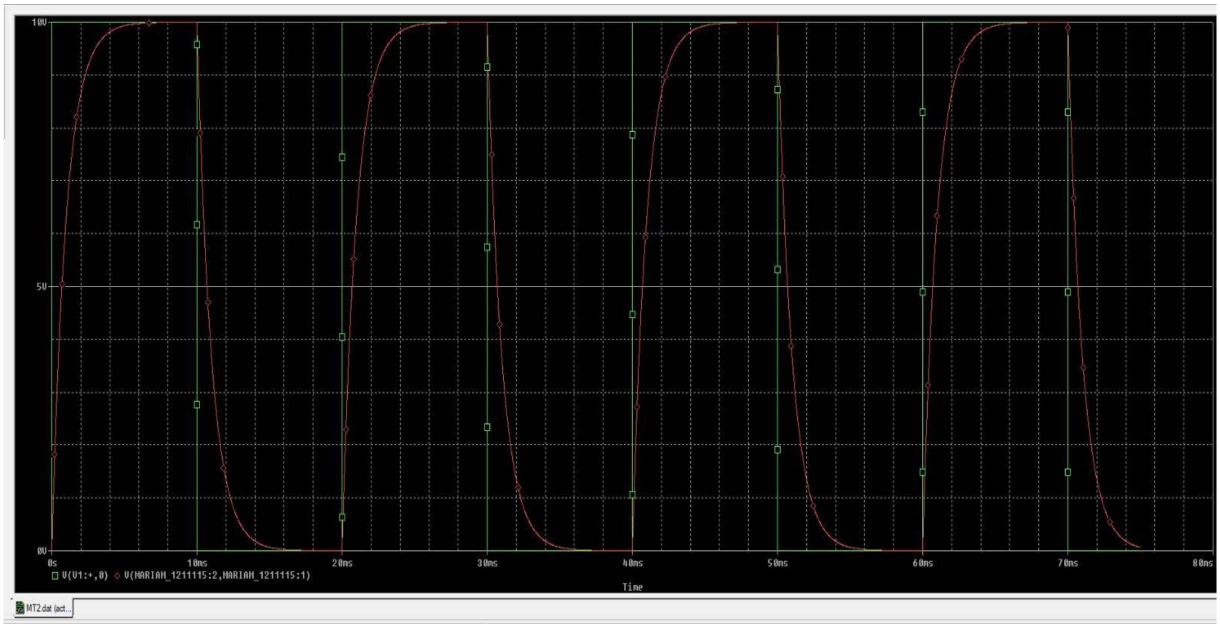
In the RL circuit I lags V , but in RC circuit I leads V , and the phase shift should for both circuits equal to 90 , so the RL circuit its phase shift equal to 89.28 , and the RC circuit its phase shift equal to 88.92. these value equal to each other and they ≈ 90.

Question 4: First Order RC Circuit Analysis

The circuit :

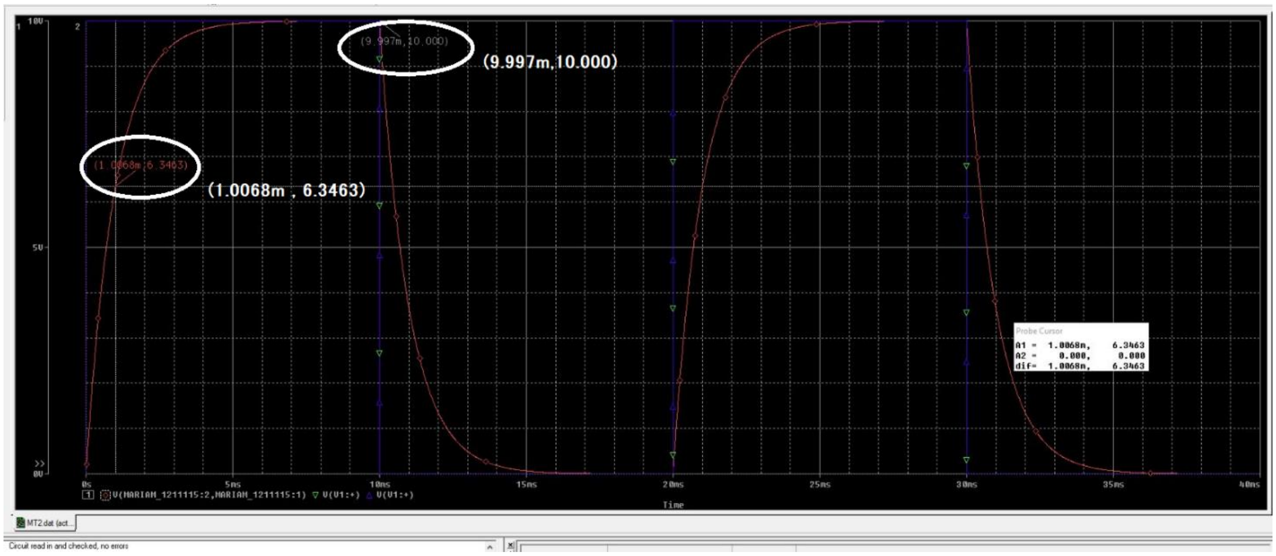


1- plot of $V_I(t)$ and $V_c(t)$:



2- find τ :

from the graph when $V_c(t) = 6.34$, $\tau = 1$ ms



Find τ theoretically:

$$\tau = R * C$$

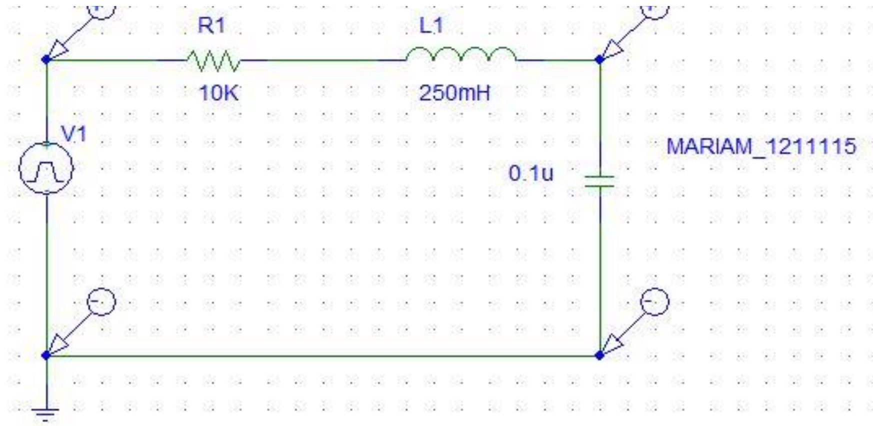
$$\tau = 10 * 10^3 * 0.1 * 10^{-6}$$

$$\tau = 10^{-3} \text{ sec}$$

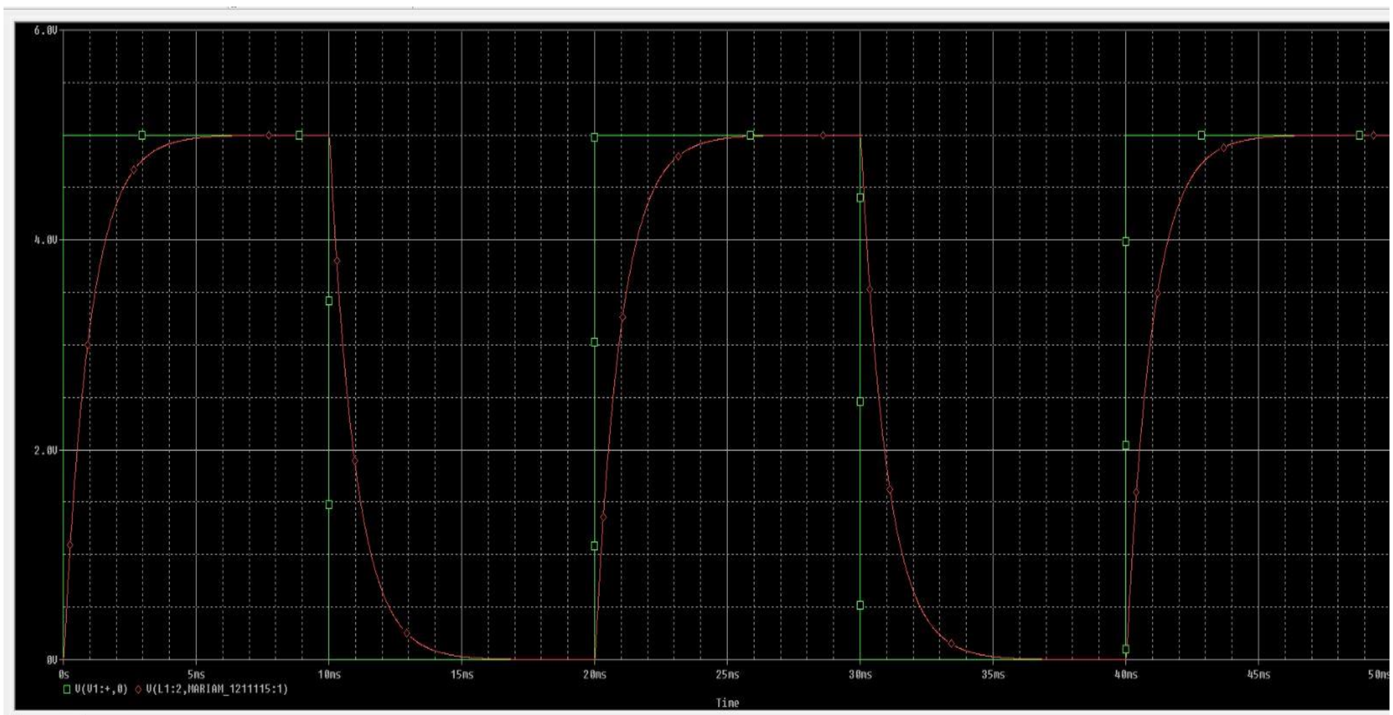
We see τ theoretically is equal τ from the graph of $V_c(t)$.

Question 5:Second Order RLC Circuit Analysis

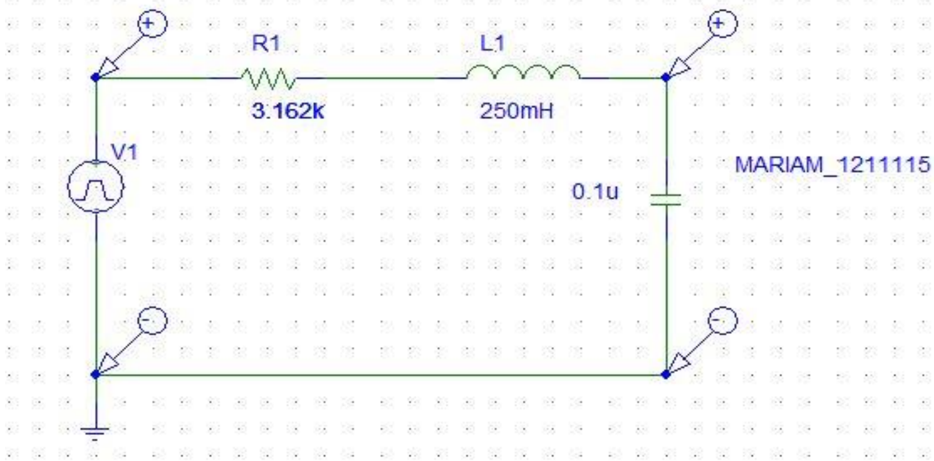
1- plot V_i (t) & V_C (t) when R = 10kΩ



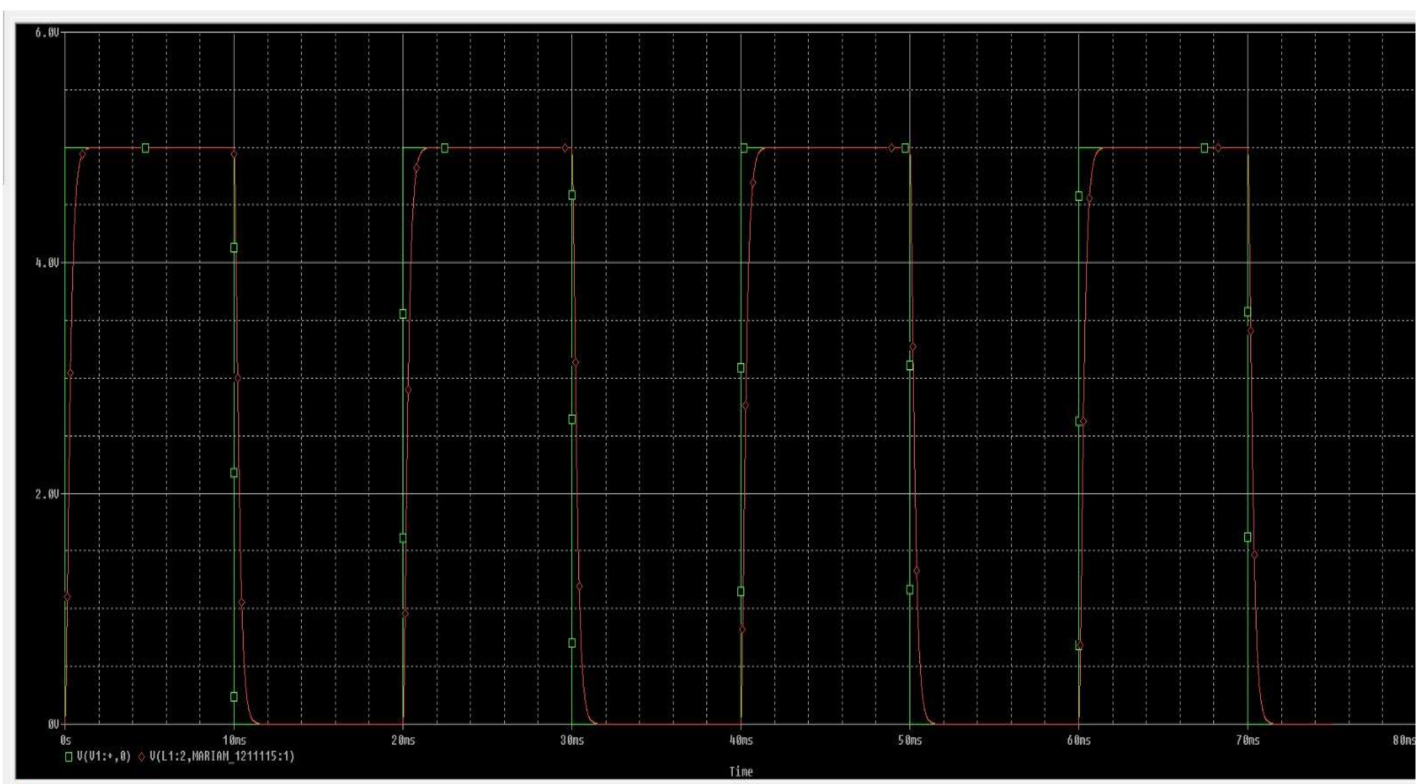
V_i (t) is Green V_C (t) is Red



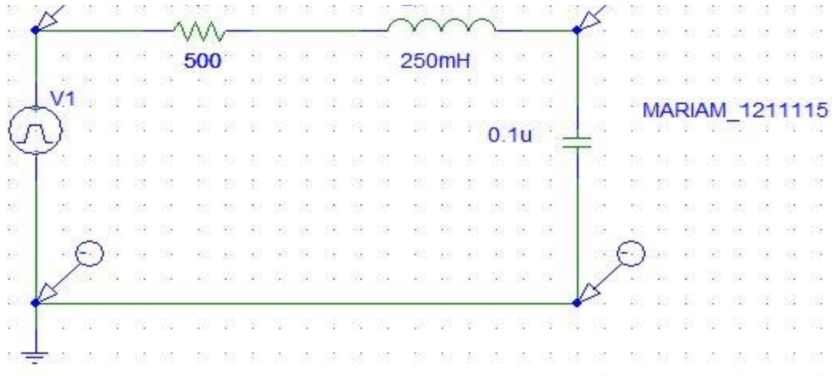
2- plot V_i (t) & V_C (t) when R = 3.162kΩ



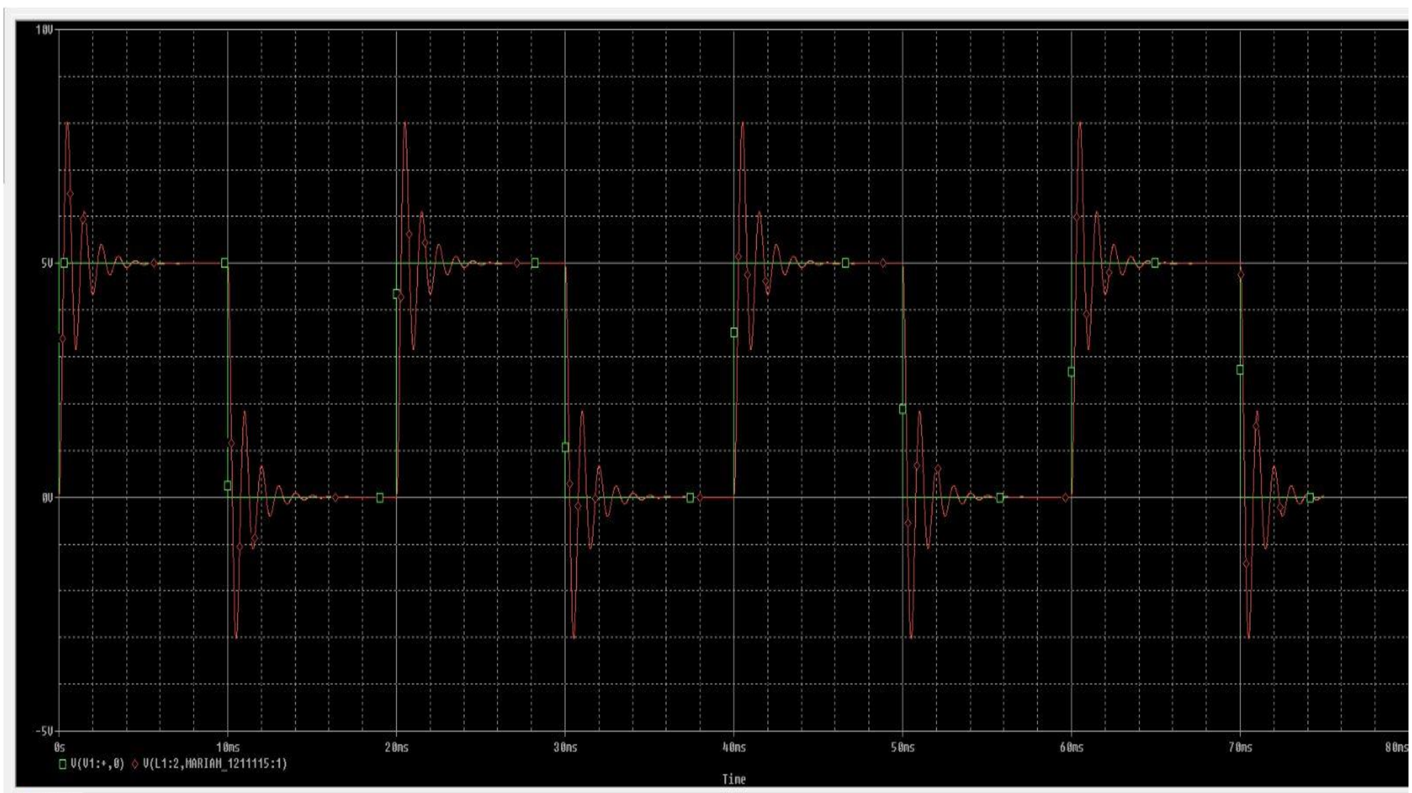
V_i (t) is Green V_C (t) is Red



3- plot V_i (t) & V_C (t) when R = 500Ω

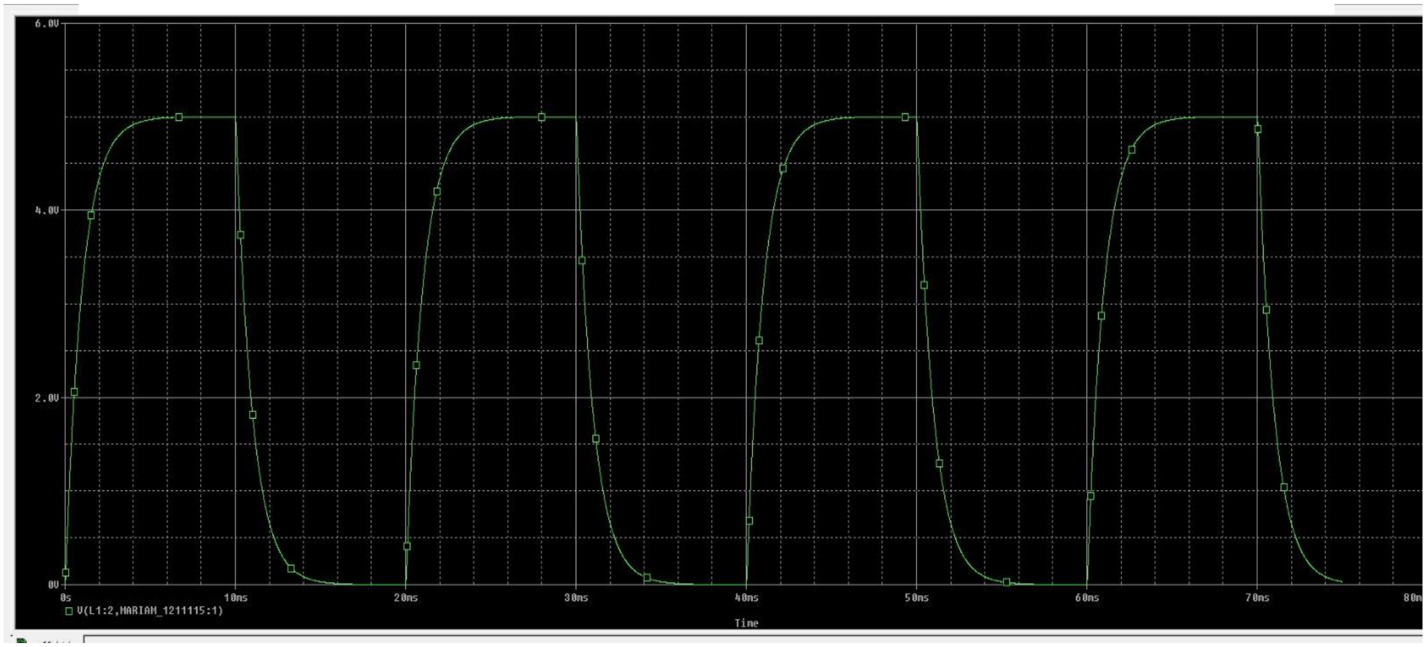


V_i (t) is Green V_C (t) is Red

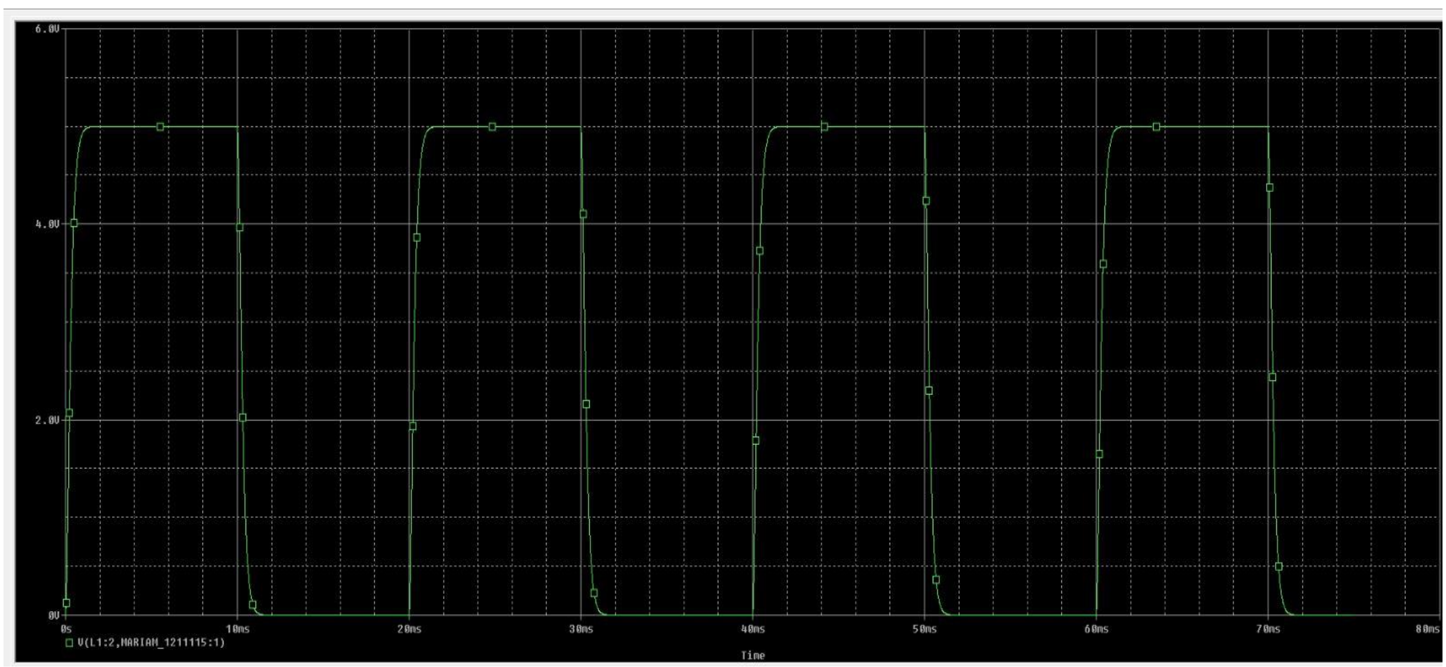


4- comment on each result:

Step1: is it over_damping



Step2: is it critical_damping



Step3 : is it under_dampin