EXPERIMENT 5
REPORT SHEET

Name : Mustafa Sezgin

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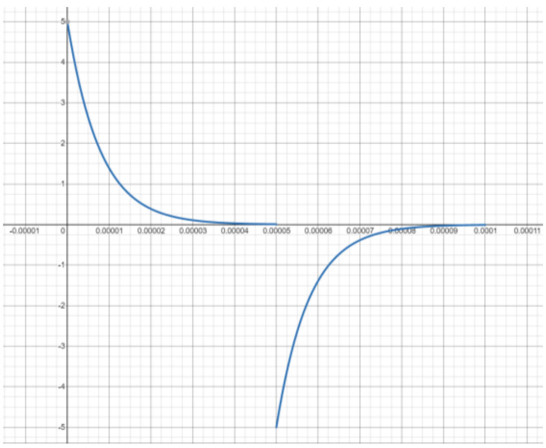
Preliminary Work :

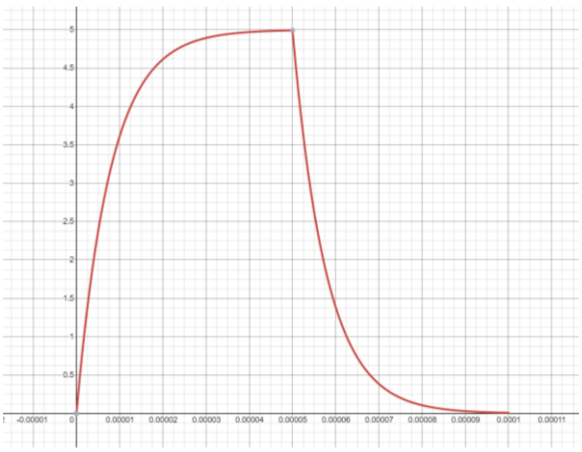
1.i.

When $0 \leq t < T/2$, we have
$-V_2 + V_L + V_R = 0$
$L(dI/dt) + IR = V_2$
$I(t) = (V_2/R)(1 - e^{-tR/L})$
$V_L(t) = L(dI(t)/dt) = V_2 e^{-tR/L}$
$V_R(t) = V_2 - V_L(t) = V_2(1 - e^{-tR/L})$

When $T/2 \leq t < T$, we have
$V_L + V_R = 0$
$L(dI/dt) + IR = 0$
$I(t) = (V_2/R)e^{-tR/L}$
$V_L(t) = L(dI(t)/dt) = -V_2 e^{-tR/L}$
$V_R(t) = -V_L(t) = V_2 e^{-tR/L}$

Graphs of $V_L(t)$ vs t, and $V_R(t)$ vs t, respectively.





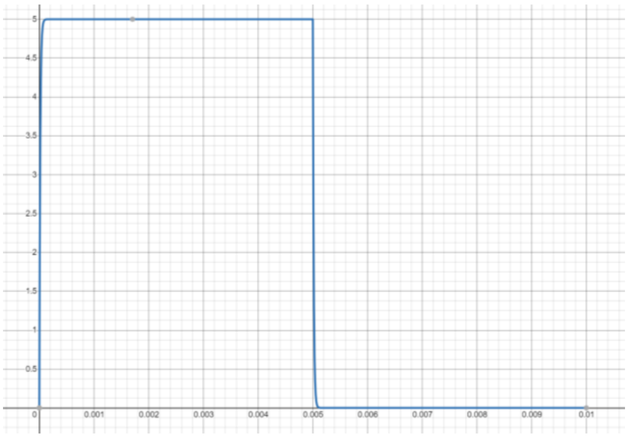
1.ii.
$\tau = L/R = 3.9mH/500\Omega = 7.8\times10^{-6}s$

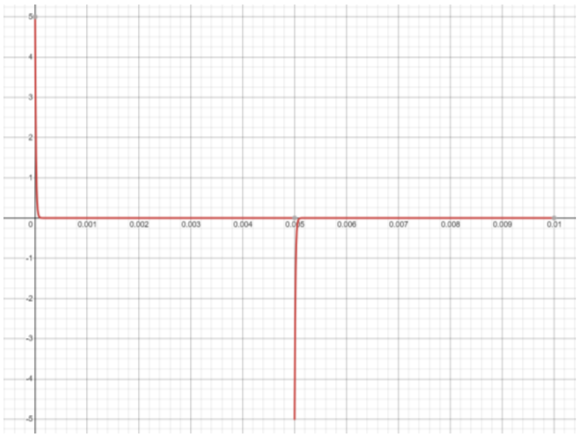
2.i.

When $0 \leq t < T/2$, we have
$-V_2 + V_R + V_C = 0$
$IR + V_C = V_2$
$RC(dV_C/dt) + V_C = V_2$
$V_C(t) = V_2(1 - e^{-t/RC})$
$V_R(t) = V_2 e^{-t/RC}$

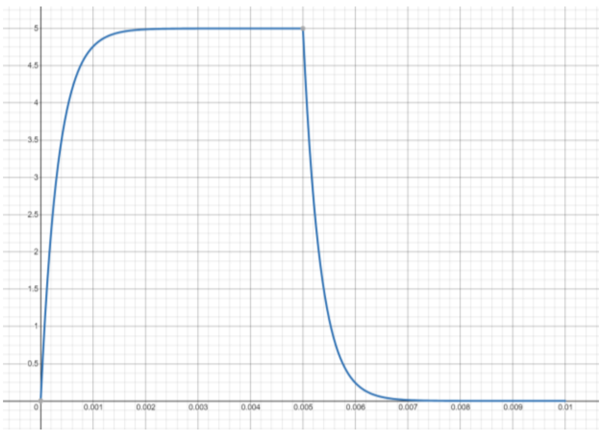
When $T/2 \leq t < T$, we have
$V_R + V_C = 0$
$IR + V_C = 0$
$RC(dV_C/dt) + V_C = 0$
$V_C(t) = V_2 e^{-t/RC}$
$V_R(t) = -V_2 e^{-t/RC}$

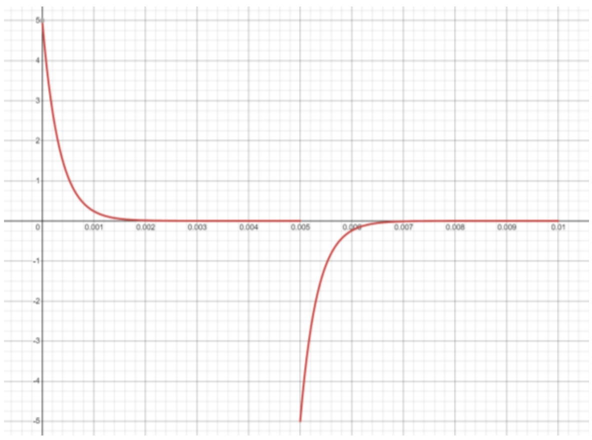
Graphs of $V_C(t)$ vs t, and $V_R(t)$ vs t for case 1, respectively.



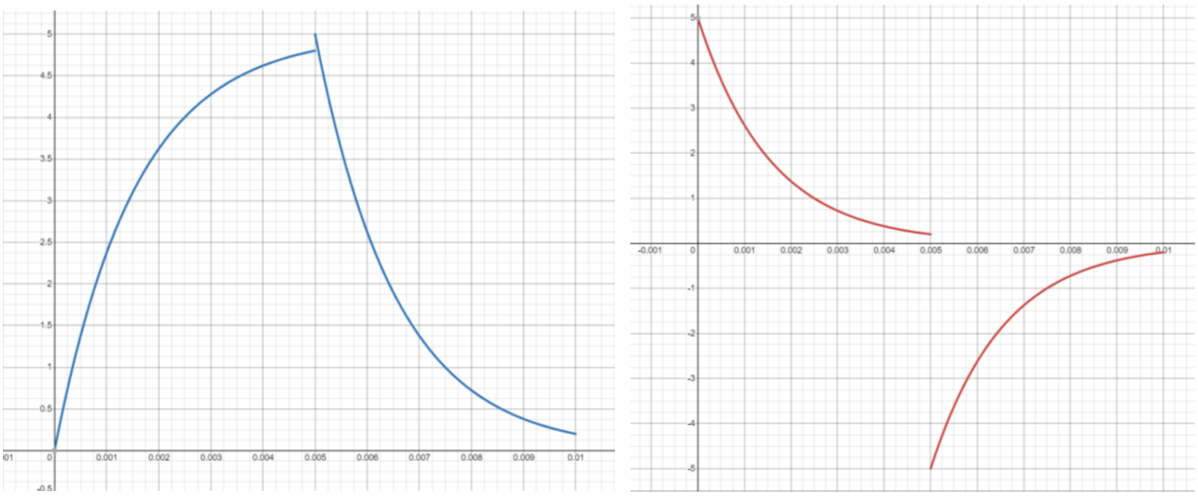


Graphs of $V_C(t)$ vs t, and $V_R(t)$ vs t for case 2, respectively.

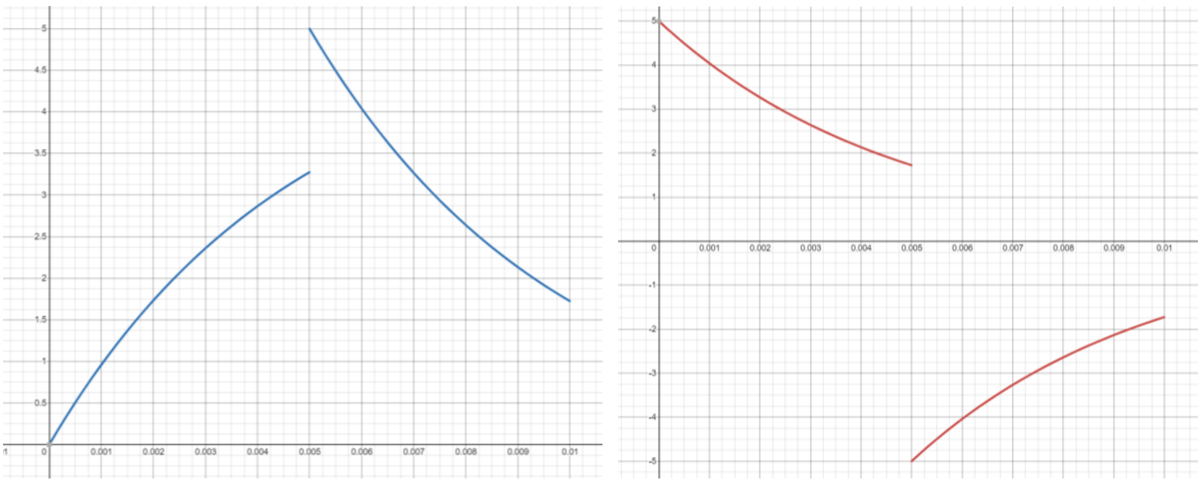




Graphs of $V_C(t)$ vs t, and $V_R(t)$ vs t for case 3, respectively.



Graphs of $V_C(t)$ vs t, and $V_R(t)$ vs t for case 4, respectively.



2.ii.
For case 1, τ = RC = (3.3kΩ)(4.7μF) = 1.6×10^{-5}s,
for case 2, τ = RC = (33kΩ)(10μF) = 3.3×10^{-4}s,
for case 3, τ = RC = (33kΩ)(47μF) = 1.6×10^{-3}s,
for case 4, τ = RC = (100kΩ)(47μF) = 4.7×10^{-3}s.

3. When t = τ, $V_R(t)$ in (**1**), and $V_c(t)$ in (**2**), gets (1-1/e) times the max value, which is 0.632×5, in the first half of the period.

Experimental Work :

Note : For each part, first, provide the LTspice circuit schematic and then corresponding scope output right below the schematic. Explain the figures with informative captions.

1. Provide the image of the schematic and plot all the signals in a single scope output. Comment on differences.

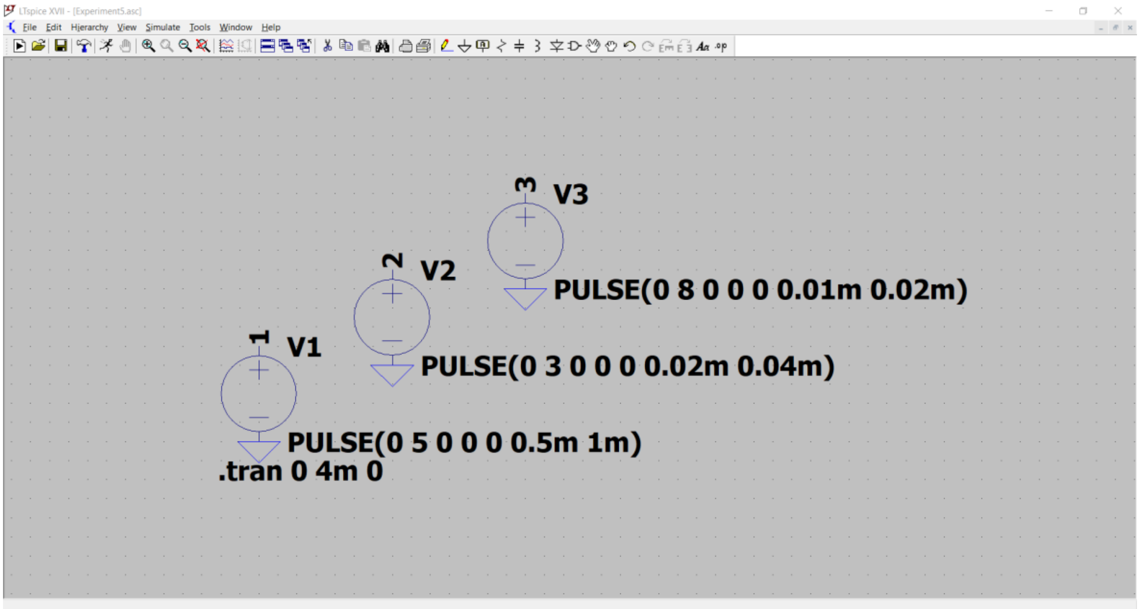


Figure 1: Schematic for question 1.

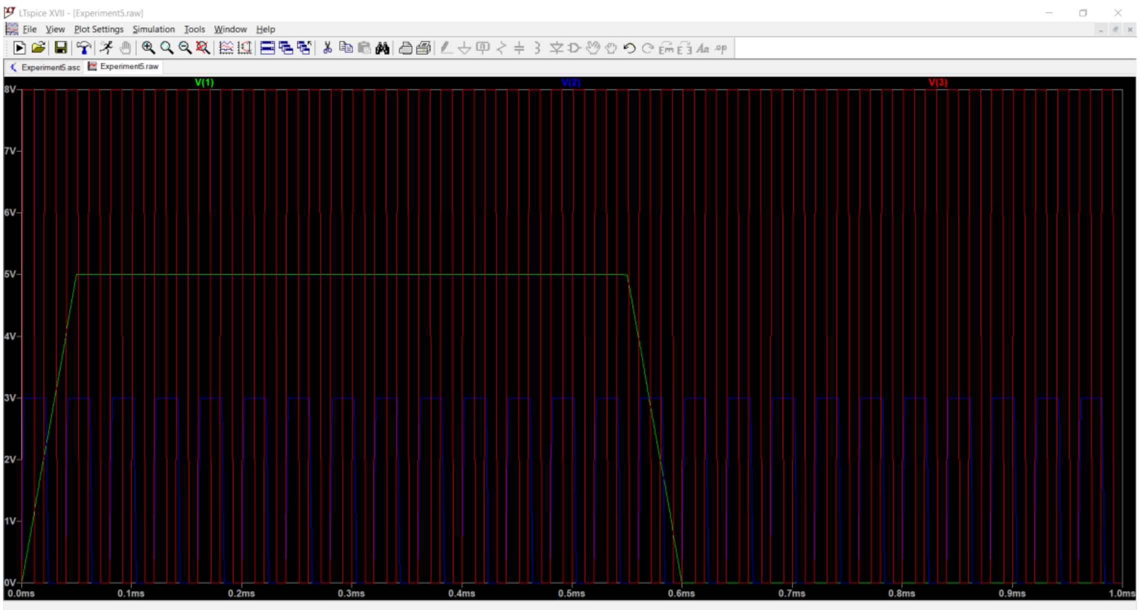


Figure 2: Scope output for question 1.

Comments: Periods of signal 1, 2, and 3 are 1ms, 40µs, and 20µs, respectively.

2. Provide the image of the schematic and plot the signals in a single scope output. Determine the time constant τ and briefly explain how you find it.

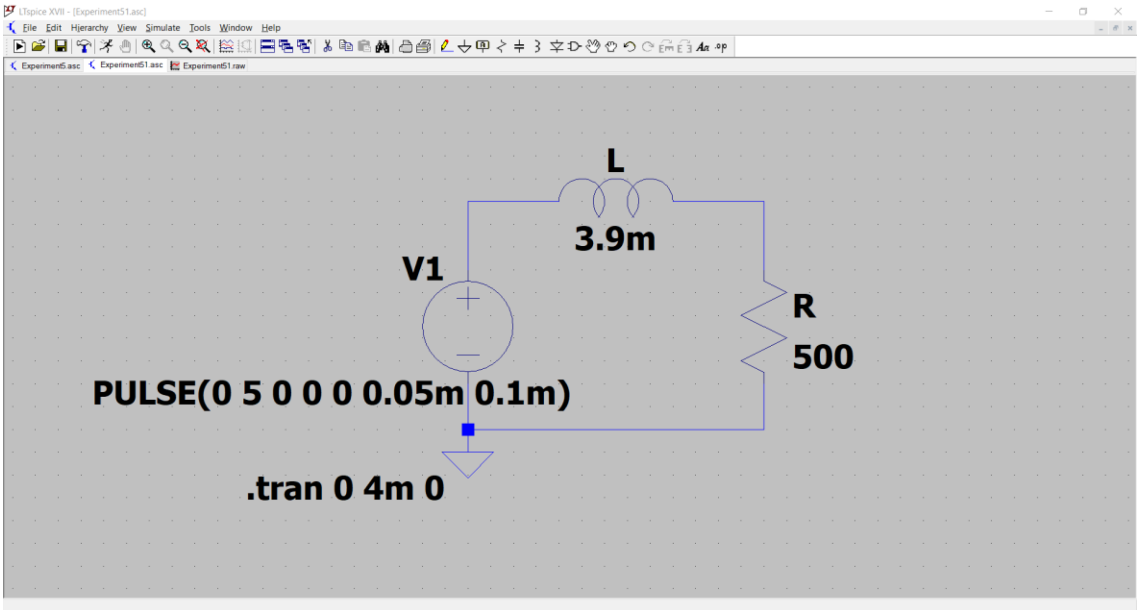


Figure 3: Schematic for question 2.

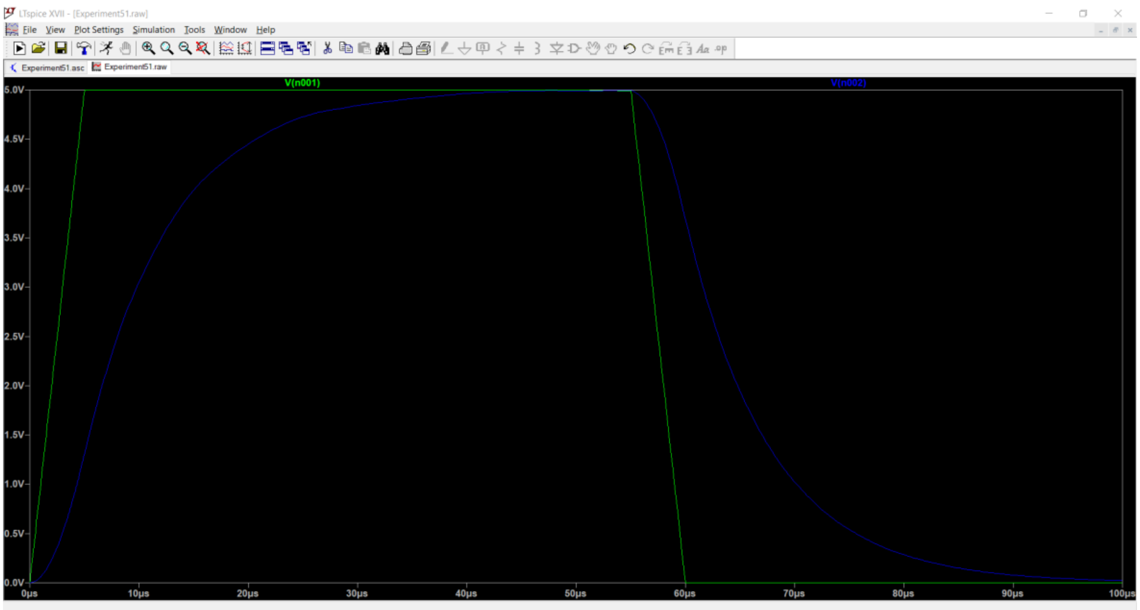


Figure 4: Scope output for question 2.

Time constant τ: 10.81µs

Comments: When t = τ, $V_R(t)$ gets (1-1/e) times the max value, which is 0.632×5, in the first half of the period.

3. Provide the image of the schematic and plot $V_{in}(t)$ and $V_R(t)$ in a single scope output. Also, plot $V_C(t)$ in a different scope output. Determine the time constant τ and briefly explain how you find it. Perform these steps for each case. Comment on your findings.

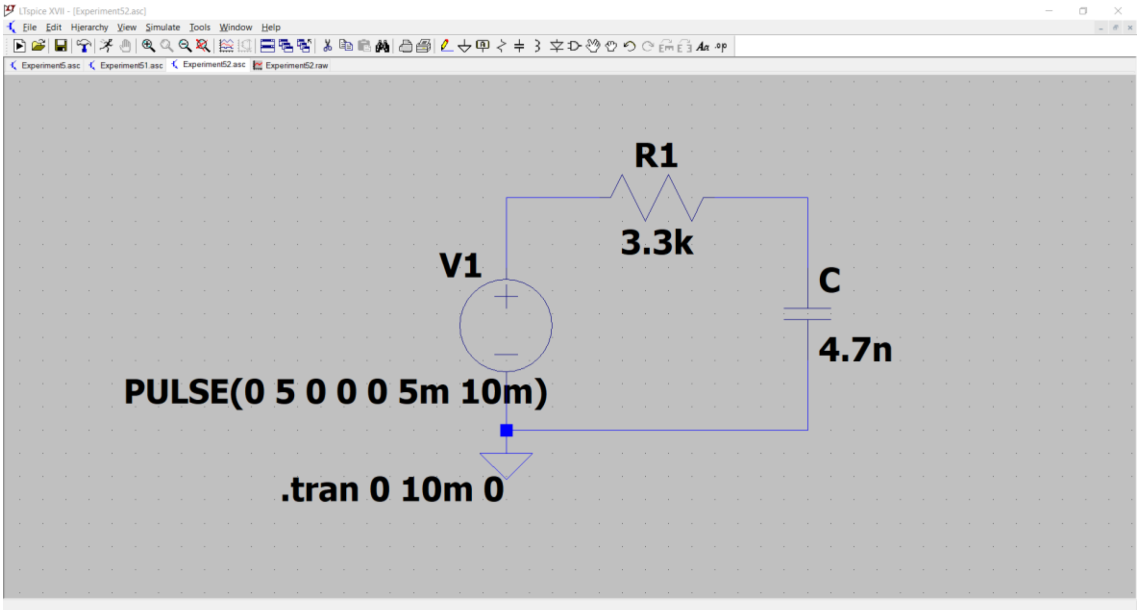


Figure 5: Schematic for question 3.

Case 1: f=100Hz, R=3.3kΩ, C = 4.7 nF

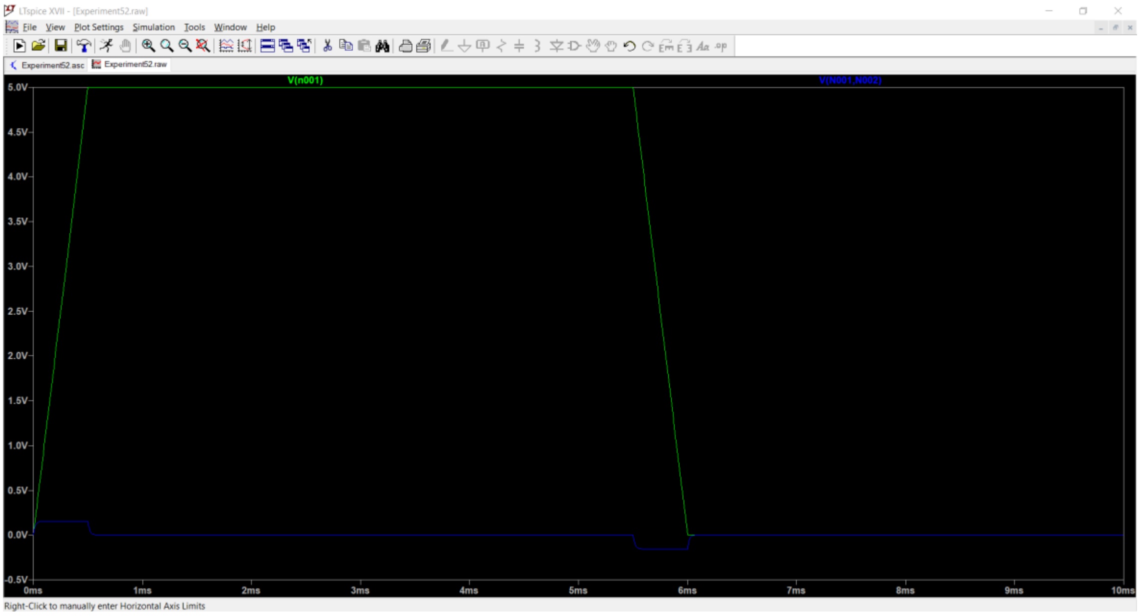


Figure 6: Scope Output for $V_{in}(t)$ and $V_R(t)$ for question 3, case 1.

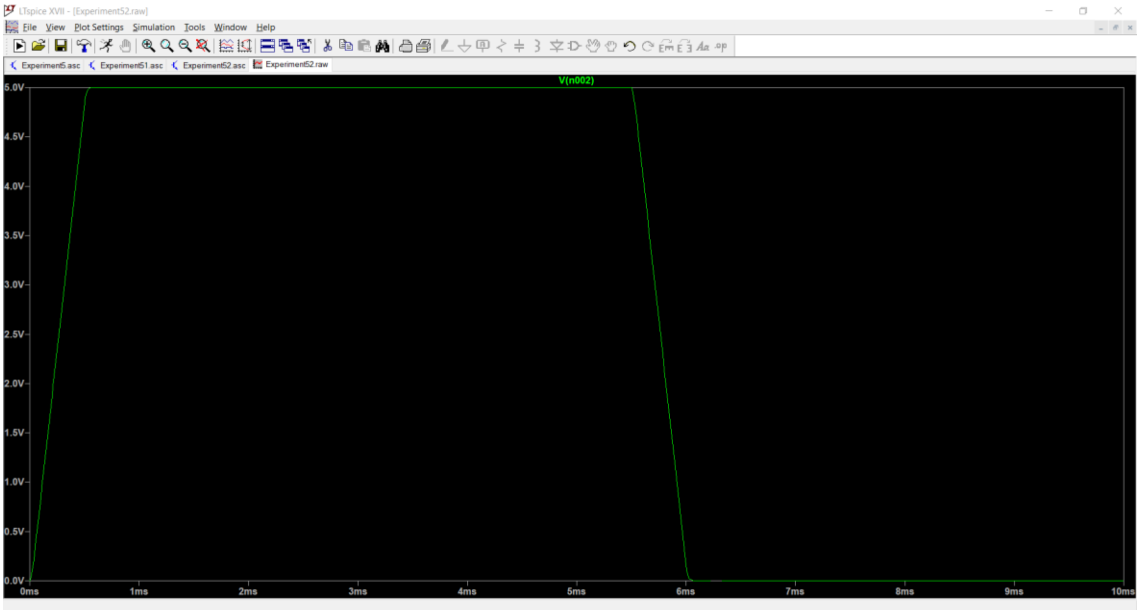


Figure 7: Scope Output for $V_C(t)$ for question 3, case 1.

Time constant τ: 0.332ms

Case 2: f=100Hz, R=33kΩ, C = 10 nF

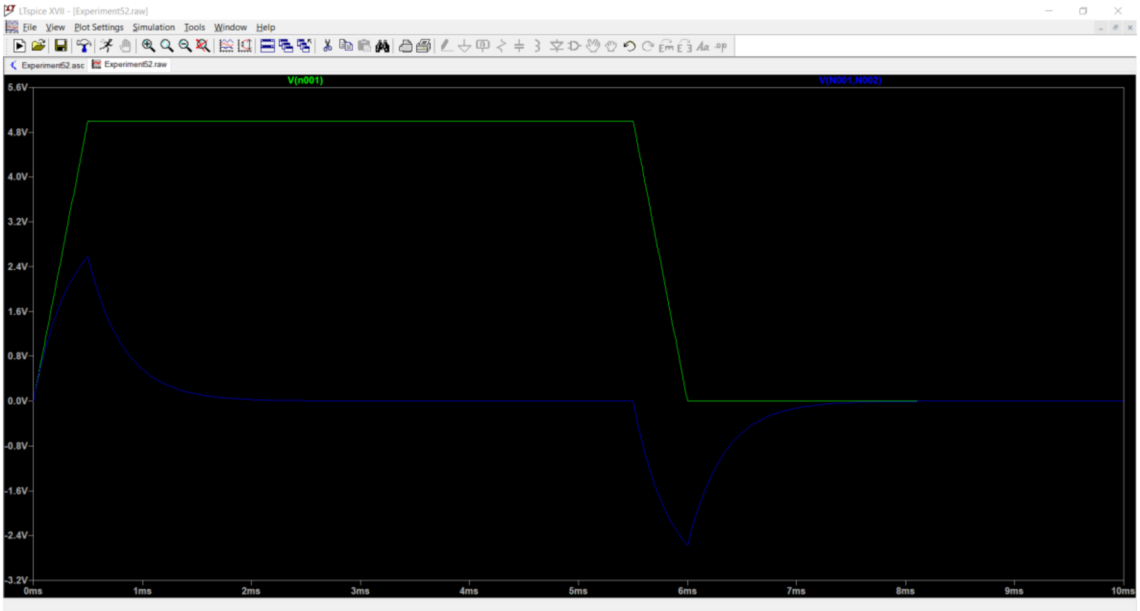


Figure 8: Scope Output for $V_{in}(t)$ and $V_R(t)$ for question 3, case 2.

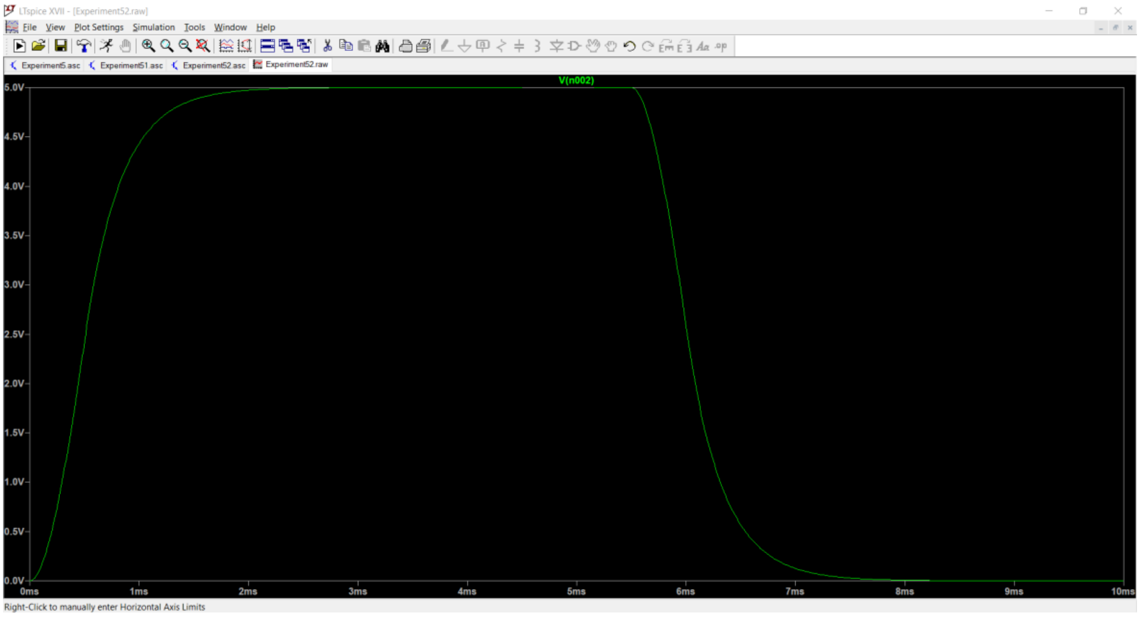


Figure 9: Scope Output for $V_C(t)$ for question 3, case 2.

Time constant τ: 0.611ms

Case 3: f=100Hz, R=33kΩ, C = 47 nF

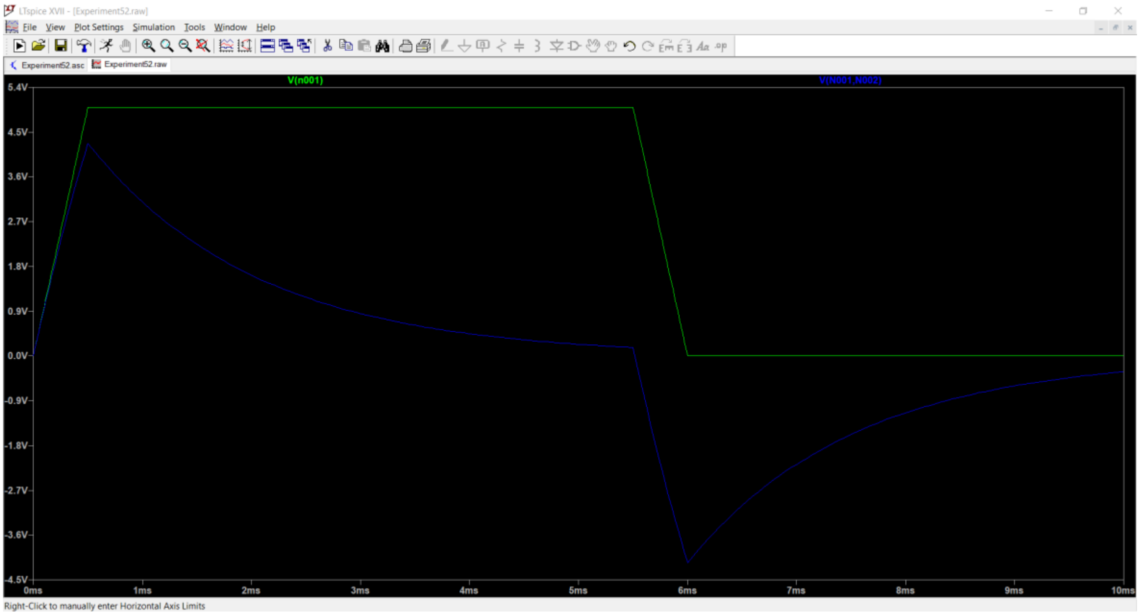


Figure 10: Scope Output for $V_{in}(t)$ and $V_R(t)$ for question 3, case 3.

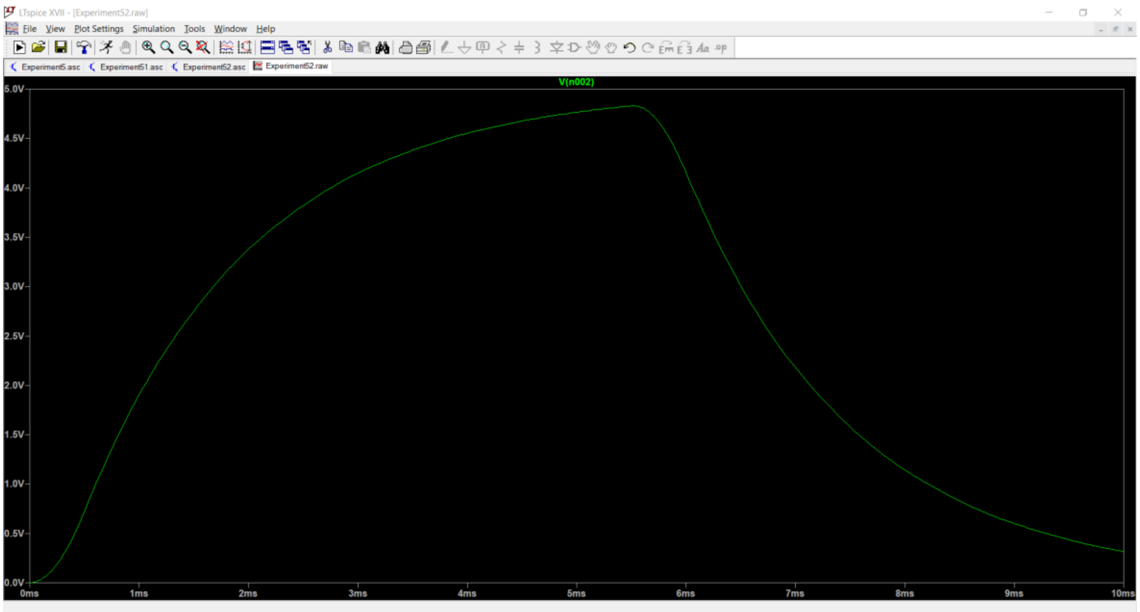


Figure 11: Scope Output for $V_C(t)$ for question 3, case 3.

Time constant τ: 1.806ms

Case 4: f=100Hz, R=100kΩ, C = 47 nF

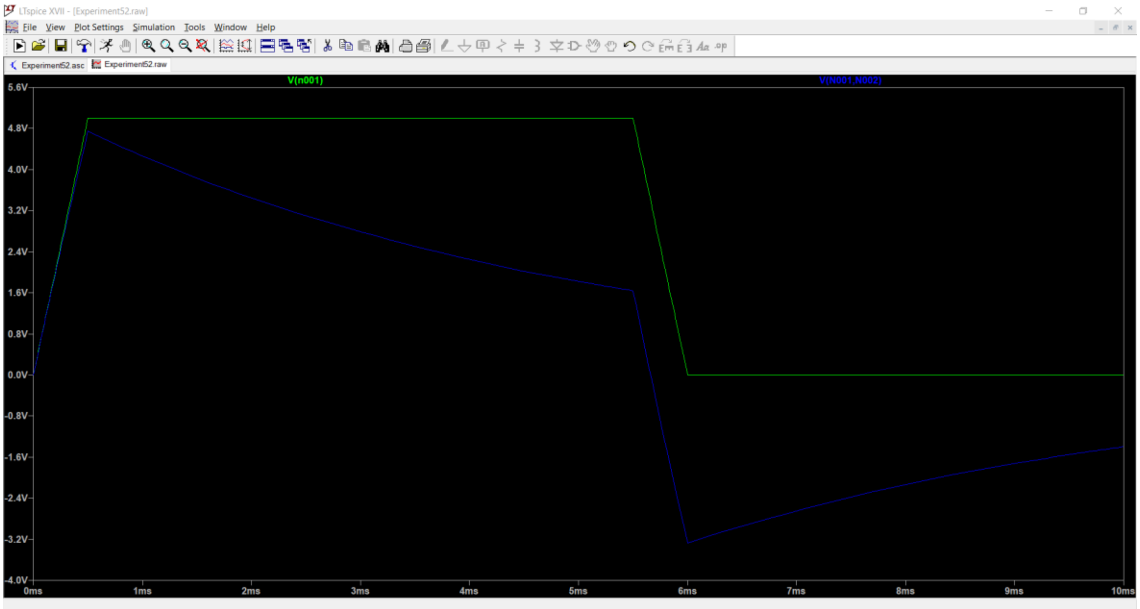


Figure 12: Scope Output for $V_{in}(t)$ and $V_R(t)$ for question 3, case 4.

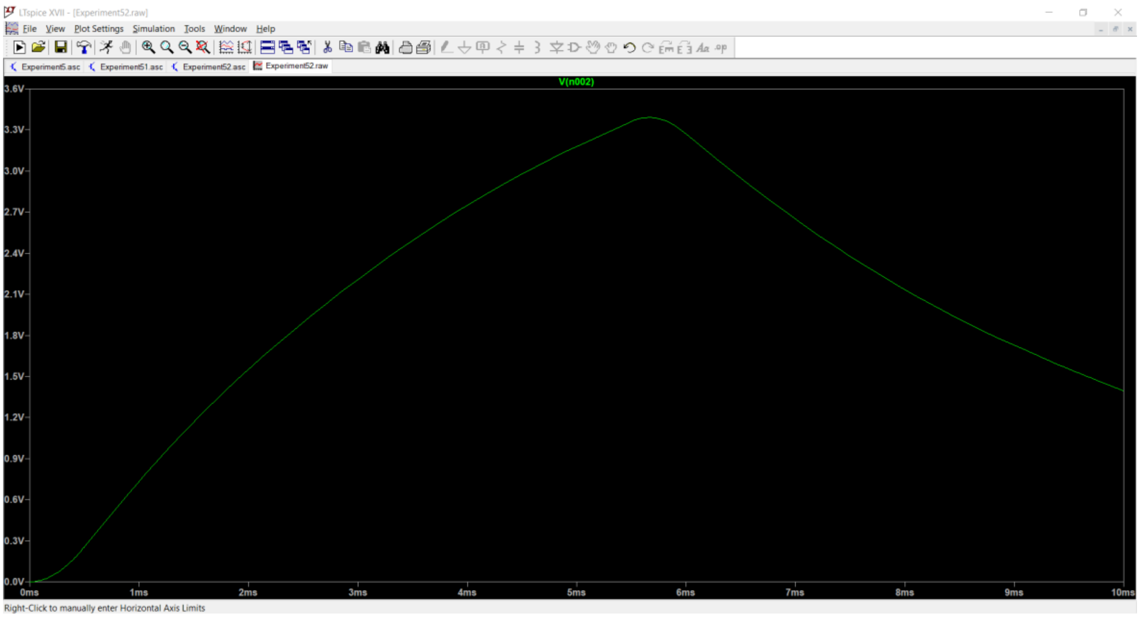


Figure 13: Scope Output for $V_C(t)$ for question 3, case 4.

Time constant τ: 4.948ms

Comments: When t = τ, $V_C(t)$ gets (1-1/e) times the max value, which is 0.632×5, in the first half of the period.

4. Conclusions:

i. Briefly explain how the time constant changes with the passive circuit elements.

In an RL circuit, if L increases, time constant also increases, and if equivalent resistance R increases, time constant decreases. This is because time constant is calculated as L/R. In an RC circuit, if R and/or C increase, time constant also increases. This is because time constant is calculated as RC. Experimentally, we can measure 63.2% of the max voltage value, at which the time value will be the time constant.