Assignment-01
EE1200

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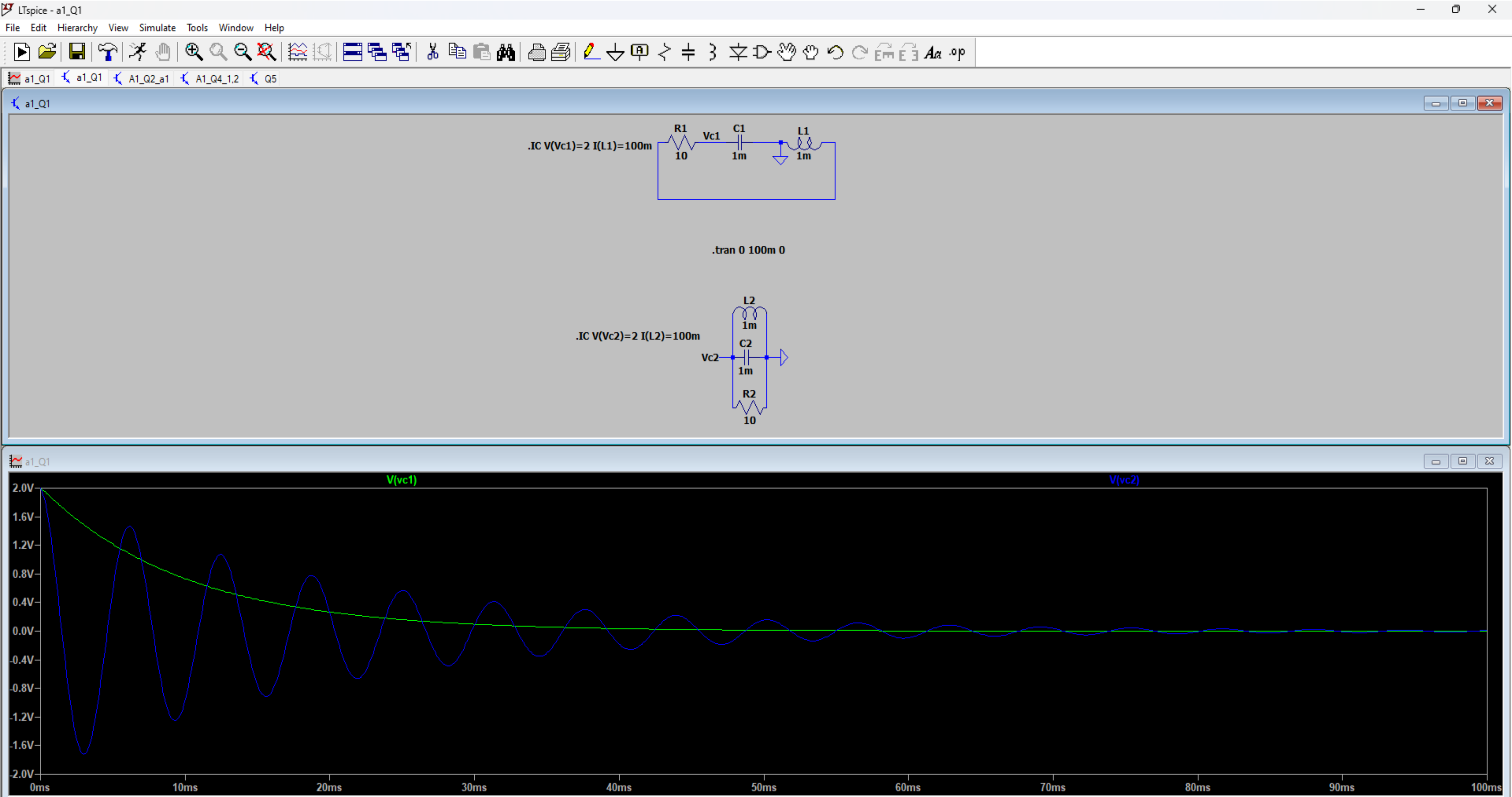
EE22BTECH11025

Q1a,b)


LTspice - a1_Q1
File Edit Hierarchy View Simulate Tools Window Help
a1_Q1 a1_Q1 A1_Q2_a1 A1_Q4_1,2 Q5
a1_Q1
.IC V(Vc1)=2 I(L1)=100m
R1
10
Vc1
C1
1m
L1
1m
.tran 0 100m 0
L2
1m
.IC V(Vc2)=2 I(L2)=100m
C2
1m
Vc2
R2
10
a1_Q1
V(vc1)
V(vc2)
2.0V 1.6V 1.2V 0.8V 0.4V 0.0V -0.4V -0.8V -1.2V -1.6V -2.0V
0ms 10ms 20ms 30ms 40ms 50ms 60ms 70ms 80ms 90ms 100ms

Q1a,b)

for series RLC Circuit, Damping Coefficient(α) = R/2L = 5000 Hz
The Natural Frequency(ω_0) = $1/\sqrt{(LC)}$ = 1000 Hz

So, the Damping Factor = α/ω_0 = R/2 $\sqrt{(C/L)}$ = 5

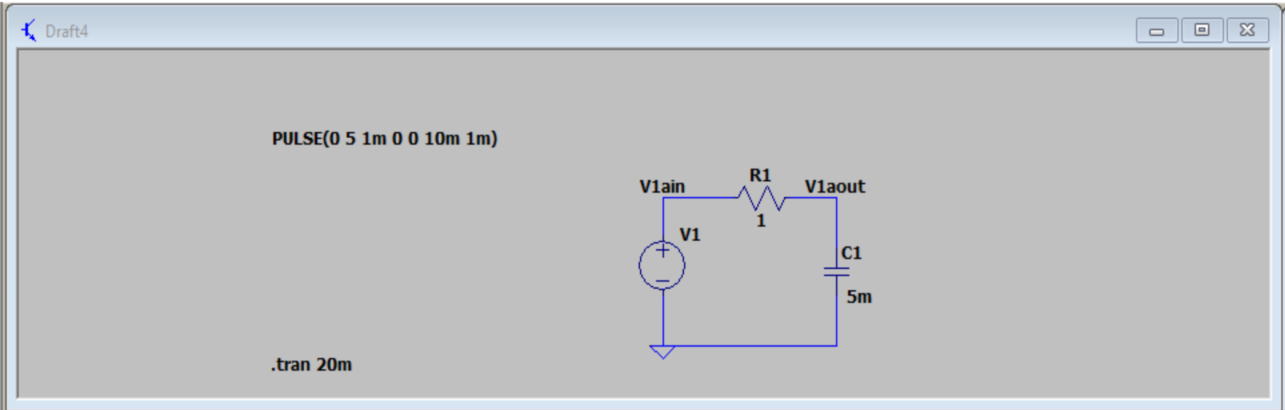
As, $\alpha > \omega_0$, it is over-damped. Overdamped cases don't oscillate.
So, it does not have a Damping Frequency.

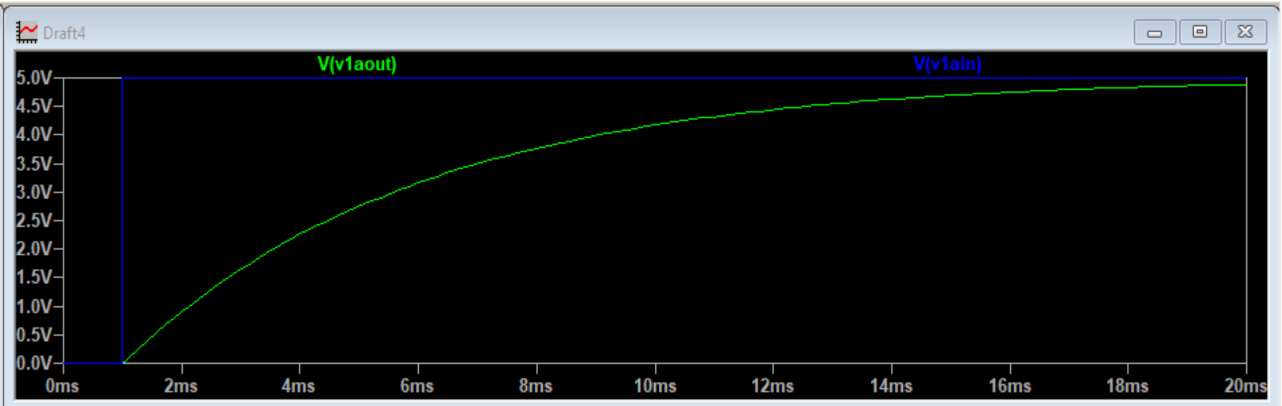
for parallel RLC Circuit, the Damping Coefficient (α) = 1/2RC = 50 Hz
The Natural Frequency (ω_0) = $1/\sqrt{(LC)}$ = 1000 Hz

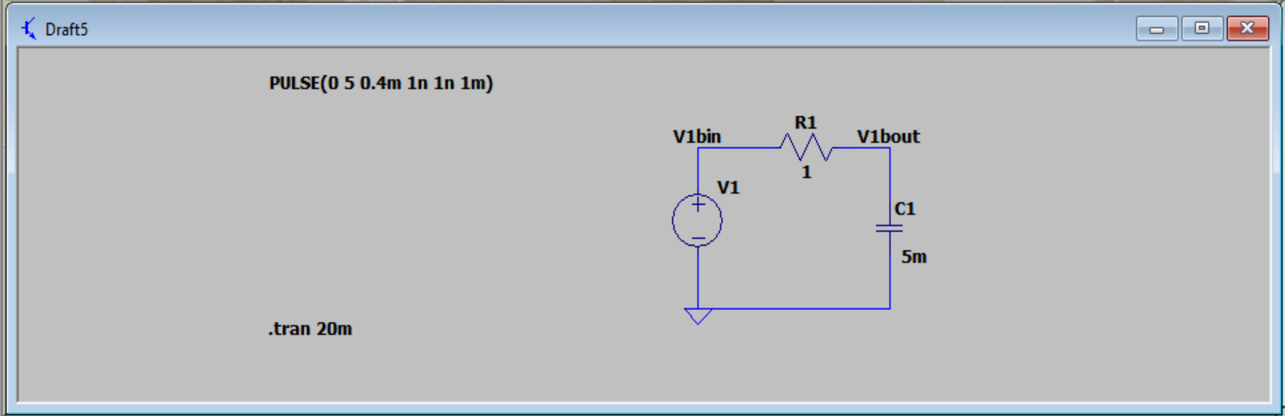
So, the Damping Factor = α/ω_0 = 1/2R $\sqrt{(L/C)}$ = 0.05

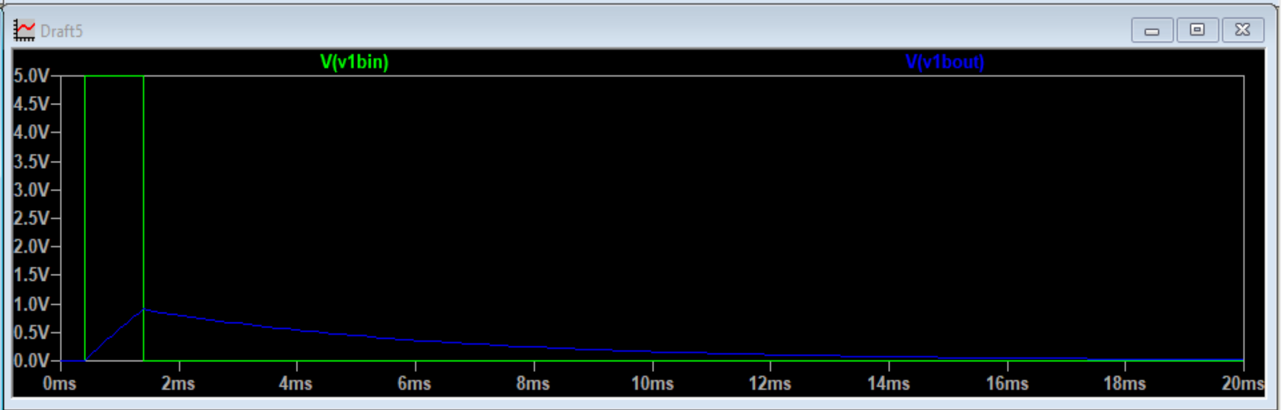
As, $\alpha < \omega_0$, it is underdamped. So, it oscillates.
The Damping Frequency (ωd) = $\sqrt{(\omega_0^2 - \alpha^2)}$ = 999 Hz

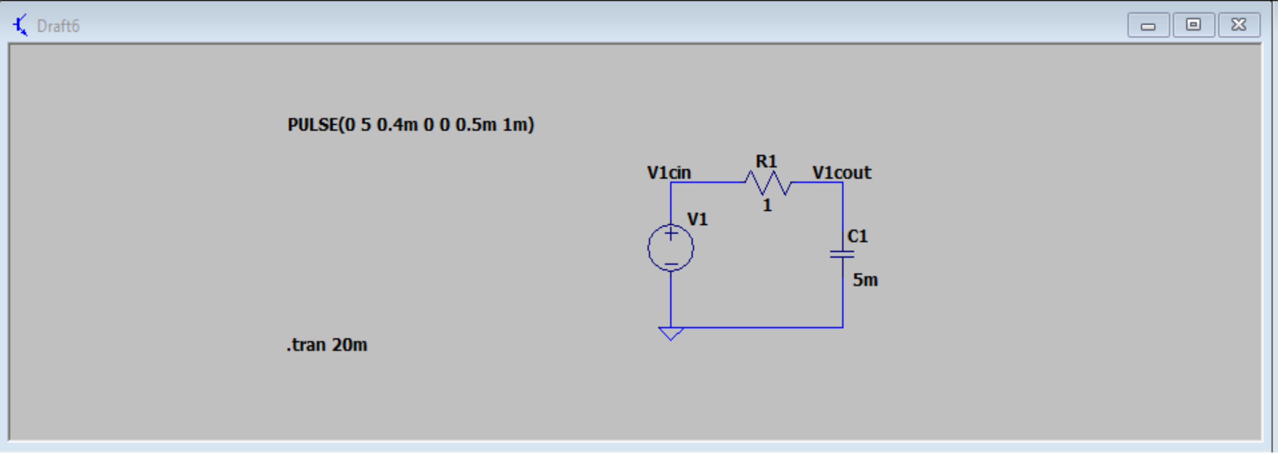
Q2) i-a,b,c

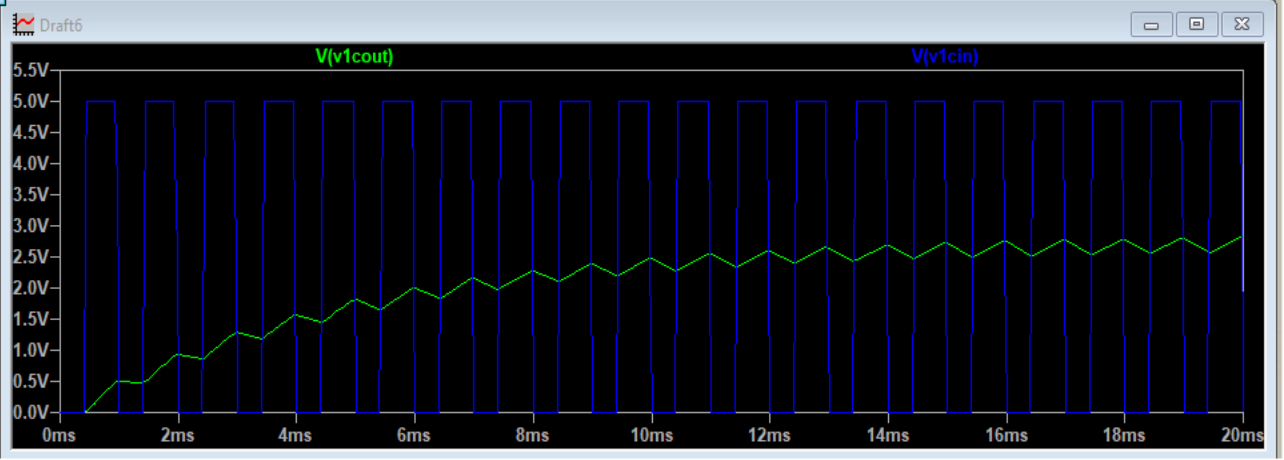

Draft4
PULSE(0 5 1m 0 0 10m 1m)
V1ain
R1
1
V1aout
V1
C1
5m
.tran 20m


Draft4
V(v1aout)
V(v1ain)
5.0V
4.5V
4.0V
3.5V
3.0V
2.5V
2.0V
1.5V
1.0V
0.5V
0.0V
0ms
2ms
4ms
6ms
8ms
10ms
12ms
14ms
16ms
18ms
20ms


Draft5
PULSE(0 5 0.4m 1n 1n 1m)
V1bin
R1
1
V1bout
V1
C1
5m
.tran 20m


Draft5
V(v1bin)
V(v1bout)
5.0V
4.5V
4.0V
3.5V
3.0V
2.5V
2.0V
1.5V
1.0V
0.5V
0.0V
0ms
2ms
4ms
6ms
8ms
10ms
12ms
14ms
16ms
18ms
20ms


Draft6
PULSE(0 5 0.4m 0 0 0.5m 1m)
V1cin
R1
1
V1cout
V1
C1
5m
.tran 20m


Draft6
V(v1cout)
V(v1cin)
5.5V
5.0V
4.5V
4.0V
3.5V
3.0V
2.5V
2.0V
1.5V
1.0V
0.5V
0.0V
0ms
2ms
4ms
6ms
8ms
10ms
12ms
14ms
16ms
18ms
20ms

Q2) i-a,b,c

i-a)

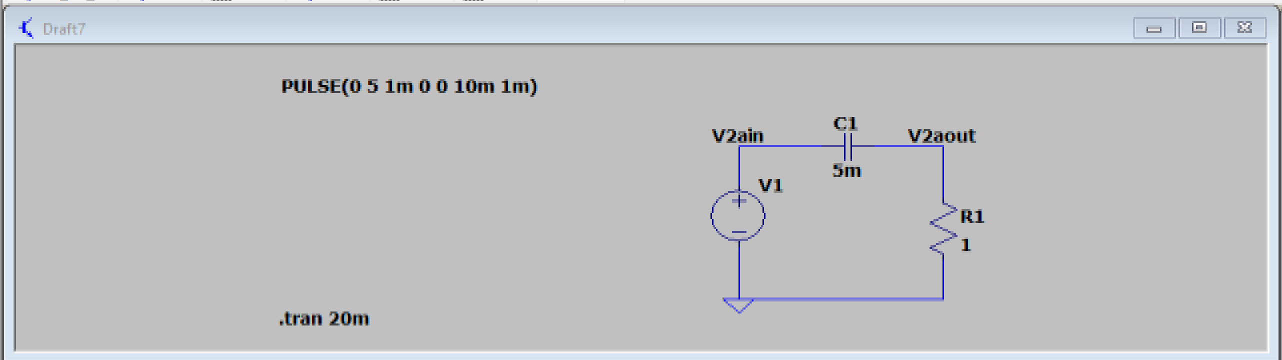
The input voltage is a unit step function,
The capacitor voltage spikes when the function takes the value 5 V , it charges the capacitor to a steady state resulting in an almost constant voltage

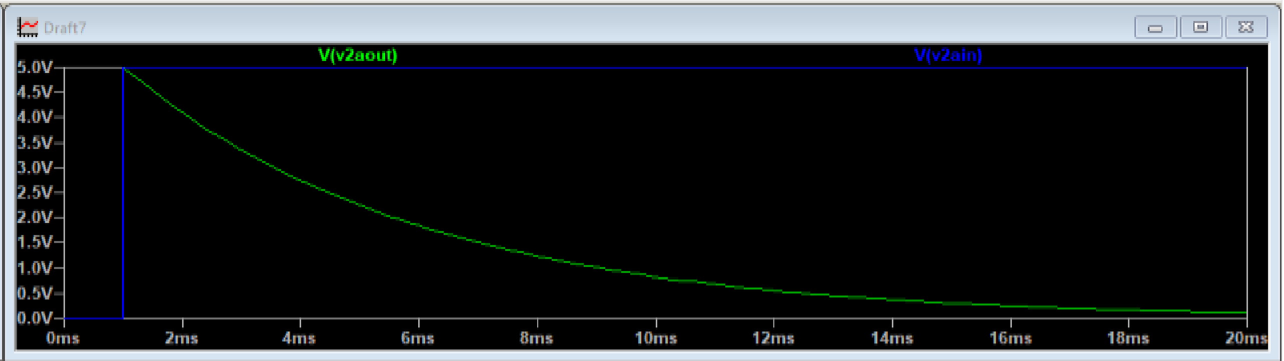
i-b)
The input voltage is a square pulse,
Square pulse input does not allow capacitor to reach max voltage due to short ON time. Capacitor charges to intermediate value and discharges, losing energy through resistor.

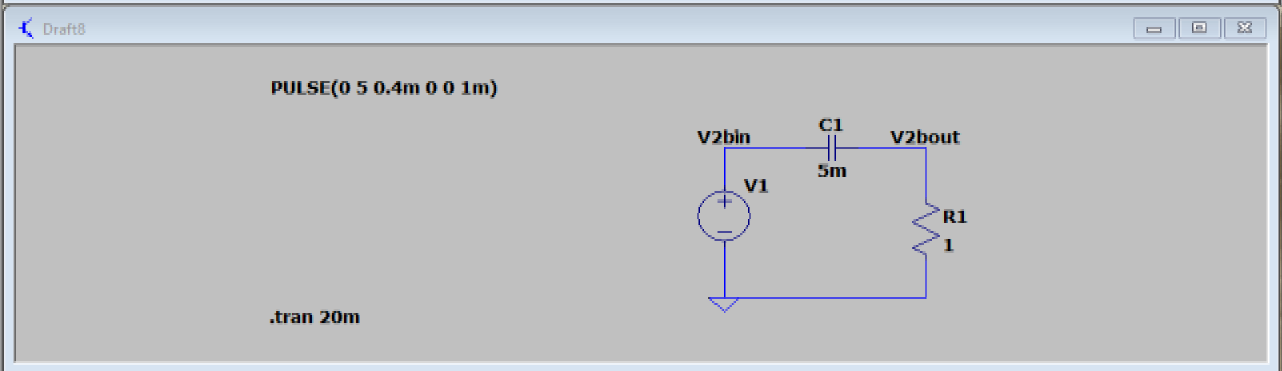
i-c)

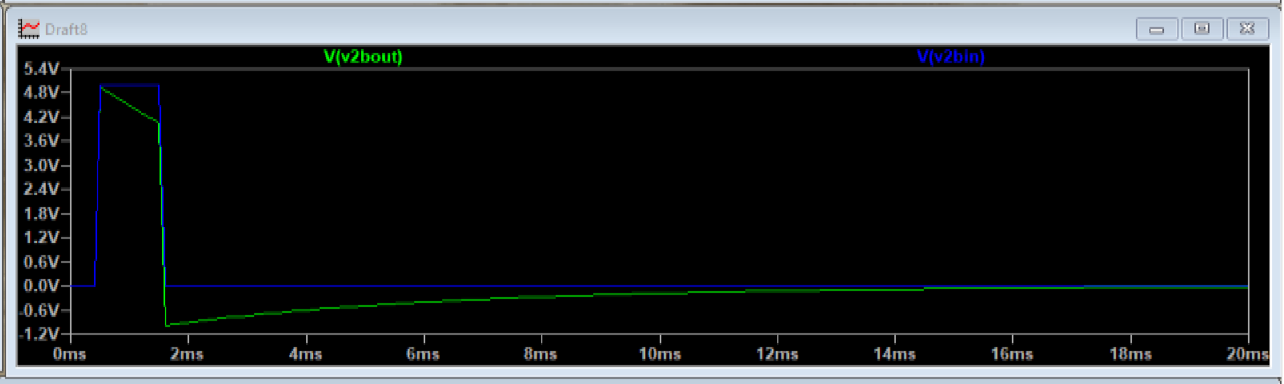
The input voltage is infinite number of square wave,
The square pulses with 5V peak and 0V minimum charge a capacitor through a resistor, causing repeated charging and discharging. Eventually, the capacitor reaches a steady state with constant max and min voltages.

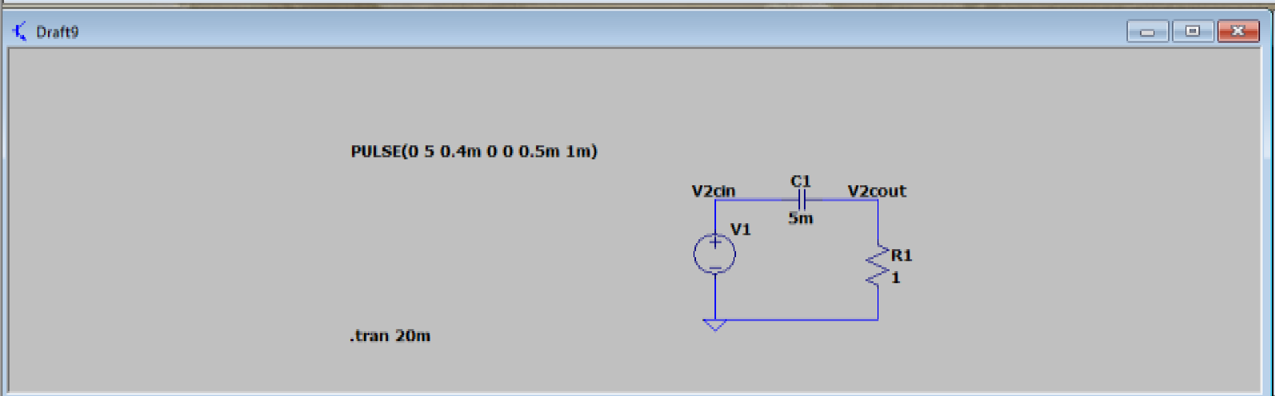
Q2) ii-a,b,c

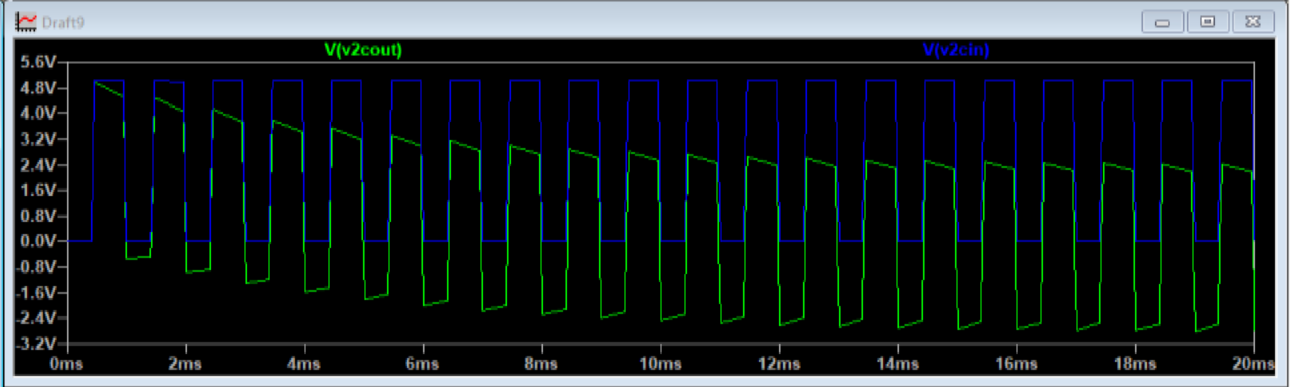

Draft7
PULSE(0 5 1m 0 0 10m 1m)
V2ain
C1
5m
V2aout
V1
R1
1
.tran 20m


Draft7
V(v2aout)
V(v2ain)


Draft8
PULSE(0 5 0.4m 0 0 1m)
V2bin
C1
5m
V2bout
V1
R1
1
.tran 20m


Draft8
V(v2bout)
V(v2bin)


Draft9
PULSE(0 5 0.4m 0 0 0.5m 1m)
V2cin
C1
5m
V2cout
V1
R1
1
.tran 20m


Draft9
V(v2cout)
V(v2cin)

Q2) ii-a,b,c

ii-a)

The input voltage is a unit step function,
when a capacitor is discharged, the voltage across the resistor is 5V. However, as the capacitor charges, the voltage across the resistor decreases and eventually becomes almost zero at a very long time.

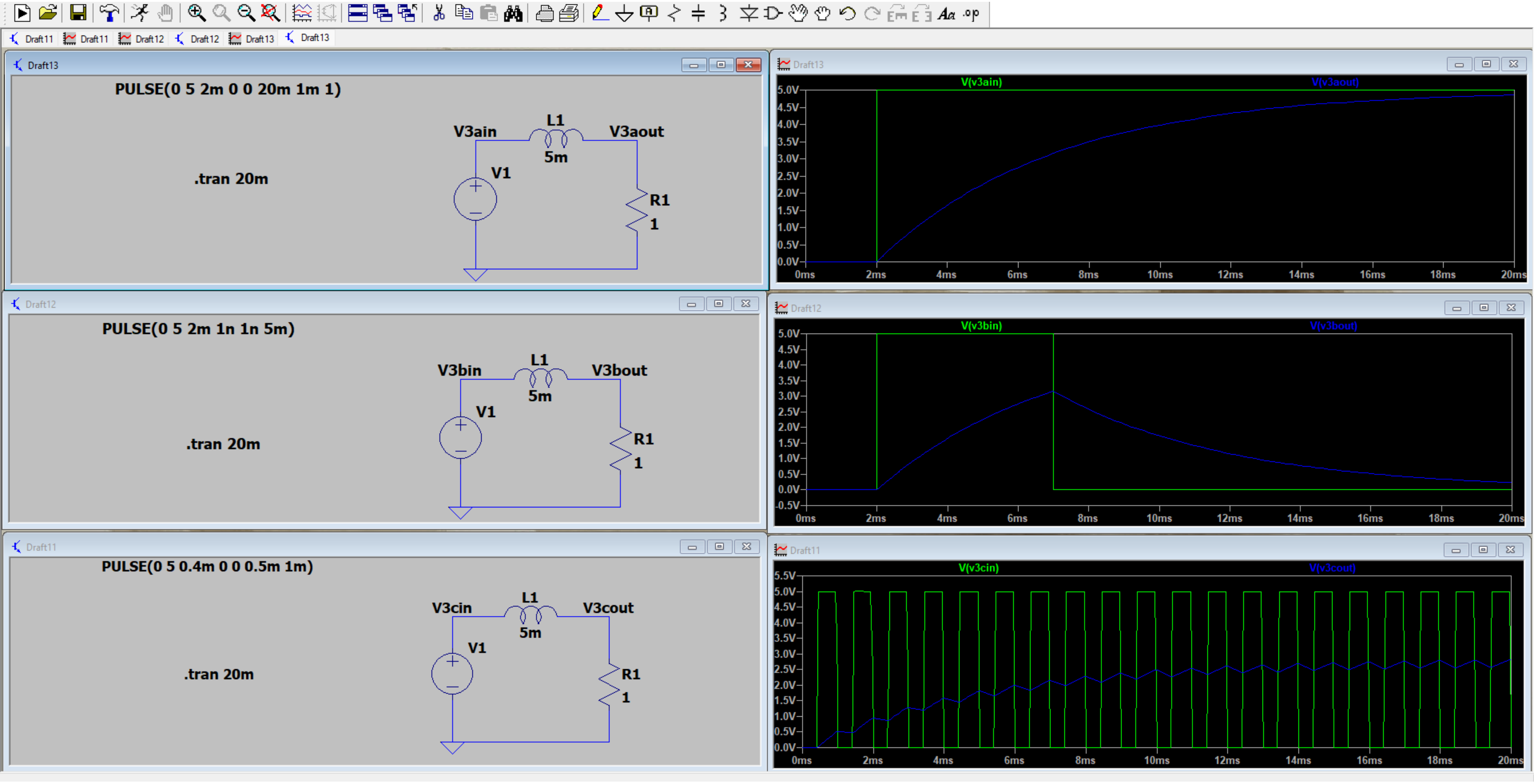
ii-b)

The input voltage is a square pulse,
Initially when the circuit is turned on, the voltage suddenly spikes to 5V as capacitor behaves shorted. Then the cap starts charging and voltage across it starts increasing, thus voltage across resistor decreases. However, as the pulse ends and V(in) becomes 0, the stored energy in the capacitor starts to dissipate. This results in a zero V(out).

ii-c)

The infinite square pulses with peak voltage 5V and minimum voltage 0V, a capacitor charges when the input voltage is 5V and discharges through a resistor when the input voltage is 0V, causing oscillations. Eventually, the capacitor reaches a steady state, resulting in constant maximum and minimum voltages across the resistor for each pulse.

Q2) iii-a,b,c


Draft13
PULSE(0 5 2m 0 0 20m 1m 1)
.tran 20m
V3ain
L1
5m
V3aout
V1
R1
1
V(v3ain)
V(v3aout)
Draft12
PULSE(0 5 2m 1n 1n 5m)
.tran 20m
V3bin
L1
5m
V3bout
V1
R1
1
V(v3bin)
V(v3bout)
Draft11
PULSE(0 5 0.4m 0 0 0.5m 1m)
.tran 20m
V3cin
L1
5m
V3cout
V1
R1
1
V(v3cin)
V(v3cout)

Q2) iii-a,b,c

iii-a)

When a unit step function takes time to increase, the inductor voltage spikes. Initially, the inductor opposes current flow, resulting in zero voltage across the resistor. Voltage across the inductor decreases exponentially, while voltage across the resistor increases over time and reaches a maximum value.

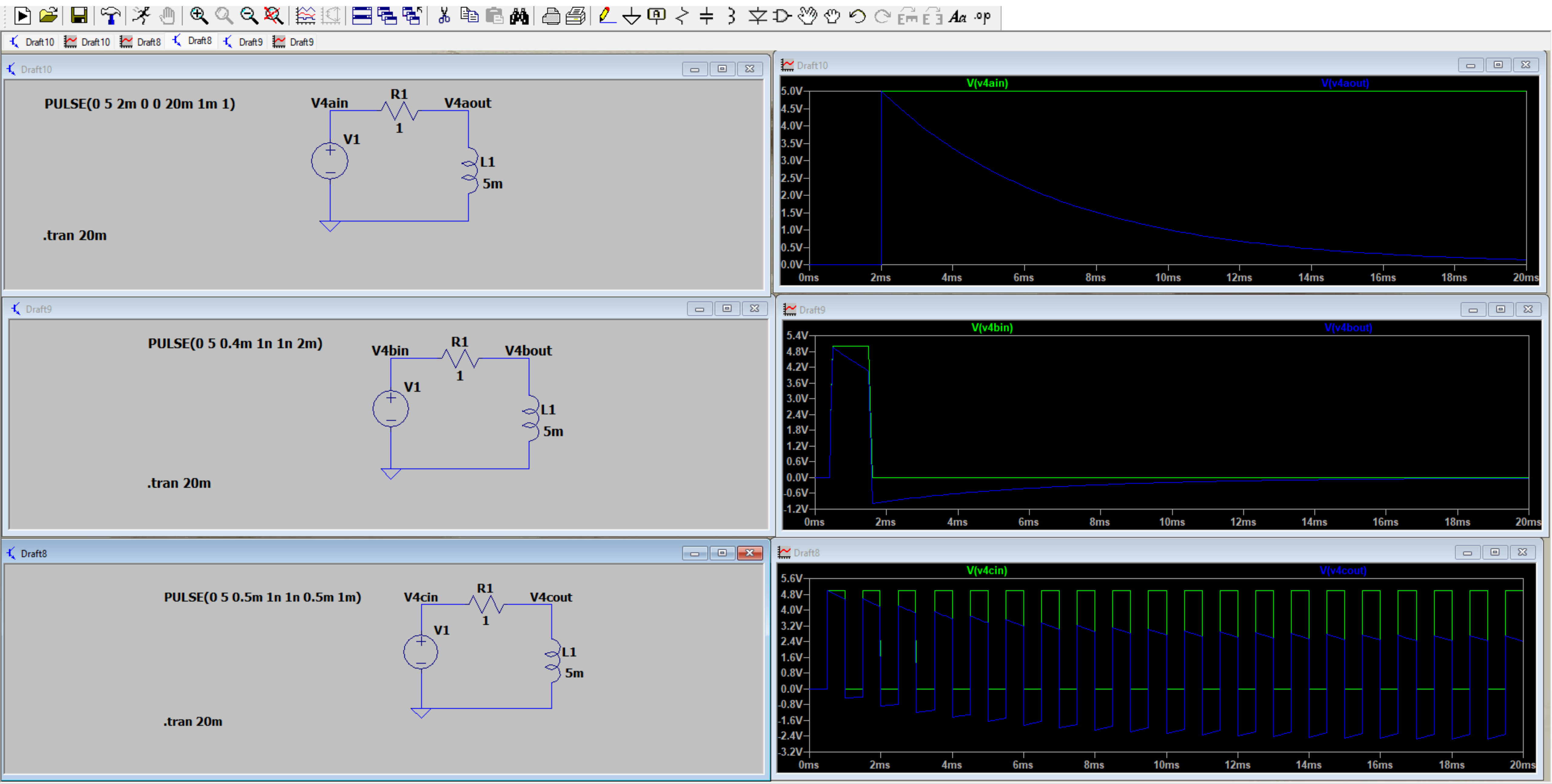
iii-b)

Initially, current and voltage across resistance are zero. Charging inductor increases current and voltage. When the pulse ends, inductor discharges and current decays, causing the voltage across the resistor to decrease and tend to 0.

iii-c)

Infinite square pulses with 5V peak and 0V minimum cause the voltage across the inductor to increase to 5V and voltage across the resistor to start increasing. When the pulse ends, the inductor decays through the resistor, causing the voltage across the resistor to decrease. After several cycles, the maximum and minimum values of V(out) become constant.

Q2) iv-a,b,c


Draft10
Draft10
Draft8
Draft8
Draft9
Draft9
Draft10
PULSE(0 5 2m 0 0 20m 1m 1)
V4ain
R1
1
V4aout
V1
L1
5m
.tran 20m
Draft10
V(v4ain)
V(v4aout)
Draft9
PULSE(0 5 0.4m 1n 1n 2m)
V4bin
R1
1
V4bout
V1
L1
5m
.tran 20m
Draft9
V(v4bin)
V(v4bout)
Draft8
PULSE(0 5 0.5m 1n 1n 0.5m 1m)
V4cin
R1
1
V4cout
V1
L1
5m
.tran 20m
Draft8
V(v4cin)
V(v4cout)

Q2) iv-a,b,c

iv-a)

The voltage across the inductor starts at 5 volts when the voltage across the resistor is zero. As the voltage across the resistor increases, the voltage across the inductor decreases and approaches zero.

iv-b)

At turn on, the voltage across the inductor spikes to 5V, then decreases. When V1 becomes 0, stored energy in the inductor dissipates across resistor, causing current reversal and voltage to tend towards 0.

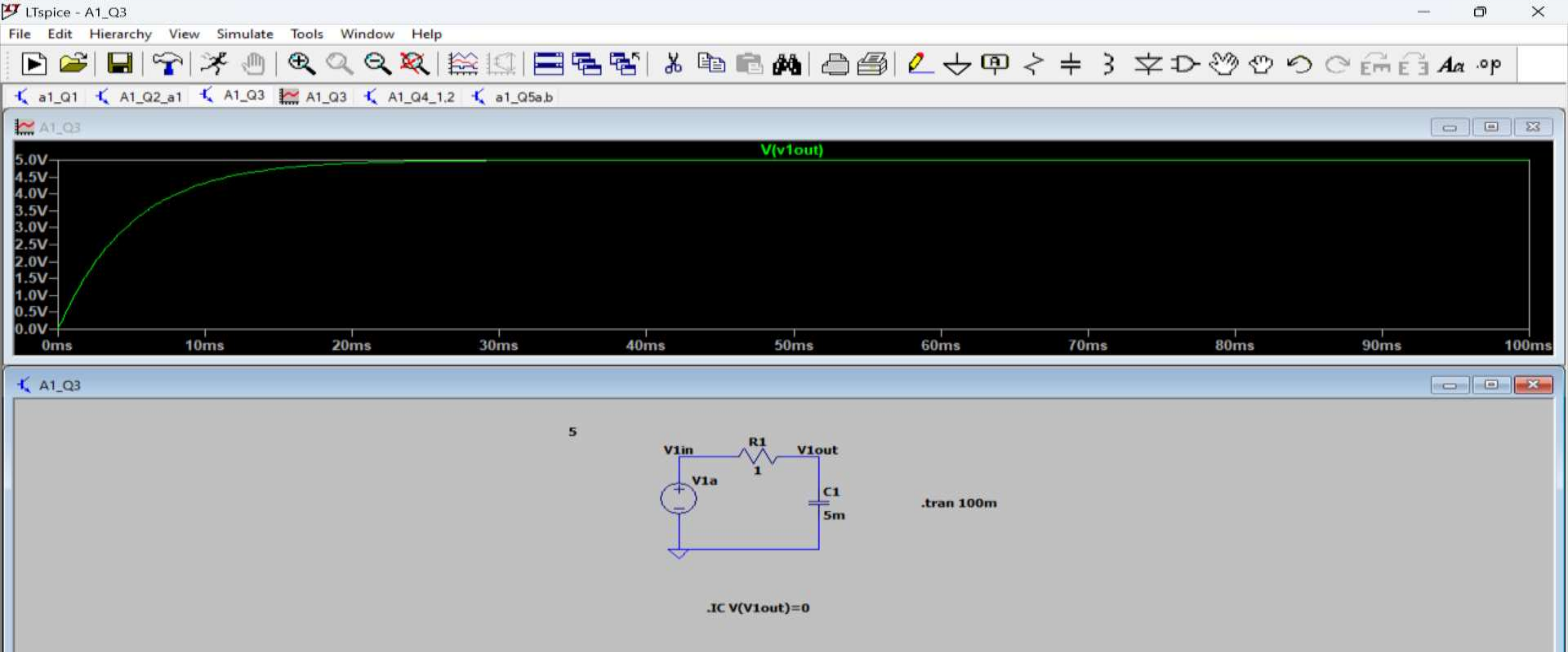
iv-c)

Infinite square pulses with 5V peak and 0V minimum cause the inductor to have 5V across it and the resistor to have 0V across it. Inductor energy decays through resistor continuously. After several cycles, inductor reaches steady state with constant max and min voltage across it.

Q3a)

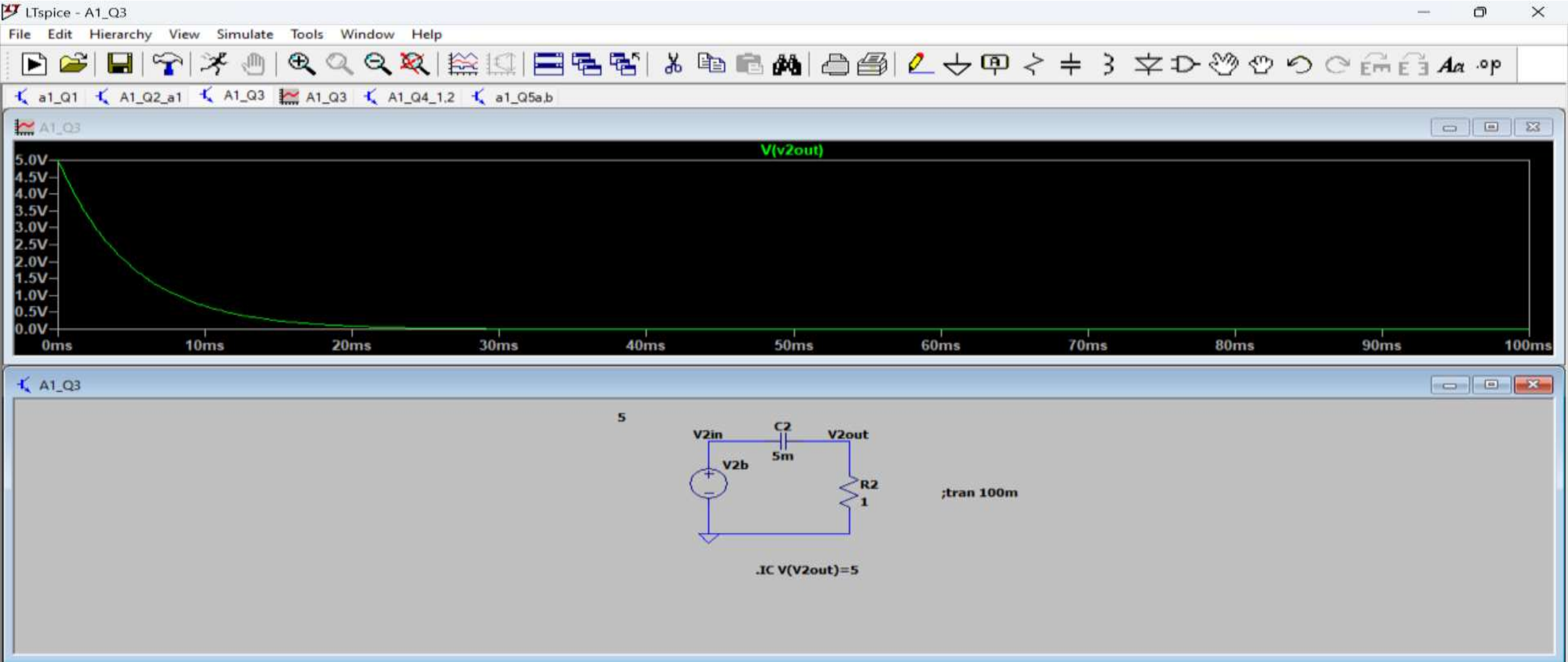
Here initially,

voltage across capacitor is zero and gets charged as time passes and reaches saturation voltage of 5 V



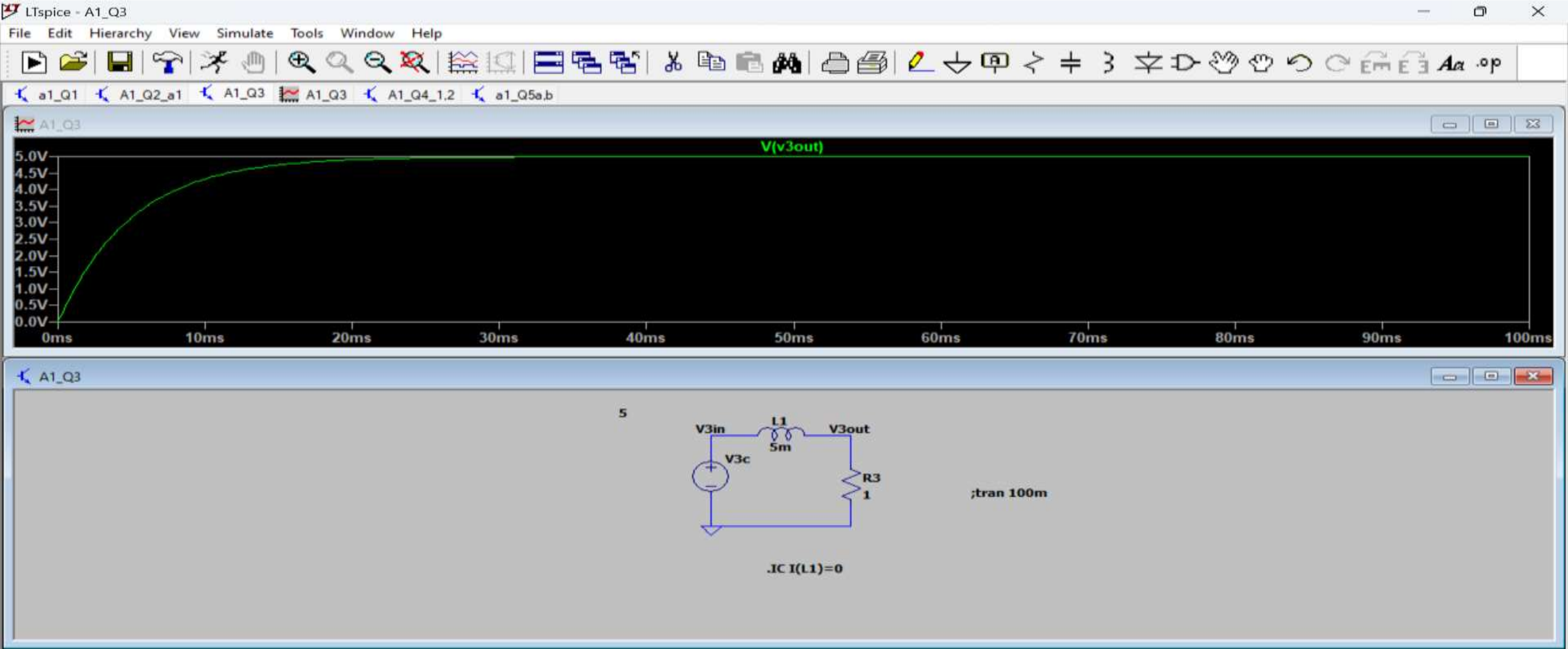
Q3b)

As capacitor is initially discharged, the voltage across resistor is 5 V. As the capacitor charges the voltage across resistor decrease and tends to zero at a very large time



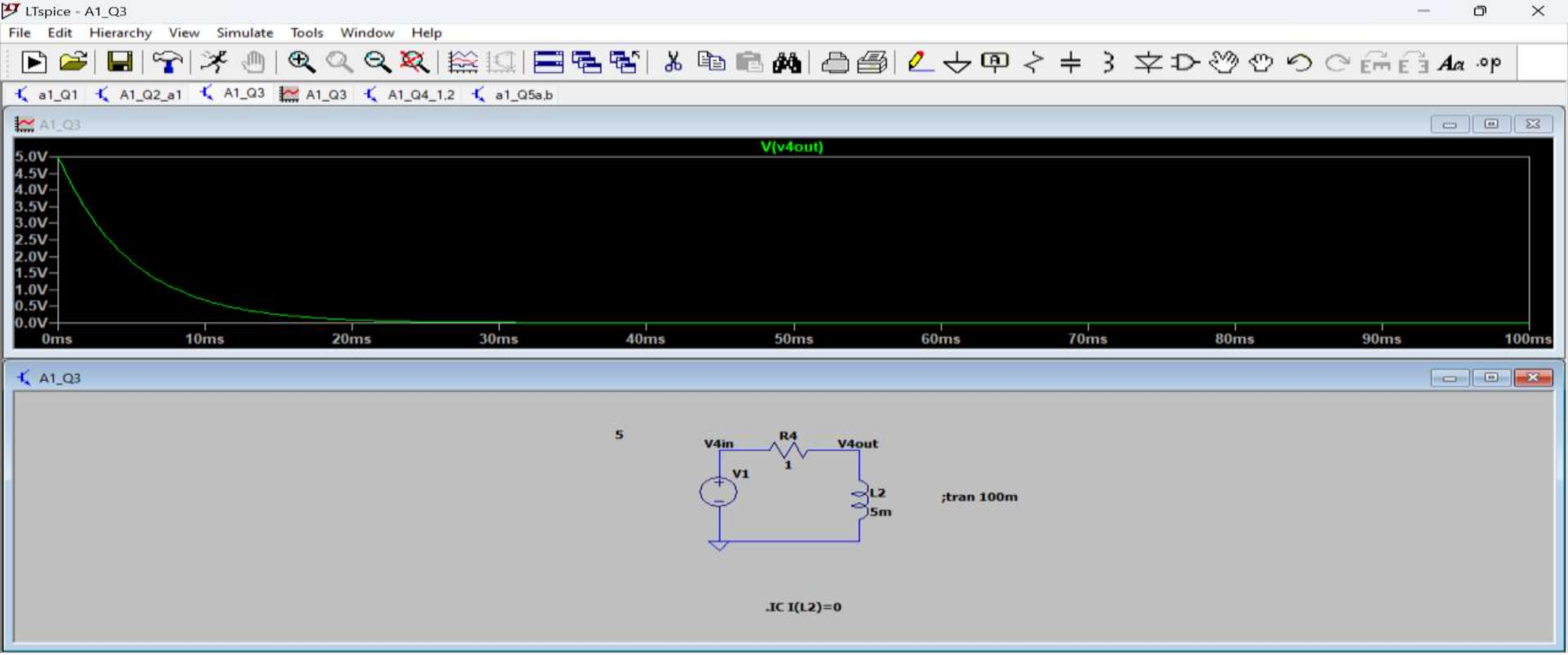
Q3c)

As inductor initially behaves like a broken wire , the current in the circuit is zero, so the voltage across resistor is also 0 V. As the current grows, the voltage across the resistor increases and reaches a saturation value of 5 V.

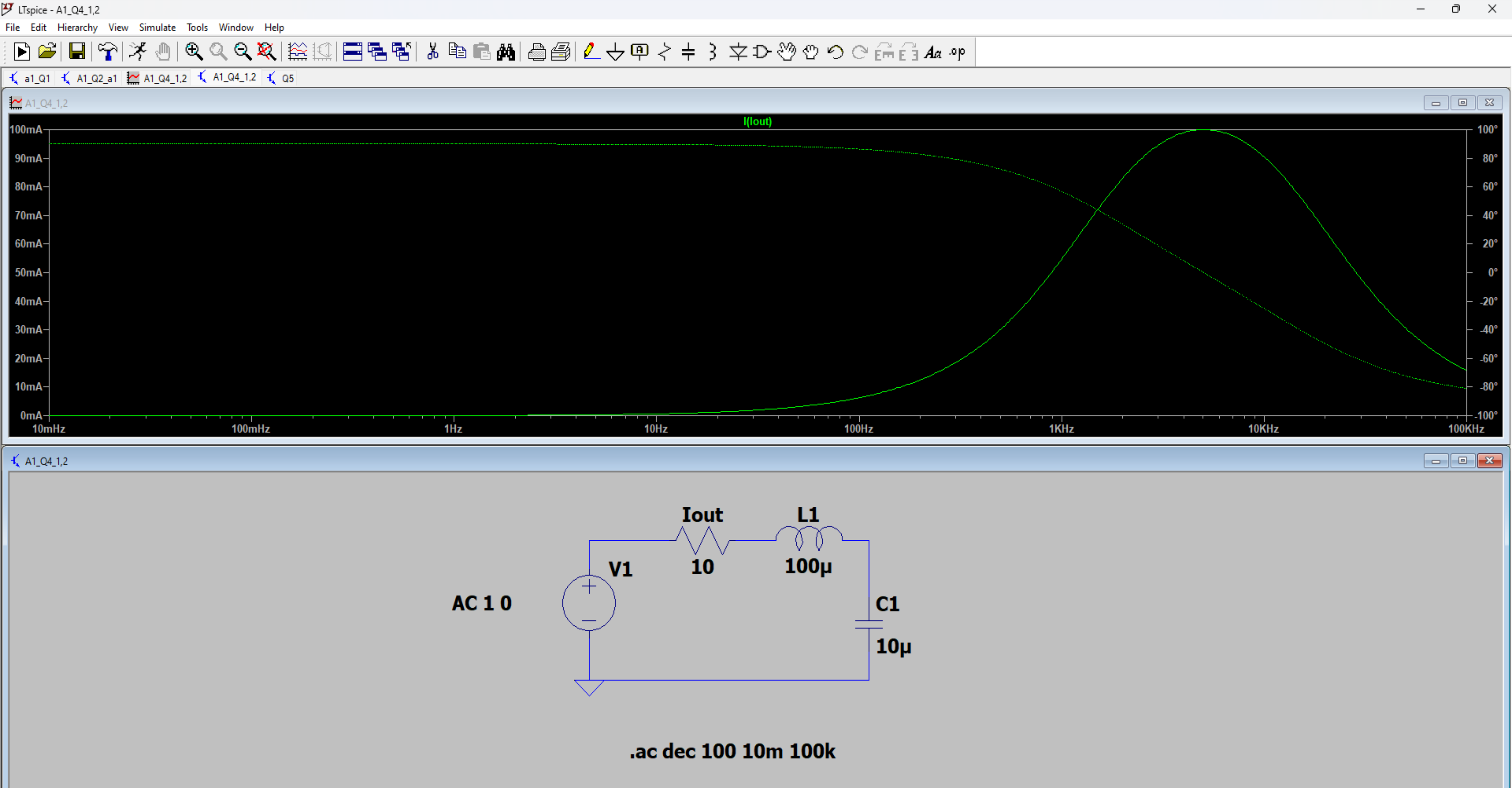


Q3d)

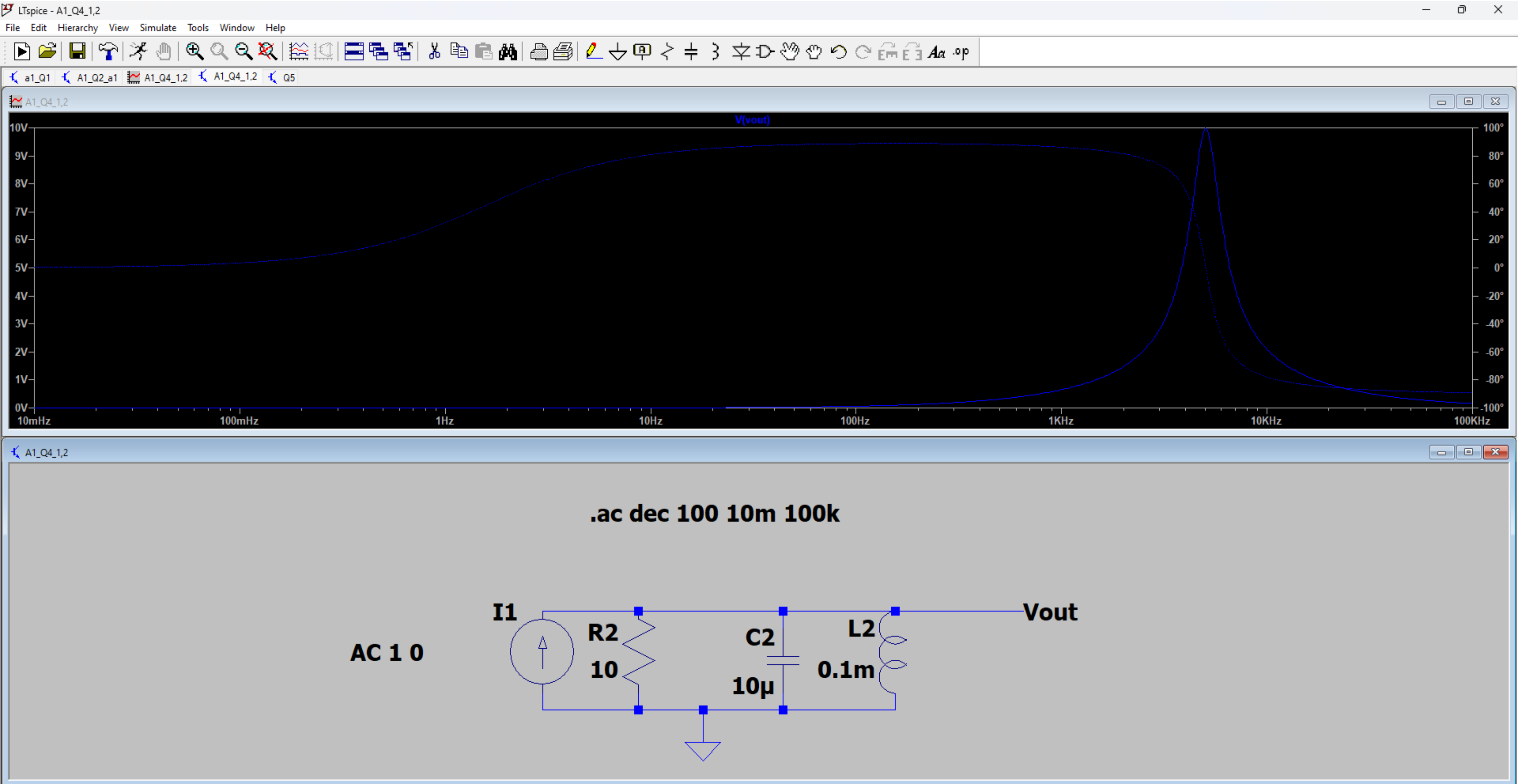
The voltage across inductor is equal to 5-Vr ,where Vr is voltage across resistor. As Vr is zero initially ,Voltage across inductor is 5 V.As Vr increases, Voltage across inductor decreases and tends to zero



Q4a)


LTspice - A1_Q4_1,2
File Edit Hierarchy View Simulate Tools Window Help
a1_Q1 A1_Q2_a1 A1_Q4_1,2 A1_Q4_1,2 Q5
A1_Q4_1,2
I(Iout)
100mA 90mA 80mA 70mA 60mA 50mA 40mA 30mA 20mA 10mA 0mA
100° 80° 60° 40° 20° 0° -20° -40° -60° -80° -100°
10mHz 100mHz 1Hz 10Hz 100Hz 1KHz 10KHz 100KHz
A1_Q4_1,2
Iout
10
L1
100μ
V1
AC 1 0
C1
10μ
.ac dec 100 10m 100k

Q4b)

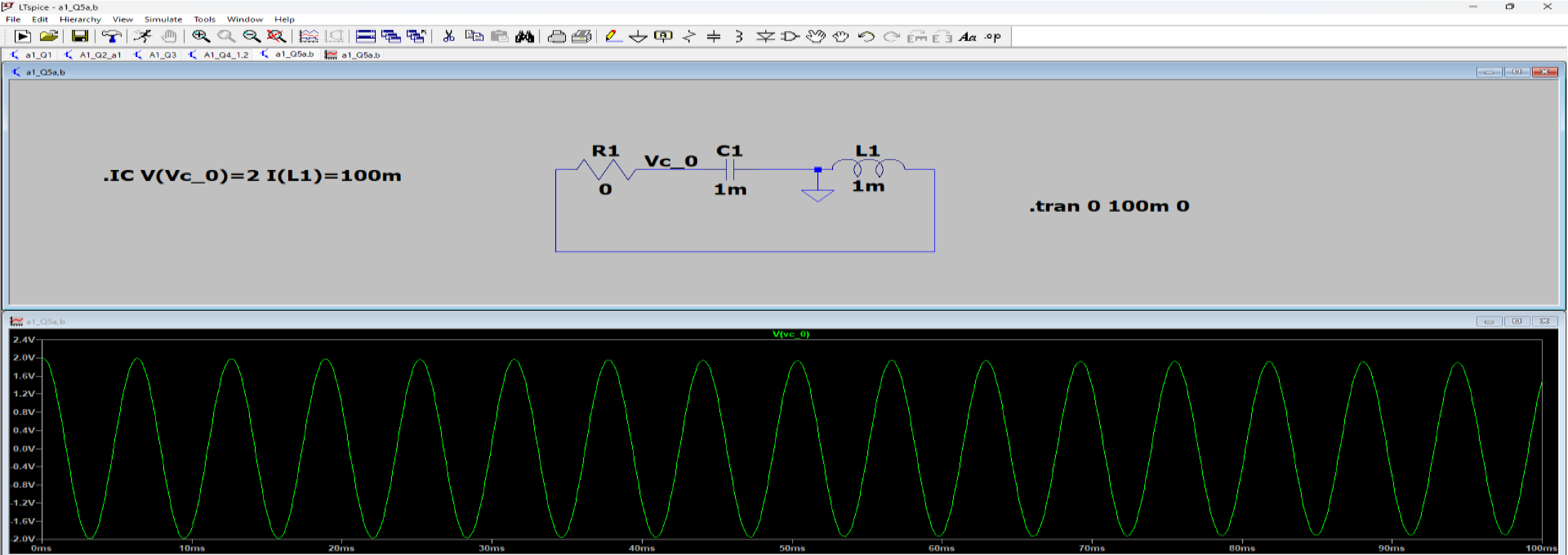


LTspice - A1_Q4_1,2
File Edit Hierarchy View Simulate Tools Window Help
a1_Q1 A1_Q2_a1 A1_Q4_1,2 A1_Q4_1,2 Q5
A1_Q4_1,2
V(vout)
10V 9V 8V 7V 6V 5V 4V 3V 2V 1V 0V
100° 80° 60° 40° 20° 0° -20° -40° -60° -80° -100°
10mHz 100mHz 1Hz 10Hz 100Hz 1KHz 10KHz 100KHz
A1_Q4_1,2
.ac dec 100 10m 100k
I1
AC 1 0
R2
10
C2
10µ
L2
0.1m
Vout

Q5)
Series connection

When Resistance is 0,
The circuit becomes a simple LC circuit with L=1mH and C=1mF.
The output is that of LC oscillations with $\omega=1/\sqrt{(LC)}=1000\ s^{-1}$

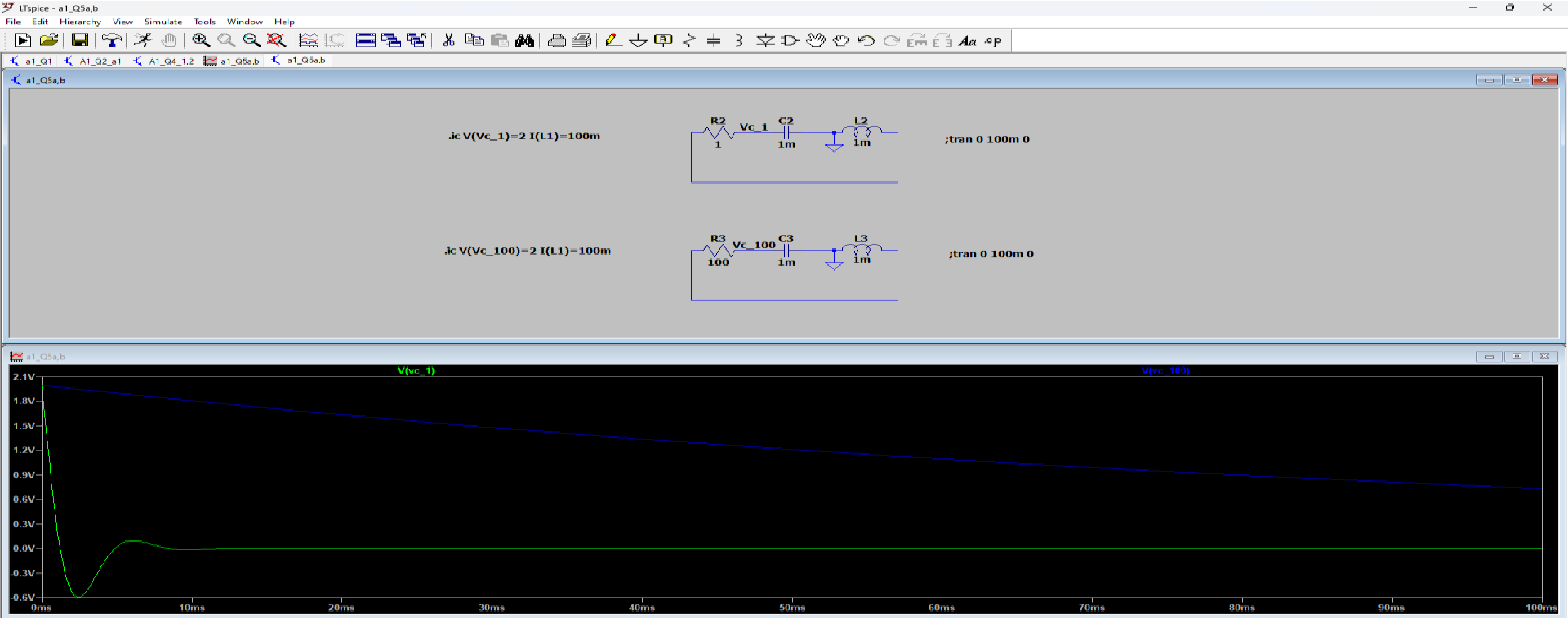
Since $\omega=1000\ s^{-1}$, Time period is $T=2\pi/\omega=2\pi$ ms.
Also since there is no resistance, there is no power dissipated.



Q5)

In R=1 case, the damping coefficient $\alpha = 1/2RC = 500$ which is less than $\omega_0 = 1/\sqrt{(LC)} = 1000$ so it is underdamped.
Thus there is mild LC oscillation which eventually disappears as the power dissipates across the resistor.

In R=100 case, the damping coefficient $\alpha = 1/2RC = 50000$ which is much lesser than ω_0 so it is overdamped.
So here there is an exponential decay of voltage across capacitor.

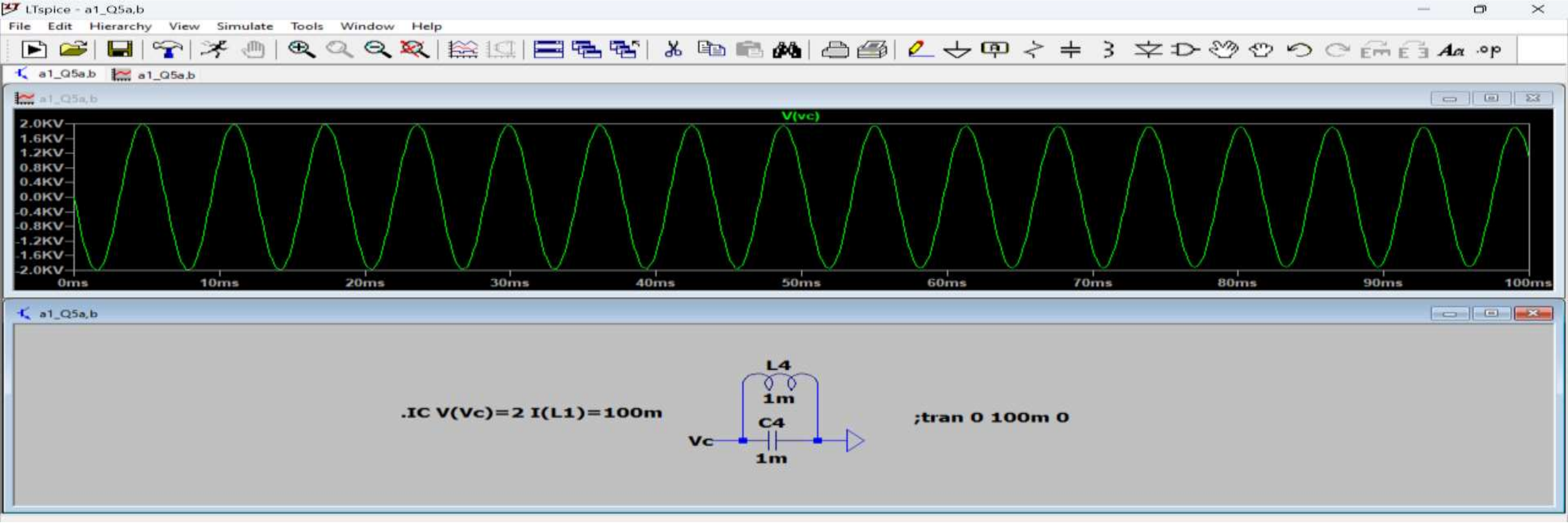


Q5)
Parallel connection

When Resistance is infinite, current through that wire becomes zero
So we can just remove the wire.

The circuit becomes a simple LC circuit with L=1mH and C=1mF.
The output is that of LC oscillations with $\omega=1/\sqrt{LC}=1000\ s^{-1}$

Since $\omega=1000\ s^{-1}$, Time period is $T=2\pi/\omega=2\pi$ ms.



Q5)

In the R=1 case, the damping coefficient α =1/2RC = 500 which is less than ω_0=1/√(LC)=1000 so it is underdamped. Thus there is mild LC oscillation which eventually disappears as the power dissipates across the resistor.

In the R=100 case, the damping coefficient α =1/2RC = 5 which is lot lesser than ω_0 so it is very underdamped. So here there is almost perfect LC oscillation at the start which decays overtime and gets imperfect eventually