Faculty of Engineering and Technology Department of Electrical and Computer Engineering

Circuit Analysis – ENEE2304

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Section:4

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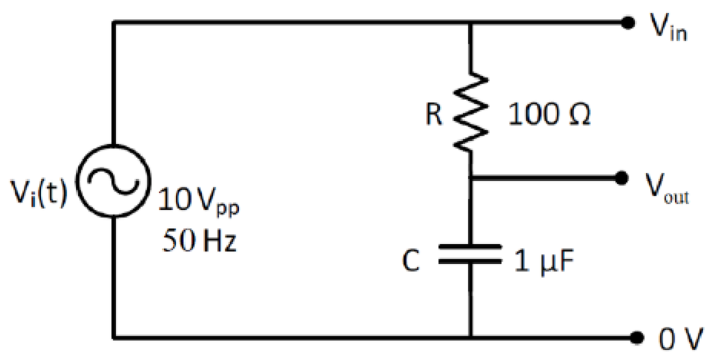
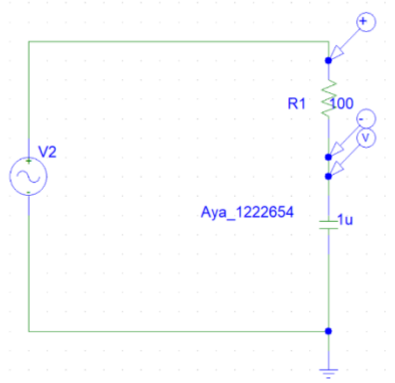
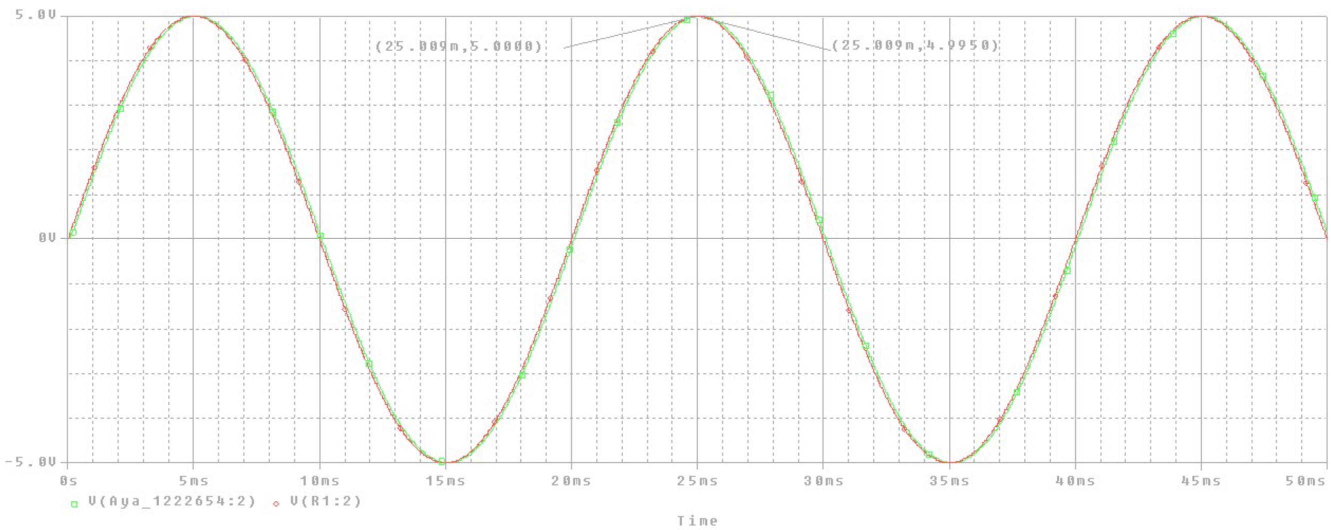
Question #1:

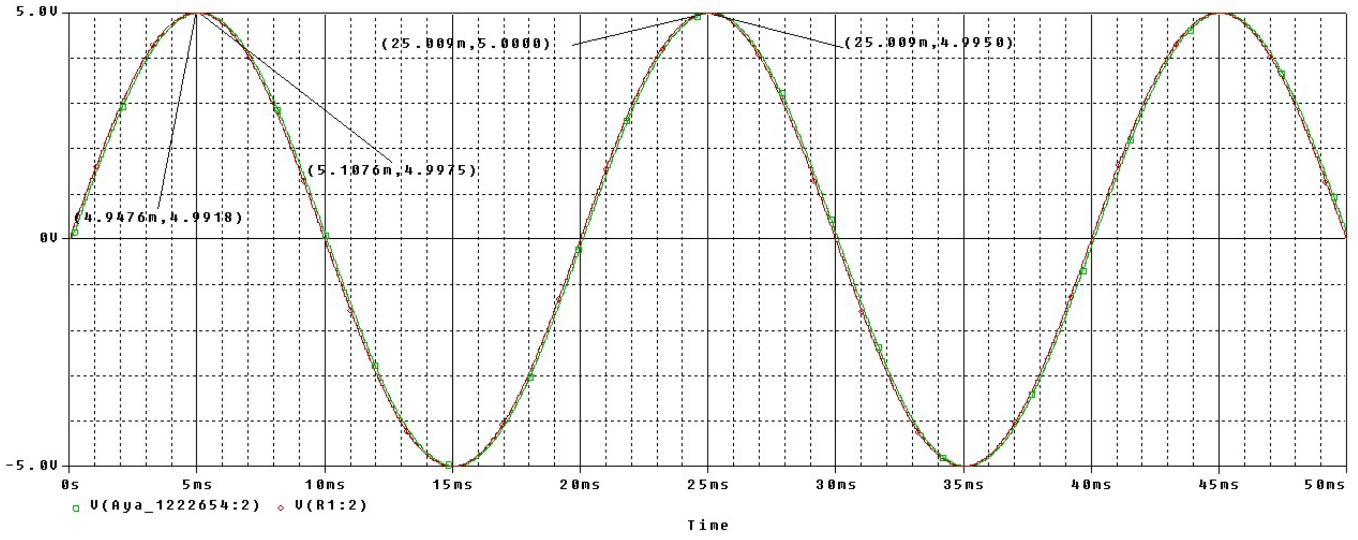
: Sinusoidal Steady State Analysis



1. Use PSPICE to do a transient analysis of the circuit, and show Vin(t) and Vout(t) on one plot (you may need to use different Y-axes).
2. Use cursors to measure the time difference between the peaks of the two signals, then use the following relationship to calculate the phase shift using the measured time $\{\Delta\boldsymbol{\theta}=360° \times f \times \Delta\mathbf{t}\}$.
3. 3. Discuss the results obtained.







$$\Delta\boldsymbol{\theta} = 360^\circ \mathbf{\ x\ f\ x\ } \Delta\mathbf{t} = 360^\circ * 50\text{Hz} * (5.1076 - 4.9476)\text{ms} = 1.8^\circ$$

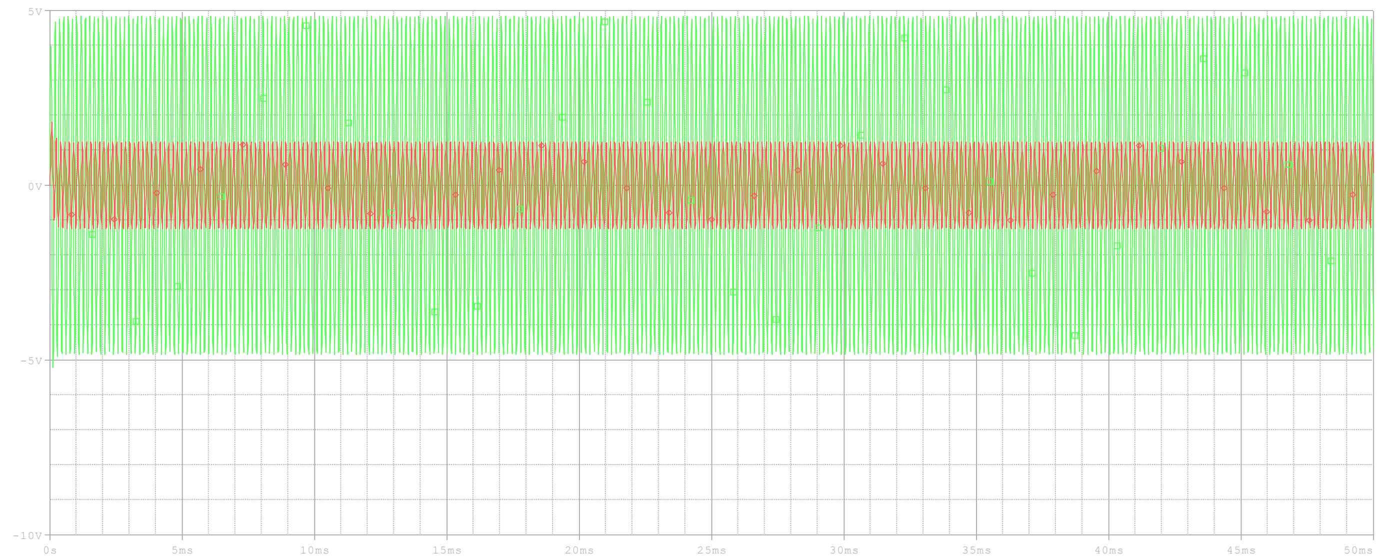
In the analysis of the circuit using PSPICE, several key aspects were explored to understand the behavior of the system under different conditions. Let's delve into a detailed discussion of the results obtained:

1. Transient Analysis and Waveform Plotting:
   - The transient analysis provided insights into how the circuit responds to changes over time. By plotting Vint(t) and Vout(t) on the same graph with distinct Y-axes, we could visualize the input and output waveforms simultaneously.
   - The plot allowed us to observe any transient effects, steady-state behavior, and the relationship between the input and output signals.
2. Phase Shift Calculation:
   - By measuring the time difference between the peaks of Vint(t) and Vout(t) using cursors, we calculated the phase shift between the two signals.
   - The phase shift value obtained signifies the delay or advancement of the output waveform relative to the input waveform. This information is crucial in understanding the circuit's response to the input signal.
3. Interpretation of Phase Shift:
   - A phase shift of 1.8° (or any specific value calculated) indicates the temporal displacement between Vint(t) and Vout(t). This phase shift can result from various factors such as circuit components, frequency response, and signal processing.
   - Understanding the phase relationship between input and output signals is essential for analyzing the circuit's behavior, especially in applications where phase alignment is critical.

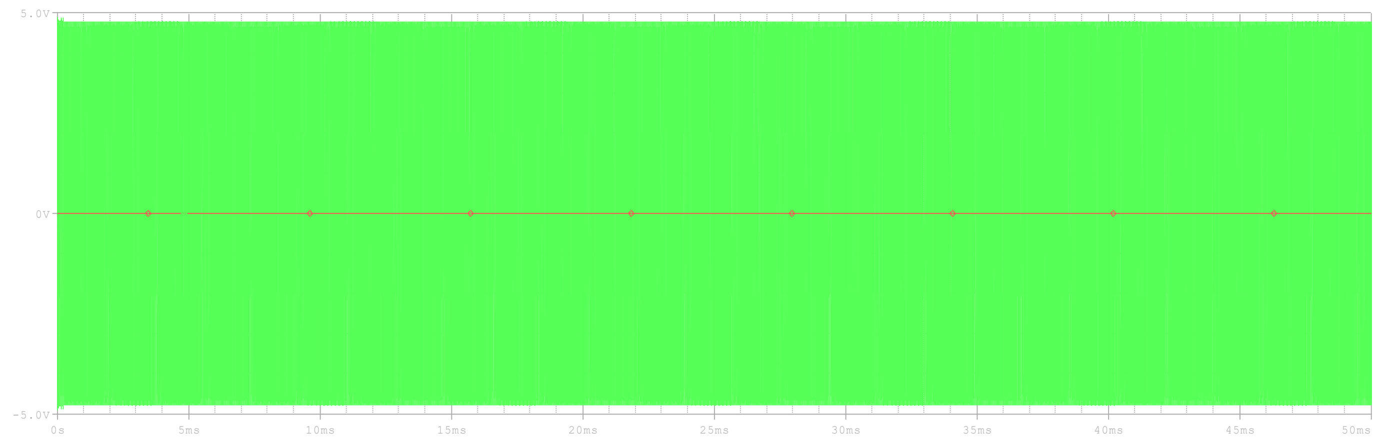
4. We want to change the input frequency three times, and make it equal to: f2= (your ID number / 500) Hz, for example, 1219999/500 = 2439.998 Hz f3 = (your ID number / 200) Hz f4 = (your ID number) Hz For each time, draw Vout(t), compare and discuss the results obtained.

When f2 = 1222654/500 = 2445.308

When f3 = 1222654/200 = 6113.27



When f4= 1222654



- Changing the input frequency to f2, f3, and f4 provided valuable insights into how the circuit responds to different frequency stimuli.
- By plotting Vout(t) for each frequency change and comparing the results, we could observe variations in amplitude, phase shift, and waveform shape. These differences reflect the circuit's frequency-dependent characteristics.

Discussion of Frequency Response:

- The comparison of Vout(t) at different frequencies revealed how the circuit's output is influenced by changes in the input frequency. Variations in frequency can impact the circuit's response, resonance behavior, and filtering characteristics.
- Analyzing the results obtained at different frequencies helps in understanding the circuit's frequency response and identifying any frequency-dependent phenomena.

Question #2:

Second-Order RLC Circuit Analysis

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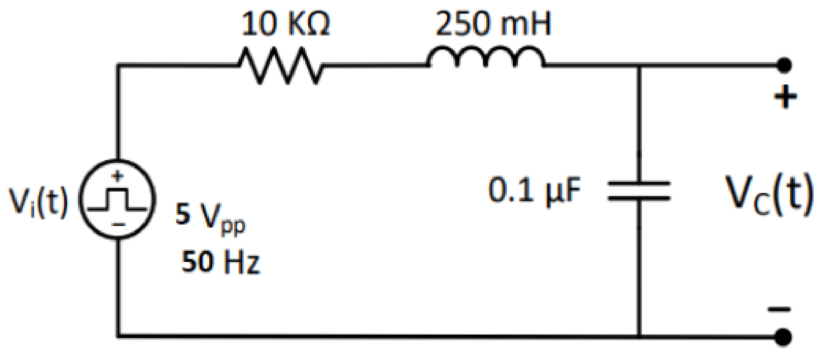
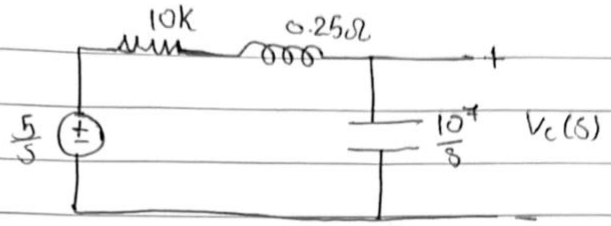


Part A:

Find Vc(t) using Laplace transform but assume the input voltage Vi(t)= 5 volt (step function)



$$V_C(S) = \frac{10^7/S}{10\times10^3 + 0.25S + 10^7/S} \times \frac{5}{S}$$

$$= \frac{5\times10^7}{S(0.25S^2 + 10\times10^3 S + 10^7)}$$

$$= \frac{20\times10^7}{S(S^2 + 40\times10^3 S + 4\times10^7)}$$

$$= \frac{K_1}{S} + \frac{K_2 S + K_3}{S^2 + 40\times10^3 S + 4\times10^7}$$

$$20\times10^7 = K_1S^2 + 40\times10^3 K_1 S + 4\times10^7 K_1 + K_2 S^2 + K_3 S$$

$4\times10^7 K_1 = 20\times10^7 \Rightarrow A = 5$

$A + B = 0 \Rightarrow \quad B = -5$

$40\times10^3 A + C \Rightarrow \quad C = -2\times10^5$

$$V_C(S) = \frac{5}{S} + \frac{-5S - 2\times10^5}{S^2 + 40\times10^3 S + 4\times10^7}$$

$$\frac{-b \mp \sqrt{b^2 - 4ac}}{2a} \rightarrow S_1 = -1026.3 \quad , \quad S_2 = -38973.6$$

$$\frac{-5S - 2\times10^5}{S^2 + 40\times10^3 S + 4\times10^7} = \frac{X_1}{S + 1026.33} + \frac{X_2}{S + 38973.6}$$

$$X_1\Big|_{S_1 = -1026.3} = -5.135 \qquad X_2\Big|_{S = -38973.6} = 0.135$$

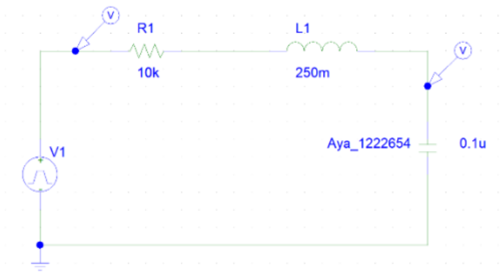
$$V_C(t) = \mathcal{L}^{-1}\left\{\frac{5}{S} - \frac{5.135}{S + 1026.3} + \frac{0.135}{S + 38973.6}\right\}$$

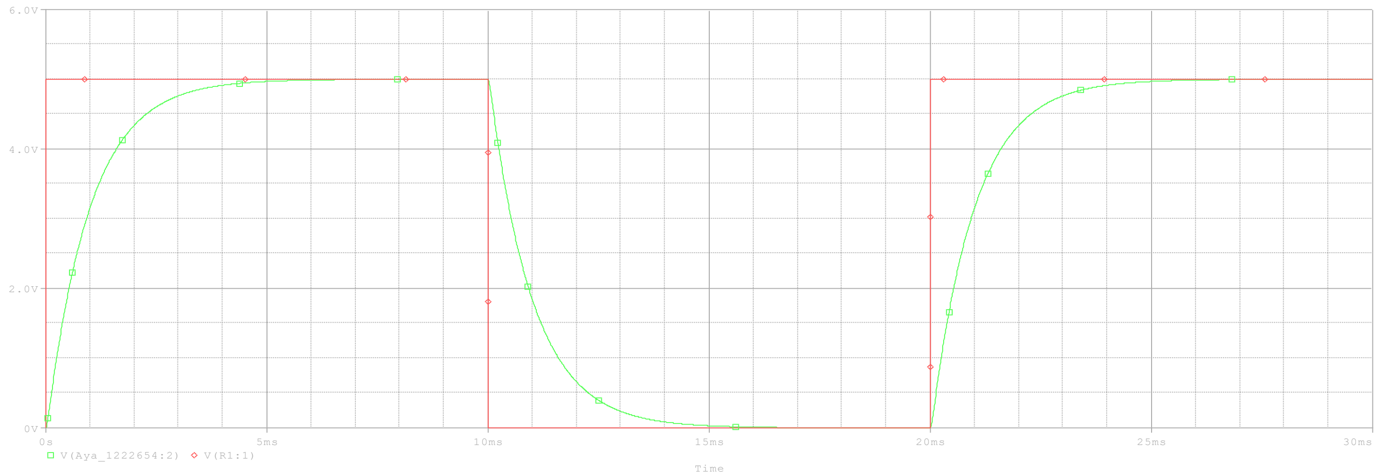
$$V_C(t) = (5 - 5e^{-1026.3} + 0.135e^{-38973.6})\,u(t)\ V$$

Part B:

The input voltage is square signal with 5 Vpeak-peak (0 V to 5 V) and frequency of 50Hz.

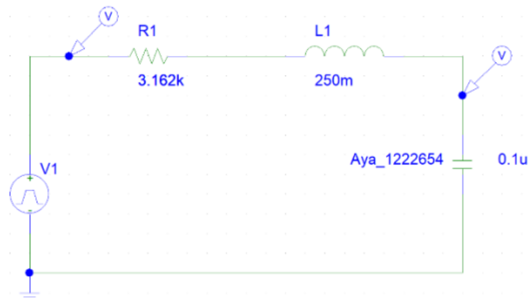
1. Use Pspice software to plot both Vi(t) and Vc(t) (on the same graph).

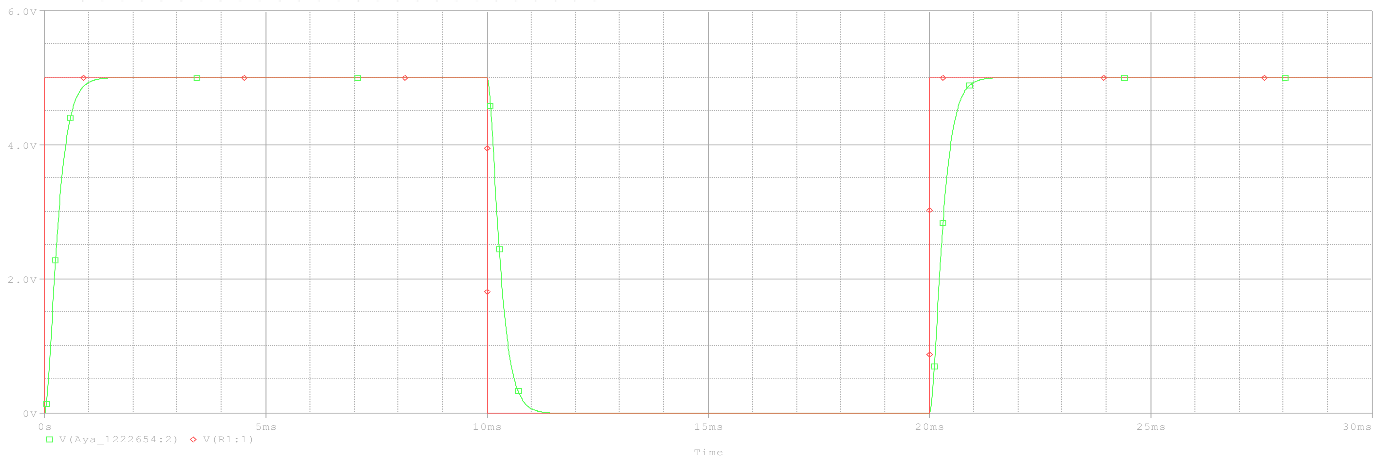




Based on the graph, exhibits characteristics of an Over-damping response

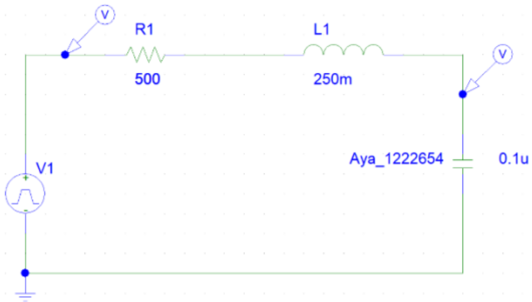
2. Change the Value of R to 3.162 kΩ, repeat step 1.

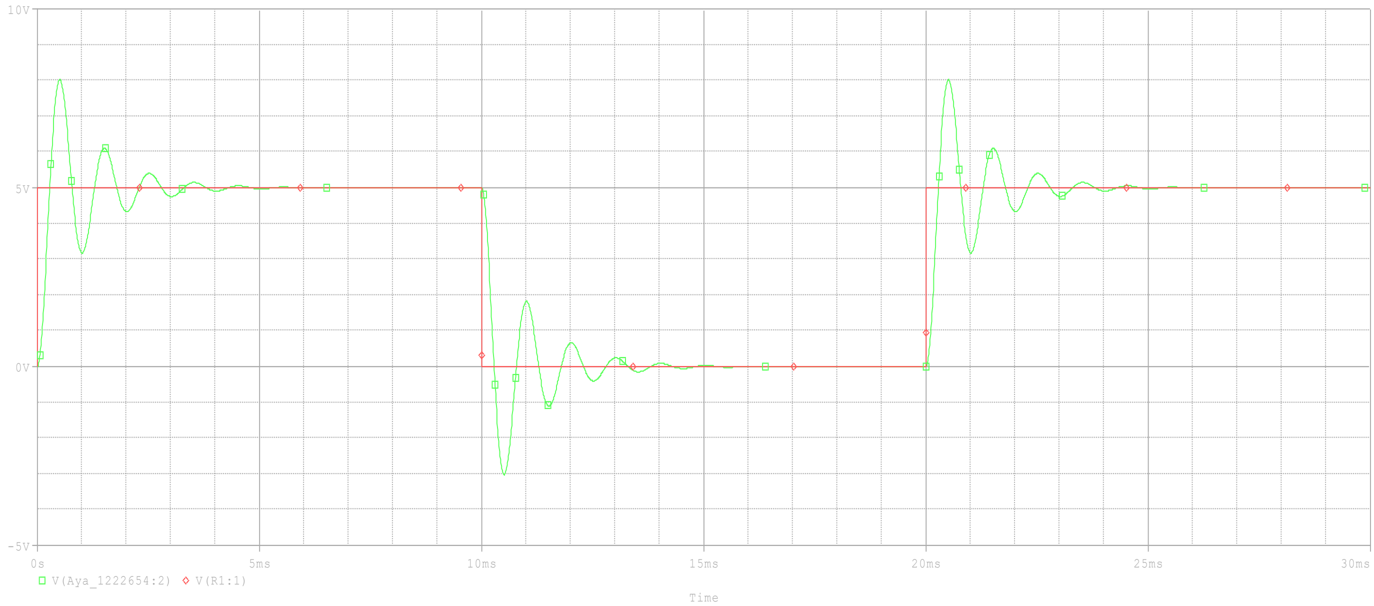




Based on the graph, exhibits characteristics of an critical-damping response

3. Change the Value of R to 500 Ω, repeat step 1.





Based on the graph, exhibits characteristics of an underdamped response

4. Comment on each result: is it over-damping, critical-damping, or under-damping response.

Over-damping: The system returns to equilibrium without oscillating but takes a longer time to reach stability.

Critical-damping: The system returns to equilibrium as quickly as possible without oscillating.

Under-damping: The system oscillates before settling to the final value.