Faculty of Engineering and Technology Department of Electrical and Computer Engineering

Circuit Analysis – ENEE2304

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Section:1

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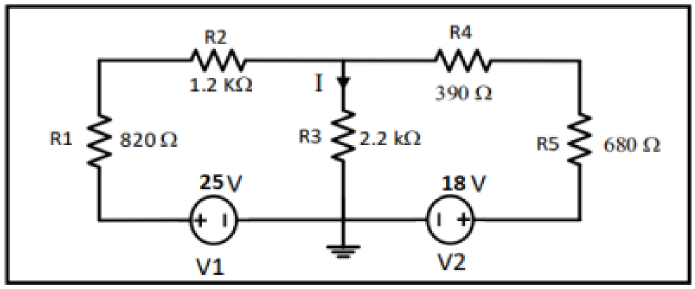
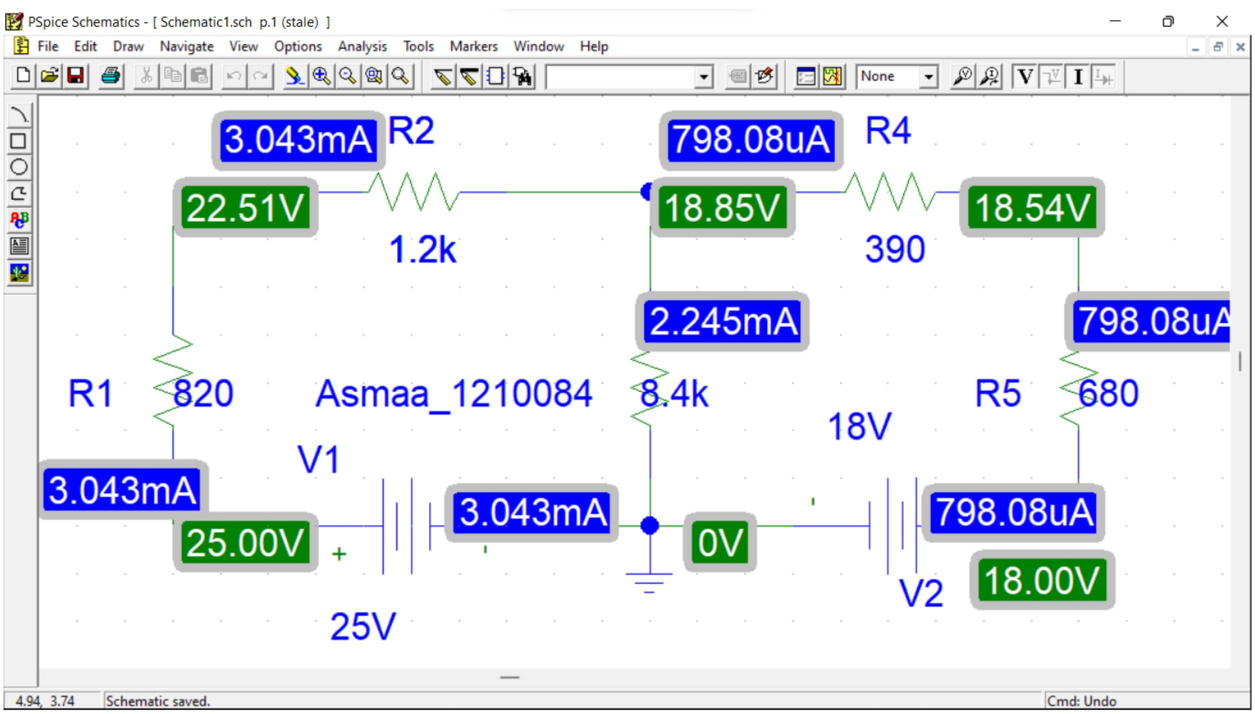
Question # 1: Superposition Technique

For the circuit:



1. Use Pspice software to simulate the circuit and get the voltage across and the current through the resistor R3.
2. Apply superposition theorem to get the voltage across and the current through the resistor R3. You have to show all the results of simulation.
3. Compare the results obtained from step 1 and step 2.

Q1) Part 1 :

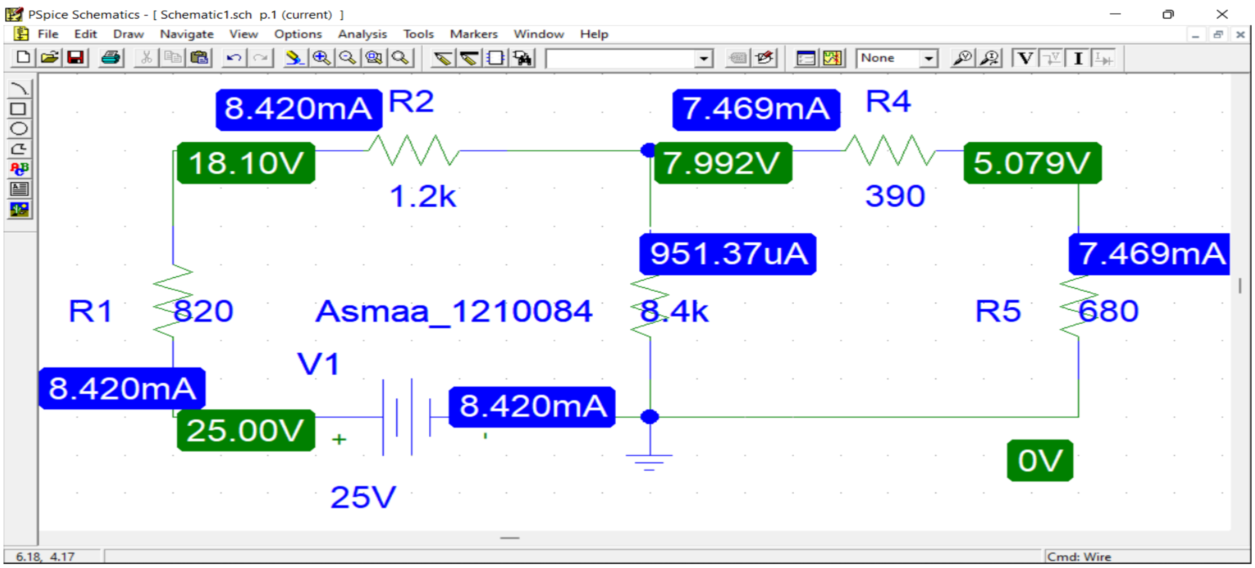


Voltage across the resistor R3(Asmaa_1210084) = 18.85V

Current through the resistor R3(Asmaa_1210084) =2.24mA

Q1) Part 2 :

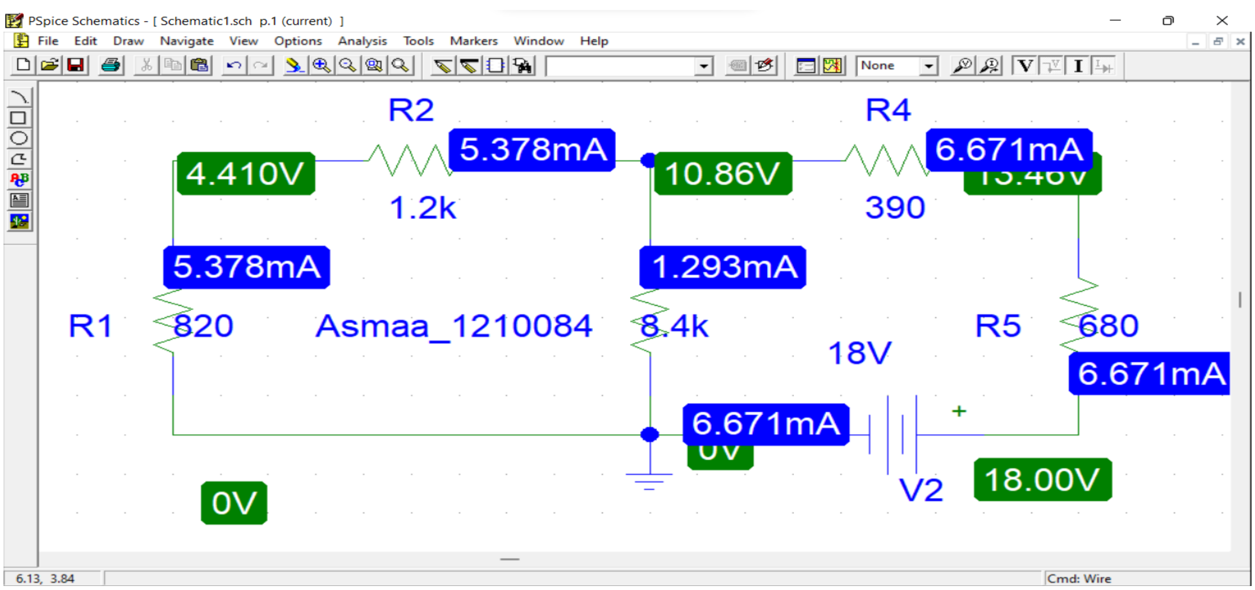
From V1 :



Voltage across the resistor R3(Asmaa_1210084) is (Va) = 7.992V

Current through the resistor R3(Asmaa_1210084) is (Ia) = 951.37uA

From V2 :



Voltage across the resistor R3(Asmaa_1210084) is (Vb) = 10.86V

Current through the resistor R3(Asmaa_1210084) is (Ib) = 1.293mA

BY SUPERPOSITION THEOREM:

Voltage across the resistor R3(Asmaa_1210084) = Va + Vb

= 7.992V + 10.86V

= 18.85200 volts

Current through the resistor R3(Asmaa_1210084) = Ia + Ib

= 0.95137mA+ 1.293mA

= 2.24437 milliamperes

Q1) Part 3 :

The results in from both the original circuit and the superposition theorem are the same, since superposition theorem is equivalent to the original circuit.

Result before superposition :

Voltage across the resistor R3(Asmaa_1210084) = 18.85V

Current through the resistor R3(Asmaa_1210084) =2.24mA

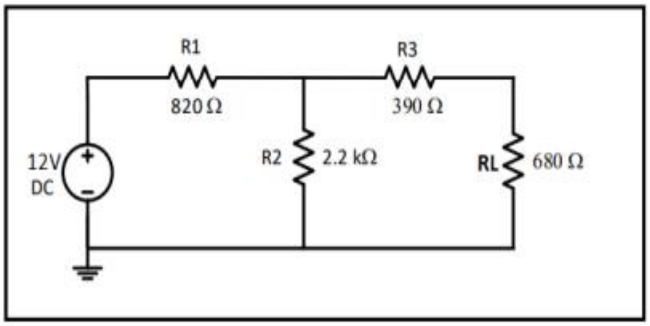
Result with superposition :

Voltage across the resistor R3(Asmaa_1210084) =18.85200 V

Current through the resistor R3(Asmaa_1210084) =2.24437mA

Question #2: Thevenin's Theorem & Maximum Power Transfer

For the circuit:



1. Use Pspice software to simulate this circuit and get the voltage across and the current through the resistor RL (xxx (last three digits) Ω).

2. Using DC sweep, set RL as a parameter that varies from 50 Ω to 1.5 kΩ and plot the power dissipated by RL as it varies (plot the power of RL versus the value of RL). With the help of cursors on Pspice simulation window, approximate at which value of RL the power maximizes)

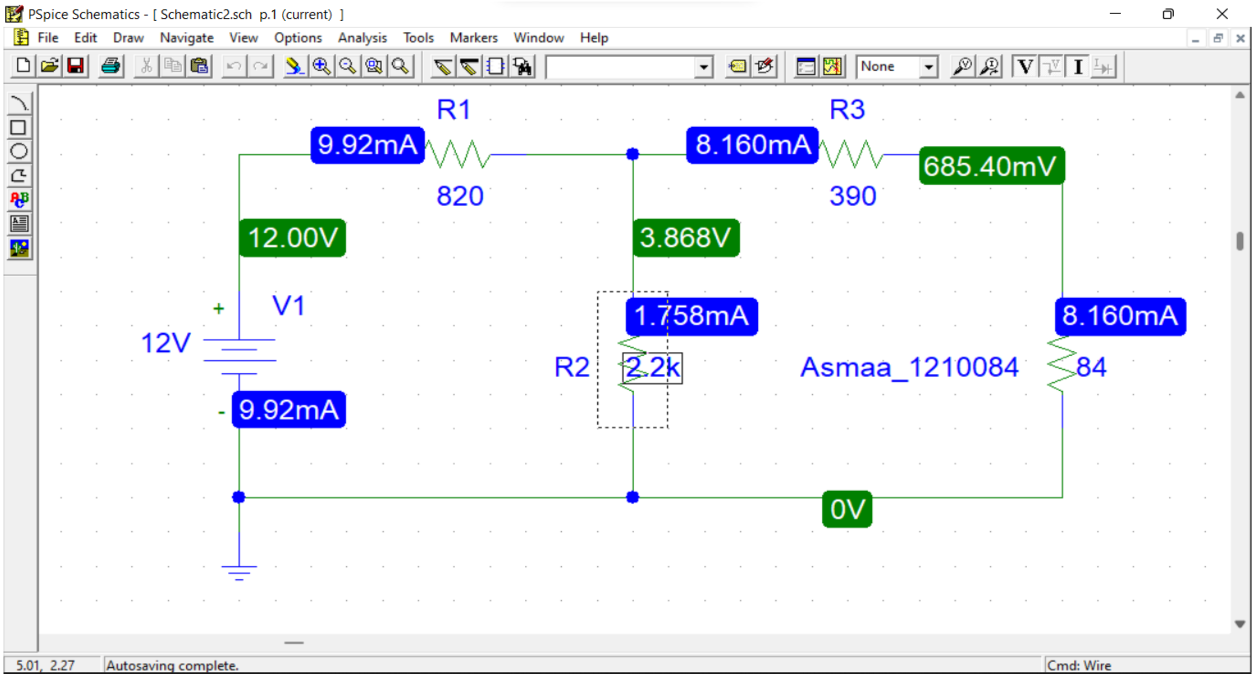
3. Use Pspice software to calculate Rthevenin seen by the resistor RL. Use Voc and Isc method only. You have to show all the simulation results when getting Voc and Isc.

4. Compare the value of RL at Pmax obtained from step 2 and the value of Rthevenin obtained from step 3.

5. Build and then simulate the Thevenin equivalent circuit with the load resistor RL and show the voltage across and the current through the resistor RL.

6. Compare the results obtained from step 1 and step 5.

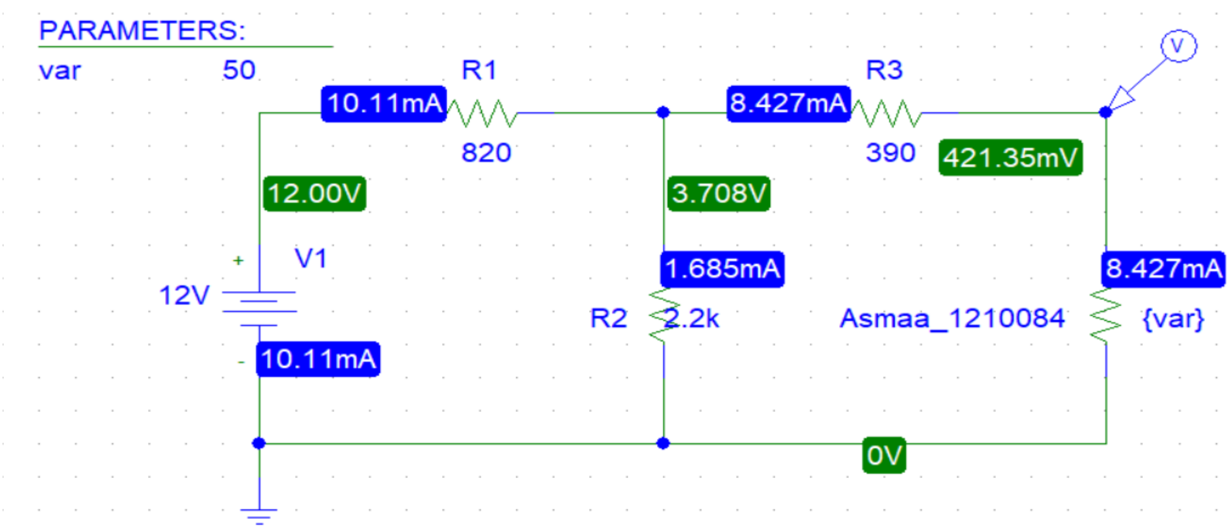
Q2) Part 1:

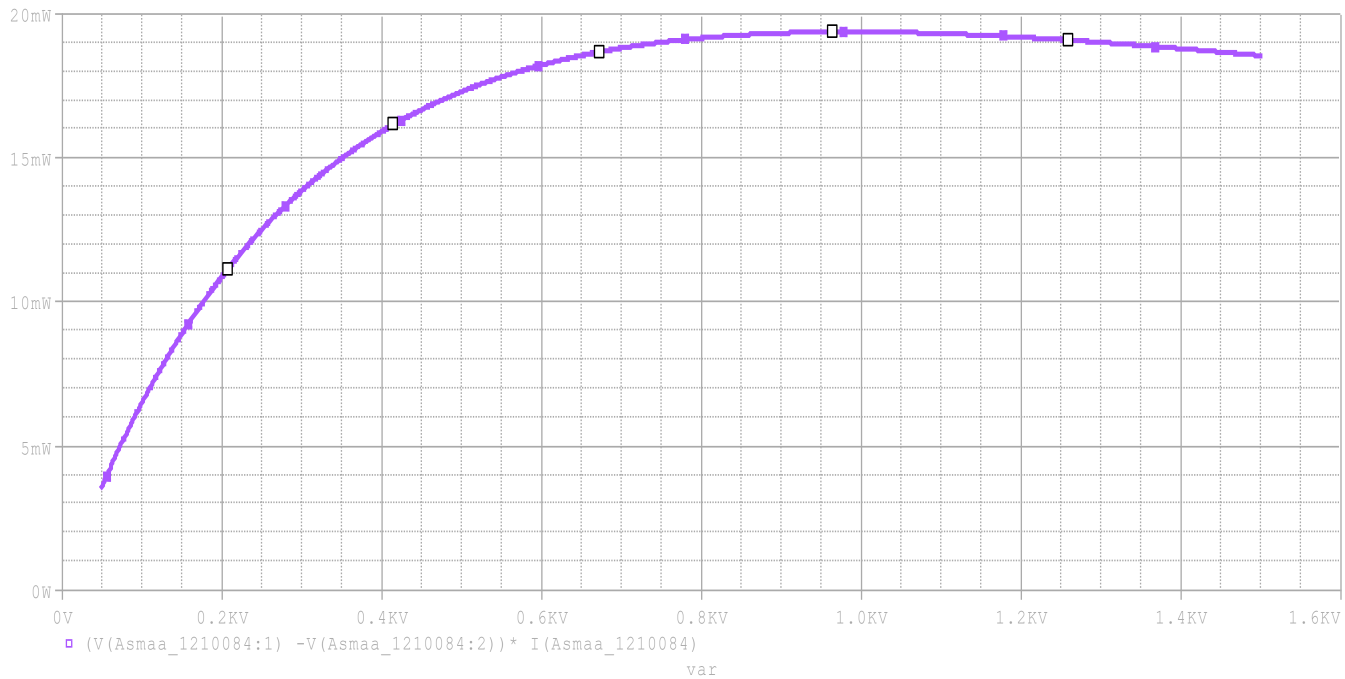


Voltage across the resistor RL (Asmaa_1210084) = 685.4mV

Current through the resistor RL (Asmaa_1210084) = 8.16mA

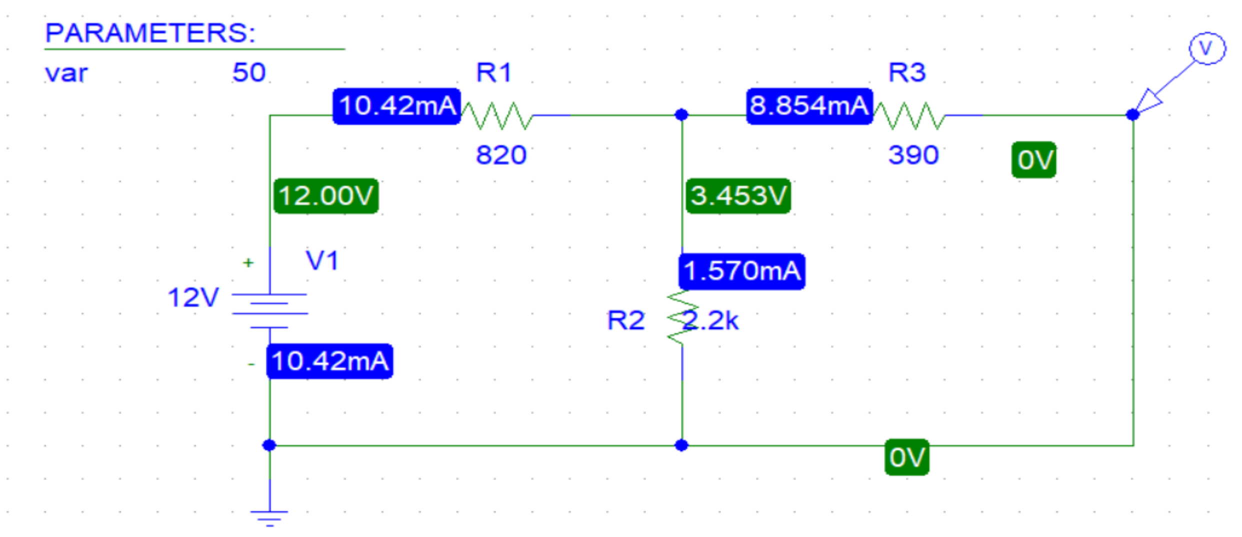
Q2) Part 2:



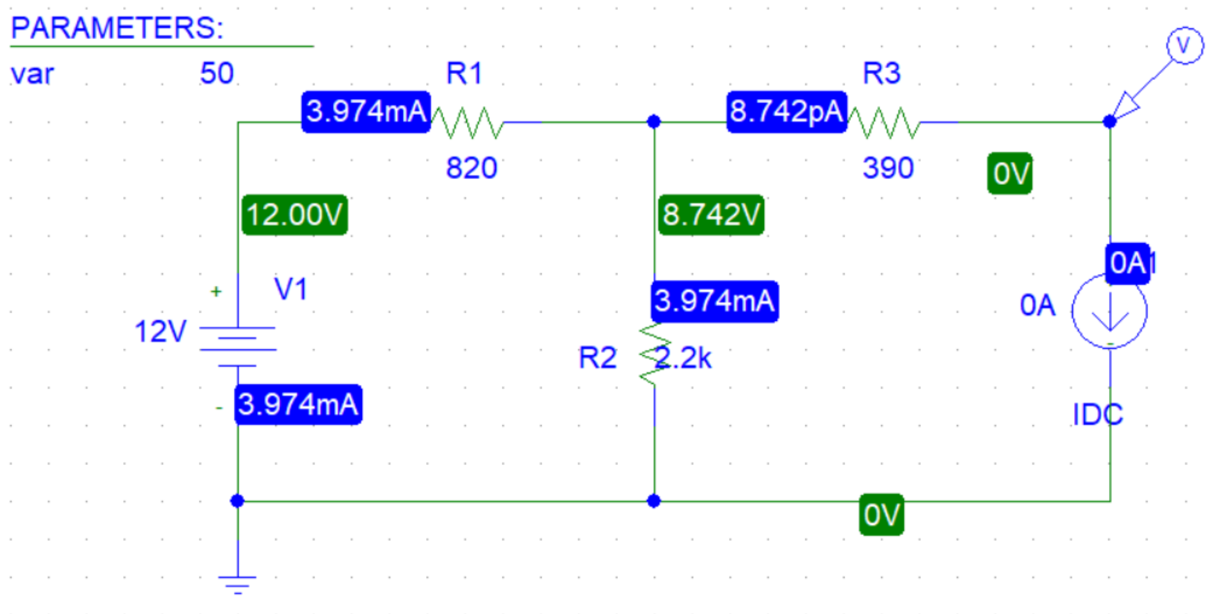


The value of RL(Asmaa_1210084) at the maximum power approximately equals 1k

Q2) Part 3:



- Isc (short circuit) equals 8.854mA



Voc (open circuit) equals 8.742V

*Voc is founded by putting a zero current source and finding the voltage across it

Rth = Voc / Isc = 8.742V / 8.854mA = 987.350 ohm

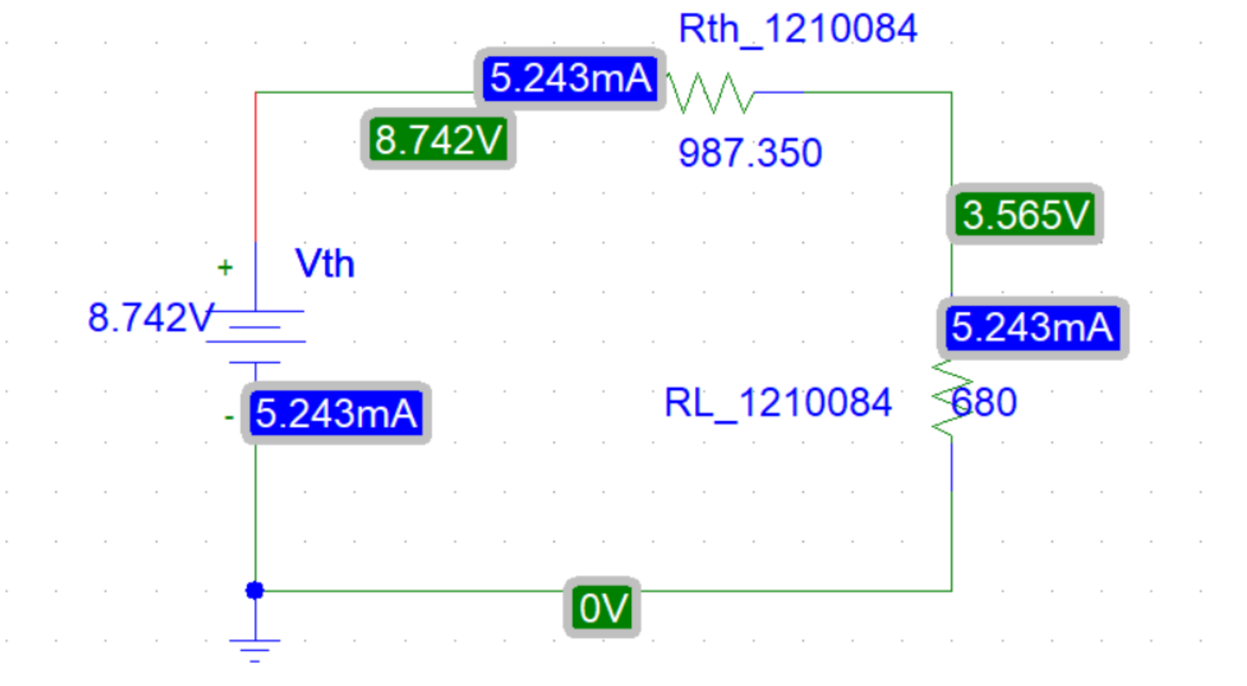
Q2) Part 4:

In step 2, we approximated RL to be 1k ohm. In step 3, Rth founded to be

987.350ohm.

Which as it is clear that the value of RL (from part 2) is almost equal to the value of Rth (from part 3).

Q2) Part 5:



Voltage across the resistor RL (RL_1210084) = 3.565V

Current through the resistor RL (RL_1210084) = 5.243mA

Q2) Part 6:

The results from both parts one & five are the same results. Because Thevenin's circuit is equivalent to the original circuit.

Question # 3: Sinusoidal Steady State Analysis

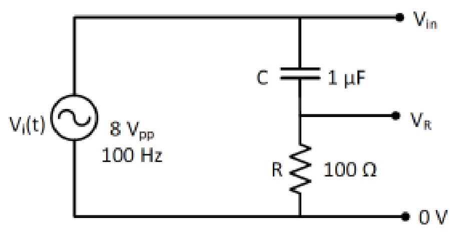


Fig. 3.1 Capacitive circuit

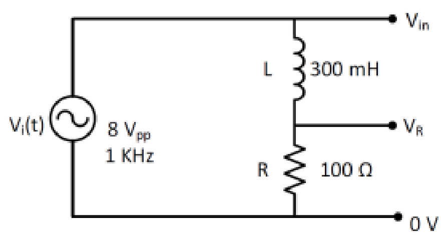


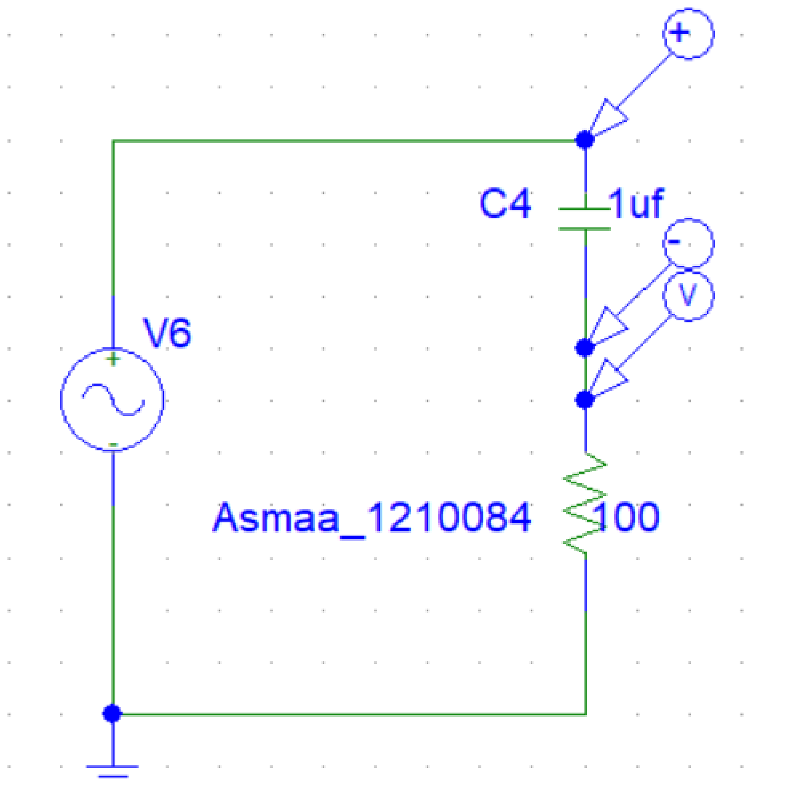
Fig. 3.2 Inductive circuit

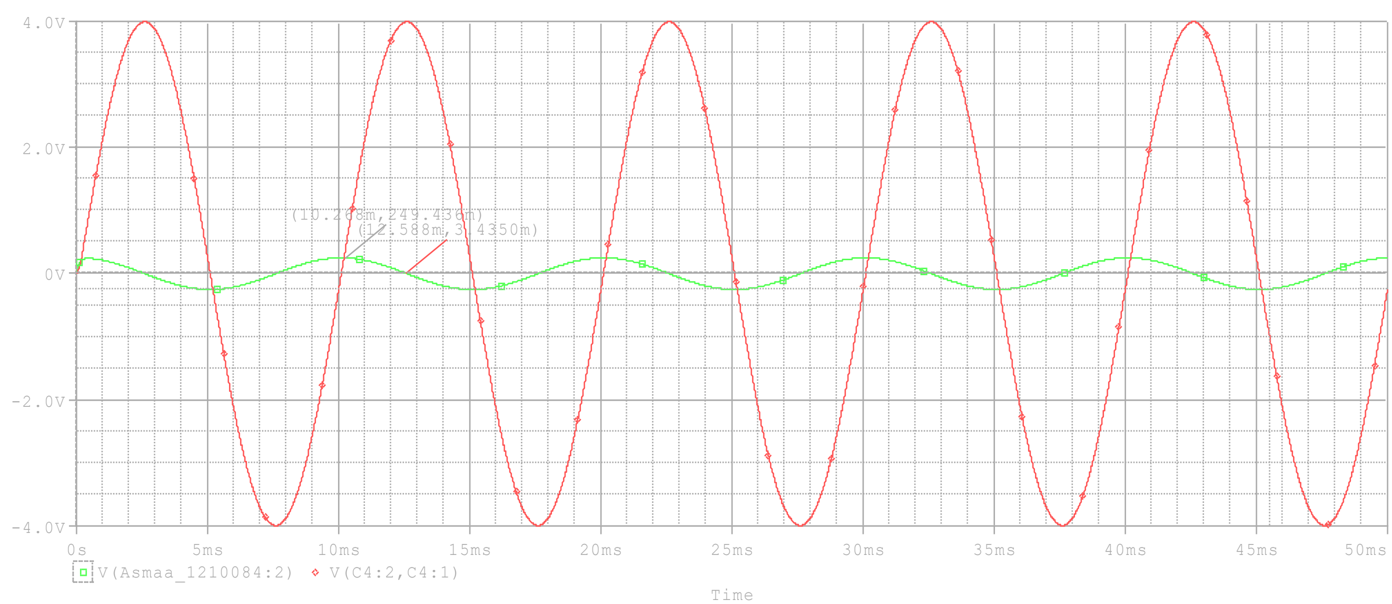
1.Use PSPICE to do transient analysis of the circuit, show Vin(t) and VR(t) on one plot (you may need to use different Y-axes).

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 {$\Delta\boldsymbol{\theta}=360° \mathbf{\ x\ f\ x\ } \Delta\mathbf{t}$}.

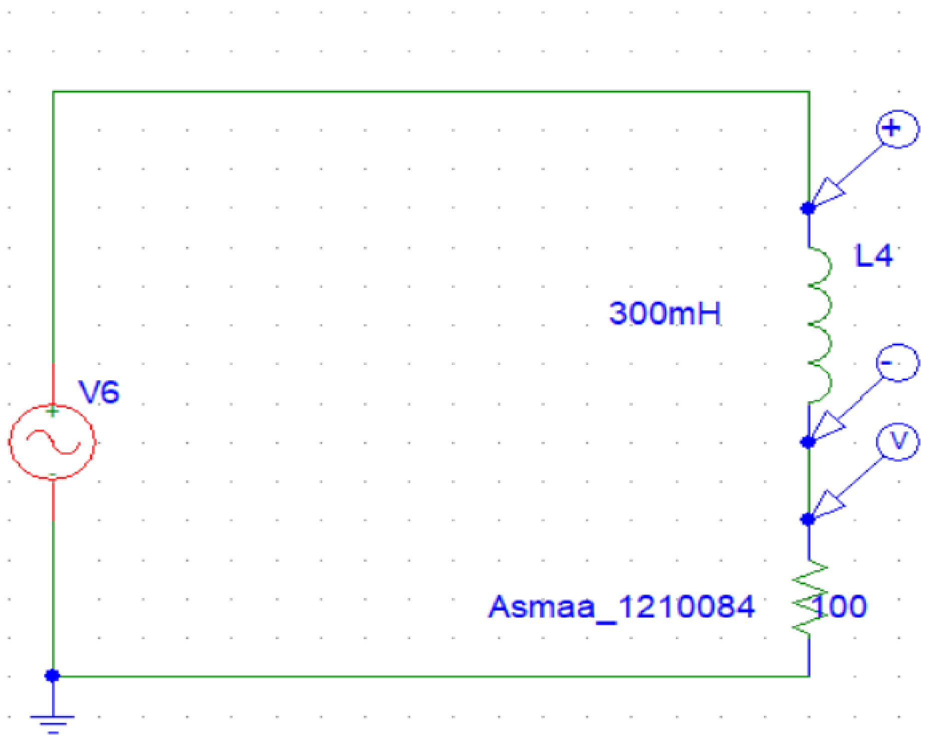
3. Repeat the same procedure in the step 1and 2 above for the circuit shown in Fig. 3.2.

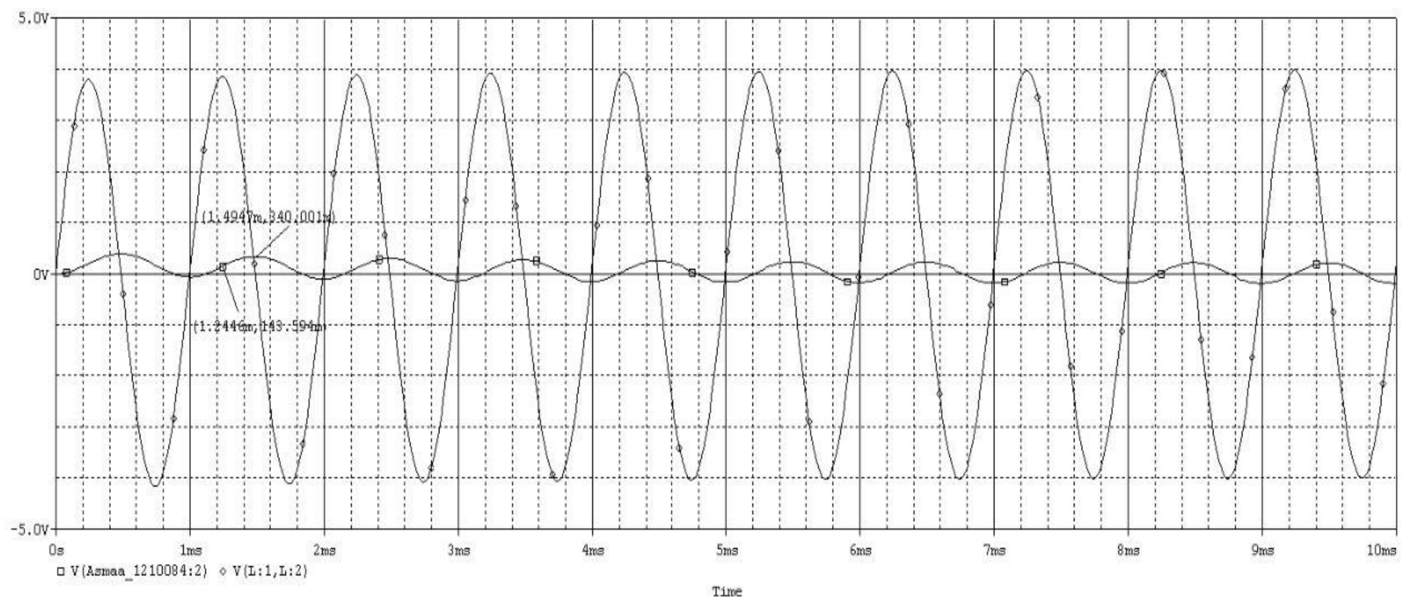
4. Compare and discuss the results obtained for the two circuits.





$\Delta\boldsymbol{\theta}$=360° **x f x** Δ**t** =360°*100Hz*(10.268-12.588)ms = -90°





$\Delta\boldsymbol{\theta}$=360° **x f x** Δ**t =**360°*100Hz*(1.4947-1.2446)ms = +90°

Q3) Part 4:

In an AC circuit, the current and voltage are constantly changing with time. Capacitors and inductors exhibit different responses to these changes, resulting in phase shifts.

Phase shift for a capacitor:

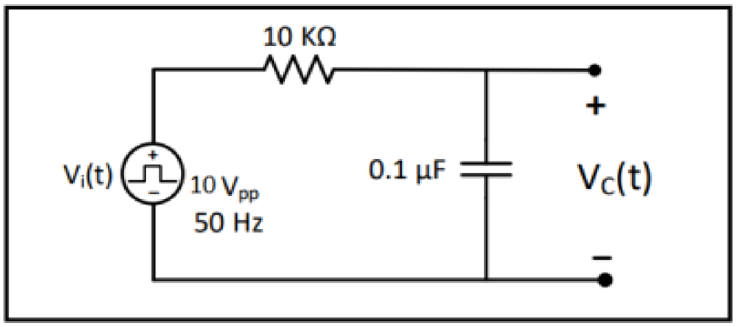
When an AC voltage is applied across a capacitor, the capacitor charges and discharges in response to the changing voltage. However, due to the property of capacitance, the current through a capacitor leads the voltage across it by 90 degrees. This means that the current reaches its peak 90 degrees ahead of the voltage. In terms of phase shift, we say that the current leads the voltage by 90 degrees or the voltage lags the current by 90 degrees. Therefore, the phase shift for a capacitor in an AC circuit is -90 degrees.

Phase shift for an inductor:

In contrast to a capacitor, an inductor resists changes in current. When an AC voltage is applied across an inductor, it induces a changing magnetic field, which generates an opposing electromotive force (EMF) to limit the rate of change of current. This causes the current to lag behind the voltage by 90 degrees. In terms of phase shift, we say that the current lags the voltage by 90 degrees or the voltage leads the current by 90 degrees. Therefore, the phase shift for an inductor in an AC circuit is +90 degrees.

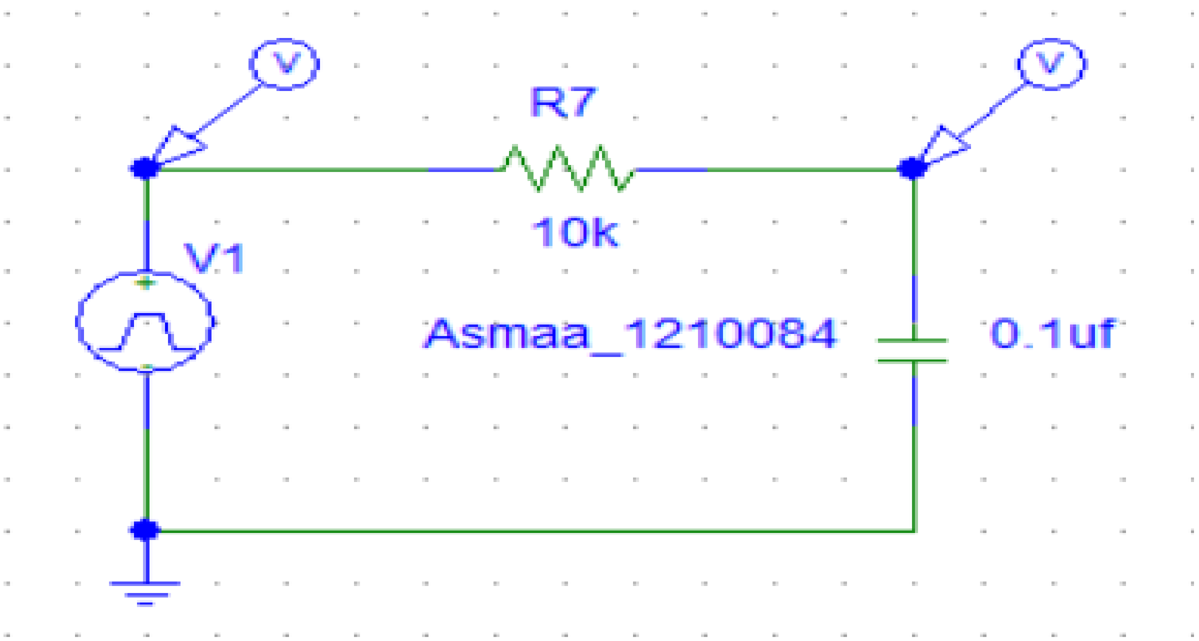
Question #4: First Order RC Circuit Analysis

For the circuit:

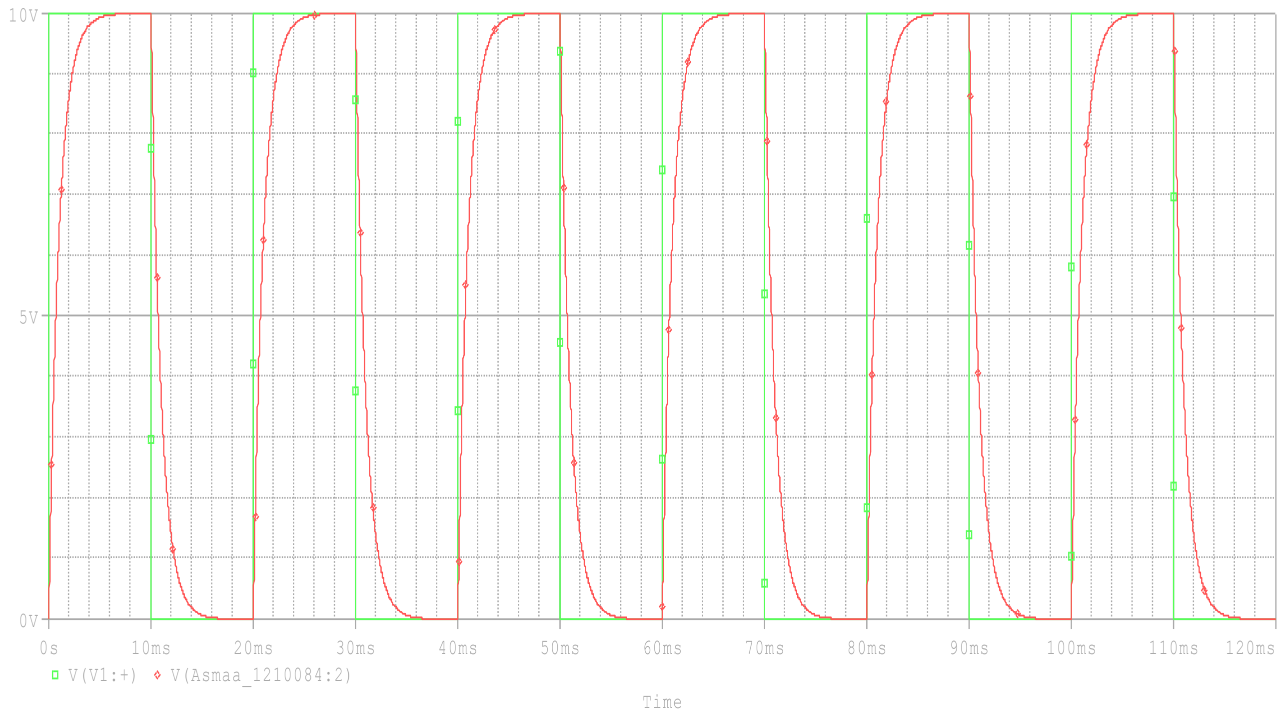


The input voltage is square signal with 10 $V_{peak\text{-}peak}$ (0 V to 10 V) and frequency of 50Hz.

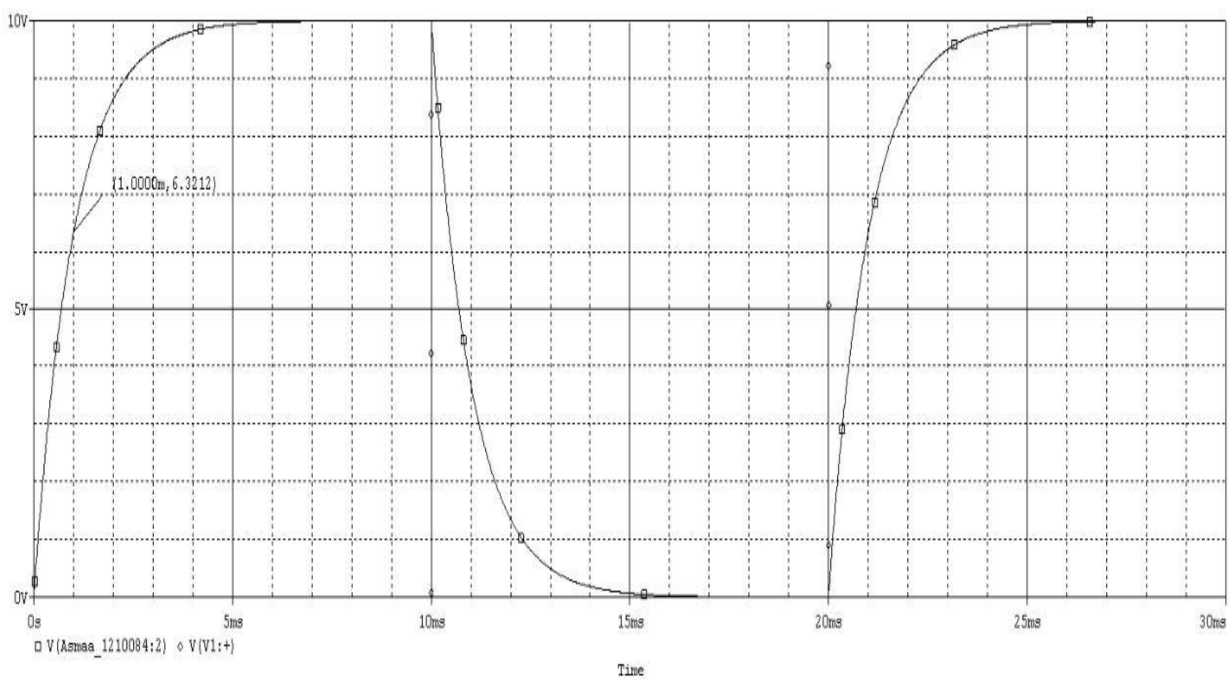
1. Use Pspice software to plot both $V_i(t)$ and $V_c(t)$ (on the same graph) for a meaningful period of time.
2. With help of cursors on Pspice simulation window, show the value of the time constant (τ). You have to show both the circuit and the simulation result.



Q4) Part 1:



Q4) Part 2:



τ from simulation = 1.0000s

To find time constant τ , Applying V(τ) = Vp*(1-e^-1) = 6.32V, we get 1.0004ms. We can also use the natural response in the second half of the period ,

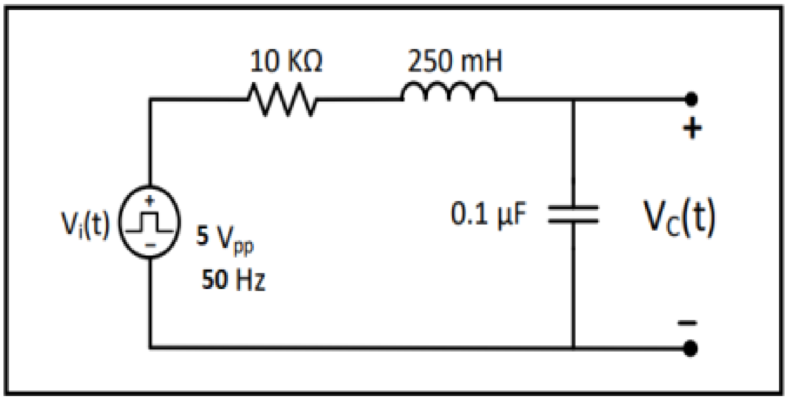
by applying v(τ+t0) =Vp*(e^-1),

where t0 = pulse width = 10ms.

To verify this result, τ = RC = 1*(10^4)*1*(10^-7) = 1*10^-3 s = 1ms, which almost the same as the previous one.

Question #5: Second Order RLC Circuit Analysis

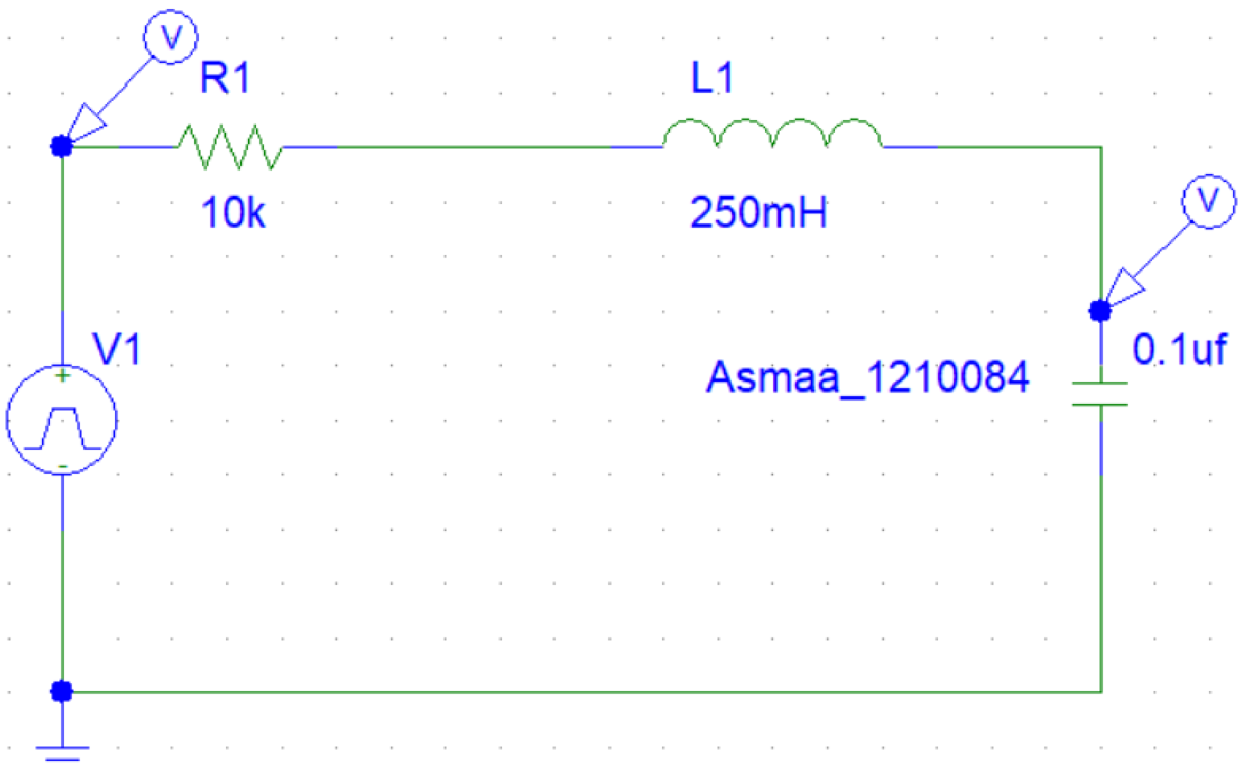
For the circuit:



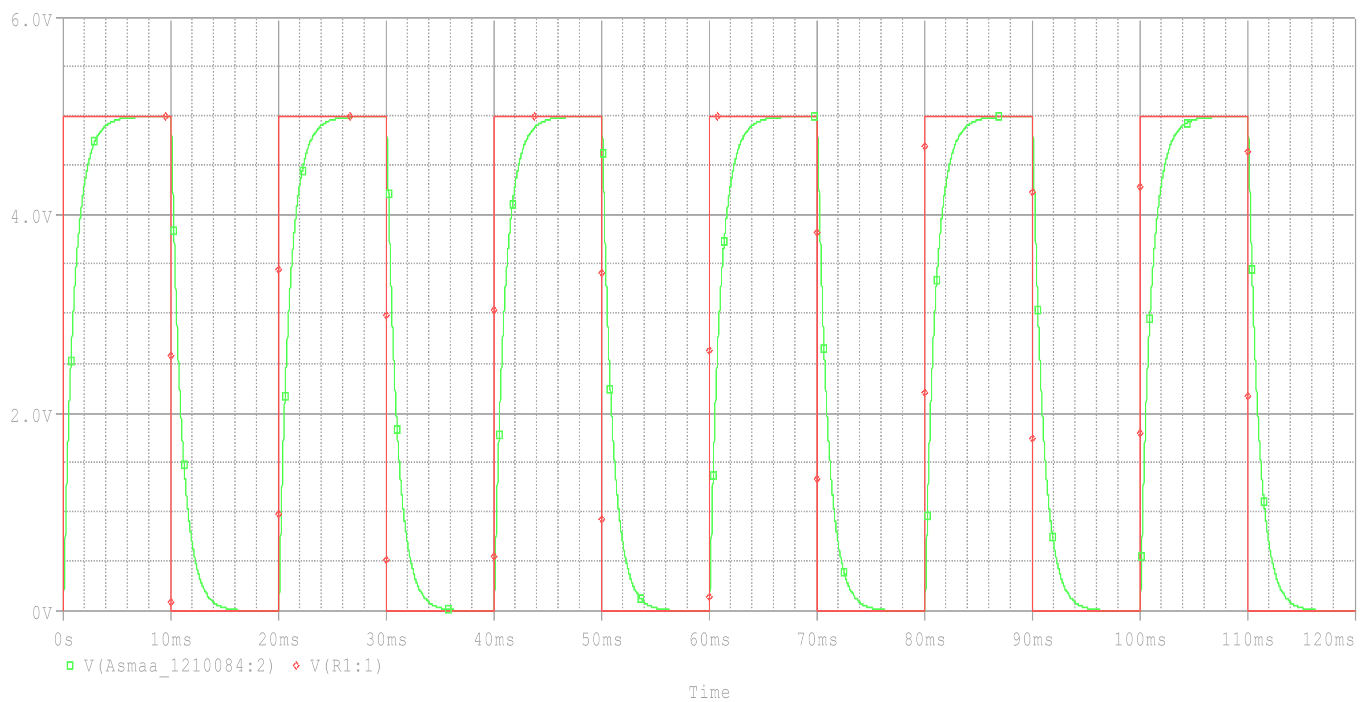
The input voltage is square signal with 5 $V_{peak\text{-}peak}$ (0 V to 5 V) and frequency of 50Hz.

1. Use Pspice software to plot both $V_i(t)$ and $V_c(t)$ (on the same graph).
2. Change the Value of R to 3.162 kΩ, repeat step 1.
3. Change the Value of R to 500 Ω, repeat step 1.
4. Comment on each result: is it over-damping, critical-damping, or under-damping response.

Q5) Part 1:

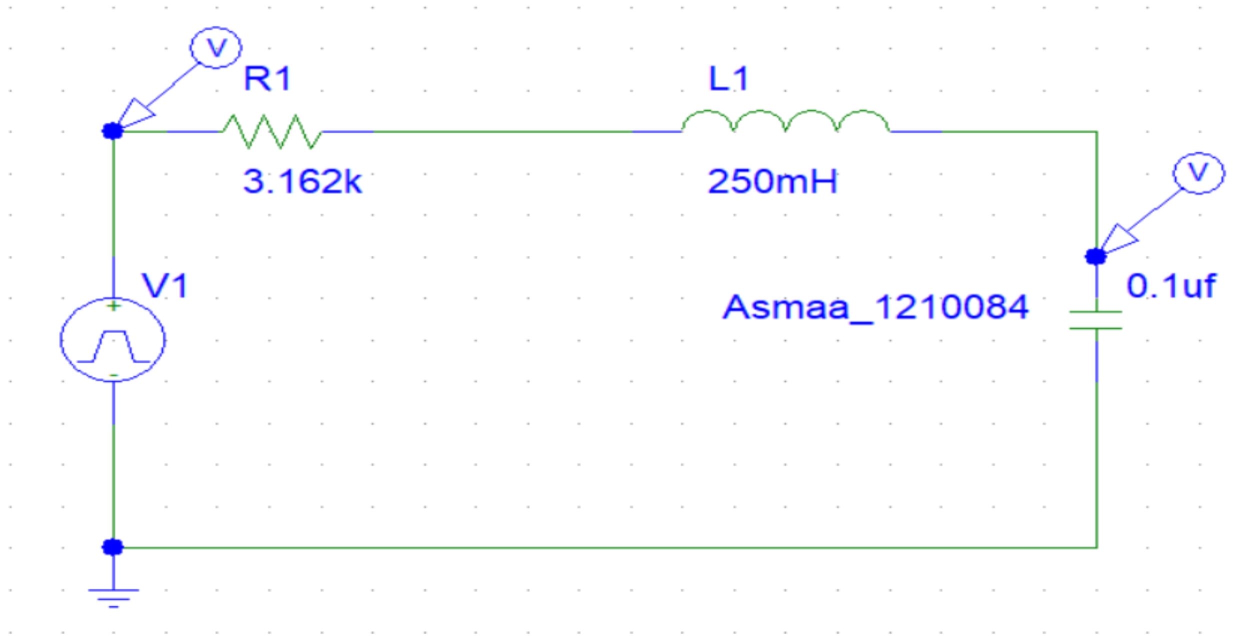


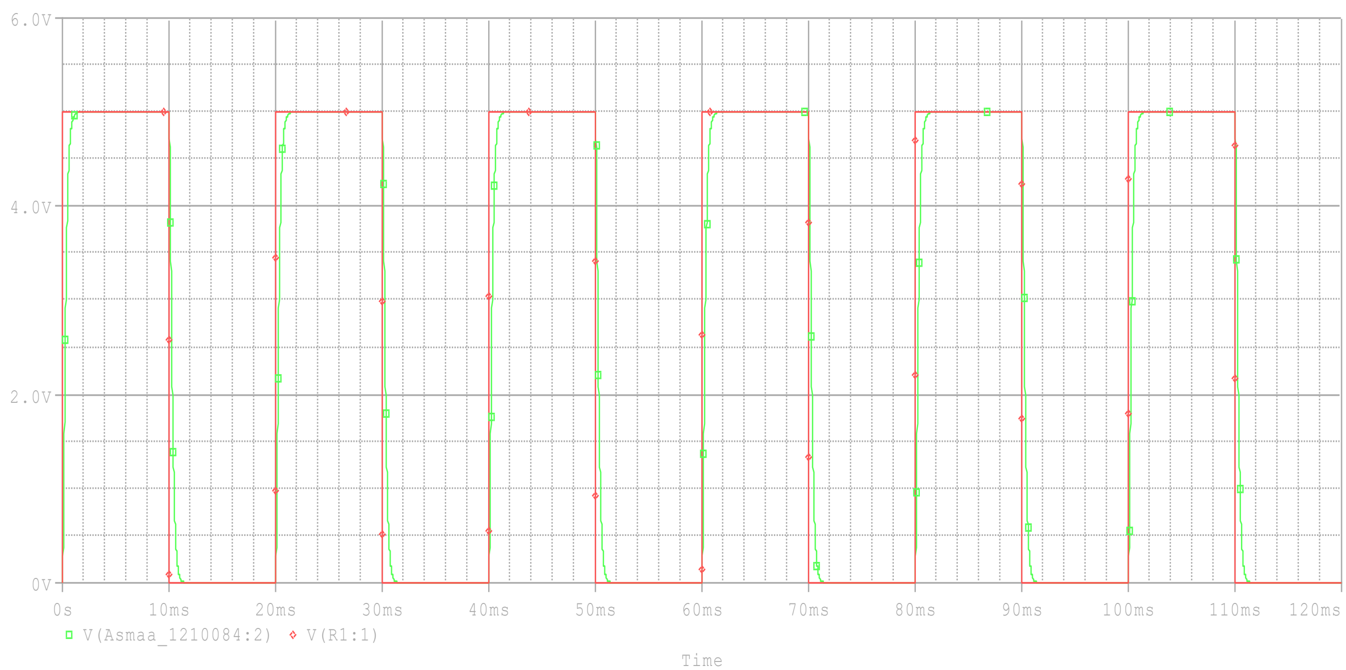
R1
L1
10k
250mH
V1
0.1uf
Asmaa_1210084



6.0V
4.0V
2.0V
0V
0s
10ms
20ms
30ms
40ms
50ms
60ms
70ms
80ms
90ms
100ms
110ms
120ms
V(Asmaa_1210084:2)
V(R1:1)
Time

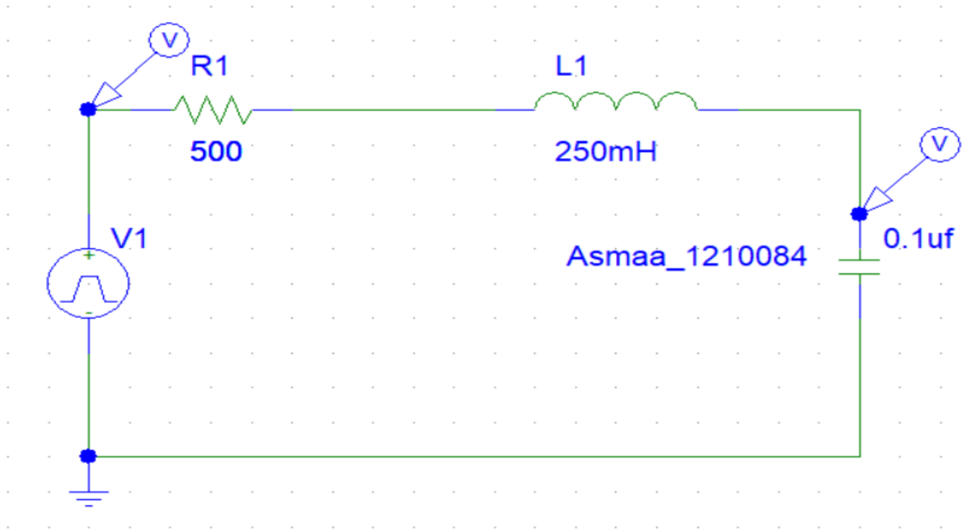
Q5) Part 2:

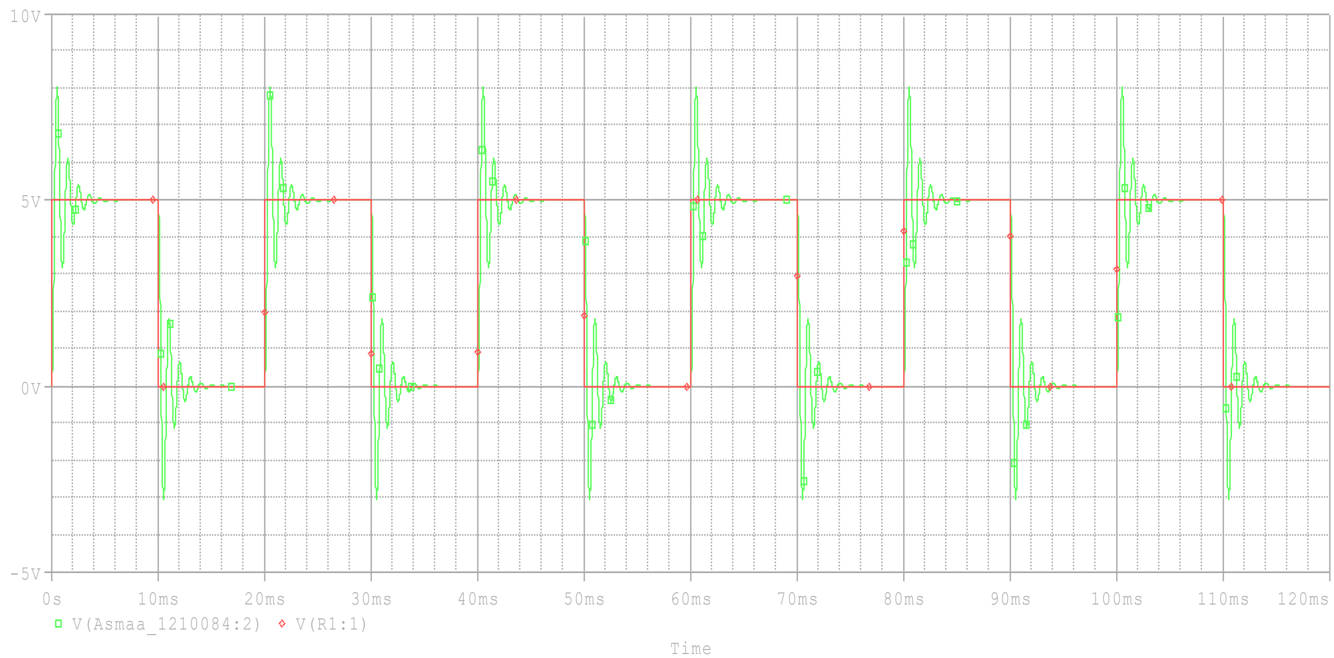




critically-damped.

Q5) Part 3:





Under damped.

Q5) Part 4:

Part one: Over-Damped response

Part two: Critical-Damped response

Part three: Under-Damped response