Electric Circuits II – Laboratory 04

Step response of 2nd order circuits

#	Student ID	Student Name	Grade (10)	Instructor signature
1				

Delivery Date	

Objective

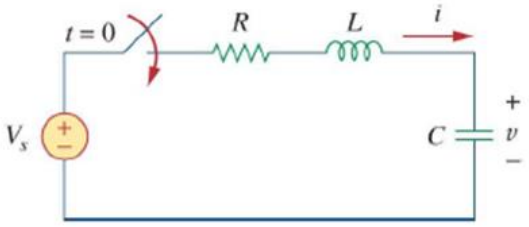
In this exercise, the DC step response of simple RLC circuits is examined. The complete response behavior of RLC circuits is also tested.

Theory Overview

- $v(t) = V_s + A_1 e^{s_1 t} + A_2 e^{s_2 t}$ (Overdamped) $\alpha > \omega_0$
- $v(t) = V_s + (A_1 t + A_2) e^{-\alpha t}$ (Critically damped) $\alpha = \omega_0$
- $v(t) = V_s + (A_1 \cos(\omega_d t) + A_2 \sin(\omega_d t)) e^{-\alpha t}$ (Underdamped) $\alpha < \omega_0$

Steady-state Soln.

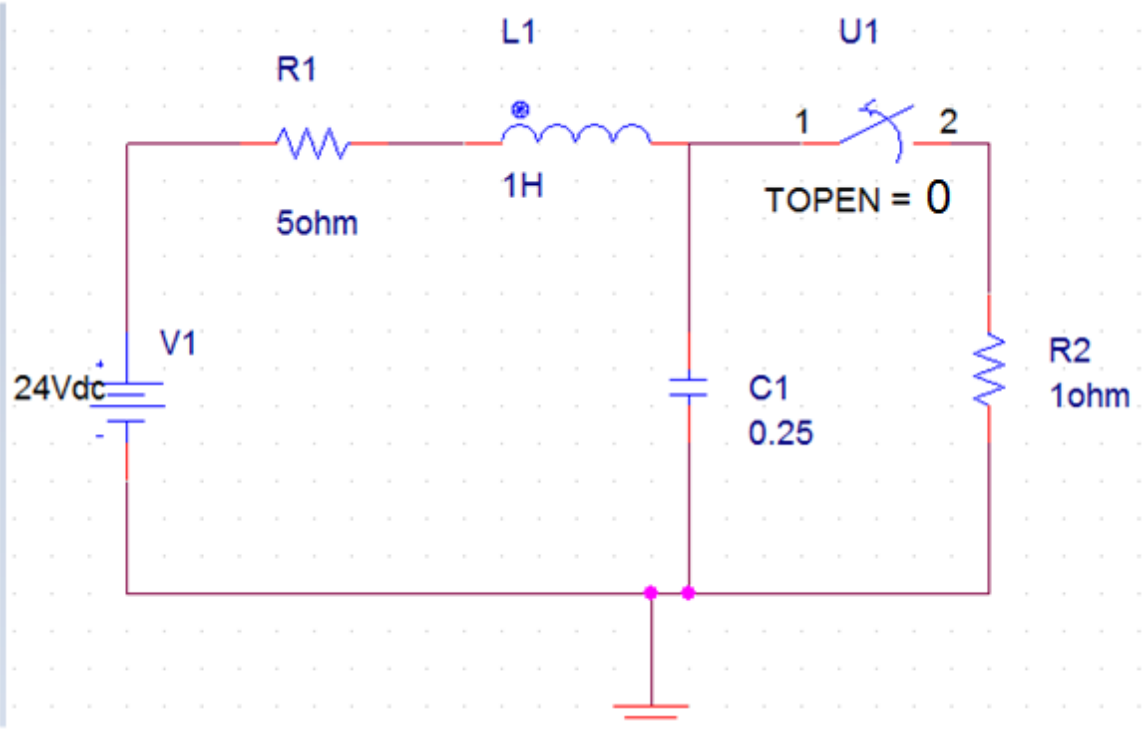
Transient soln.



Procedure

Part 1

1. Build the following schematic using orcad pspice



2. from lecture 06 we find the voltage and current equations in time domain as follows

$$v(t) = 24 + \frac{4}{3}(-16e^{-t} + e^{-4t})\ \text{V}$$

$$i(t) = \frac{4}{3}(4e^{-t} - e^{-4t})\ \text{A}$$

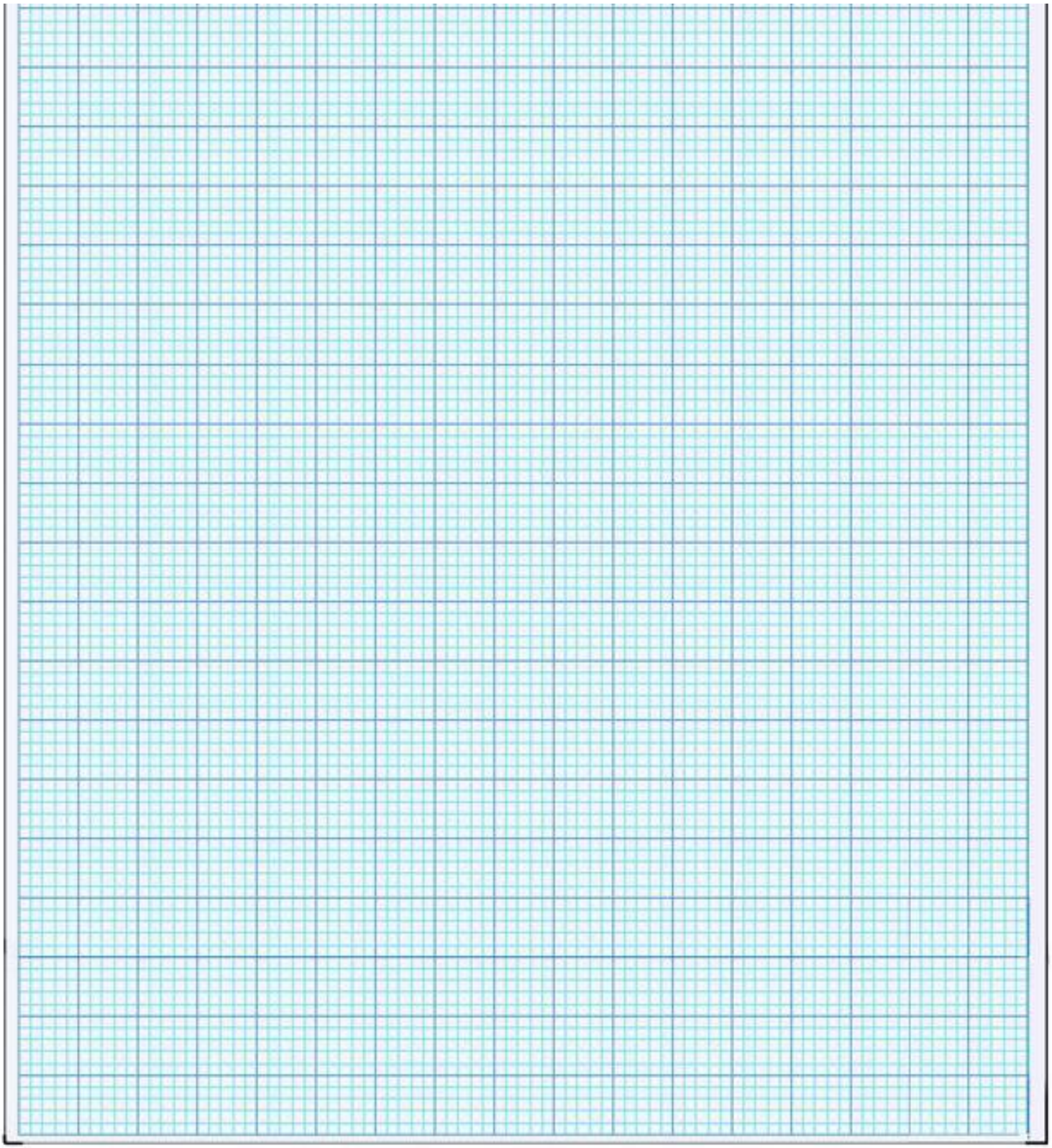
3. Use time domain transient in simulation profile, set the runtime to 6 seconds
4. Run simulation then plot the relation between V(C1:2)-V(C1:1) and time
5. Run simulation then plot the relation between I(L1) and time
6. Fill the table with voltage and current readings from simulation and calculation
7. Plot the voltage and current in time domain

Results and data analysis

Time (sec)	Vc (simulated)	Vc (calculated)
0.0		
0.5		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		

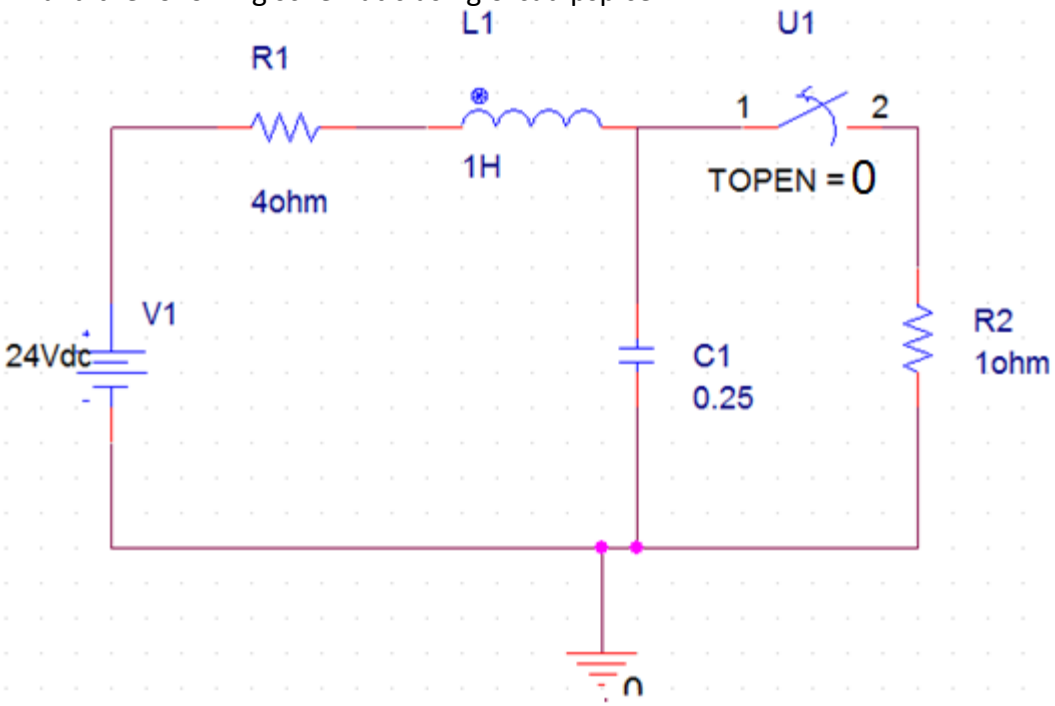
Time (sec)	Ic (simulated)	Ic (Calculated)
0.0		
0.5		
1.0		
1.5		

2.0		
2.5		
3.0		
3.5		
4.0		



Part 2

1. Build the following schematic using orcad pspice



2. From lecture 06 we find the voltage and current equations in time domain as follows

$$v(t) = 24 - 19.2(1 + t)e^{-2t}\ \text{V}$$

$$i(t) = (4.8 + 9.6t)e^{-2t}\ \text{A}$$

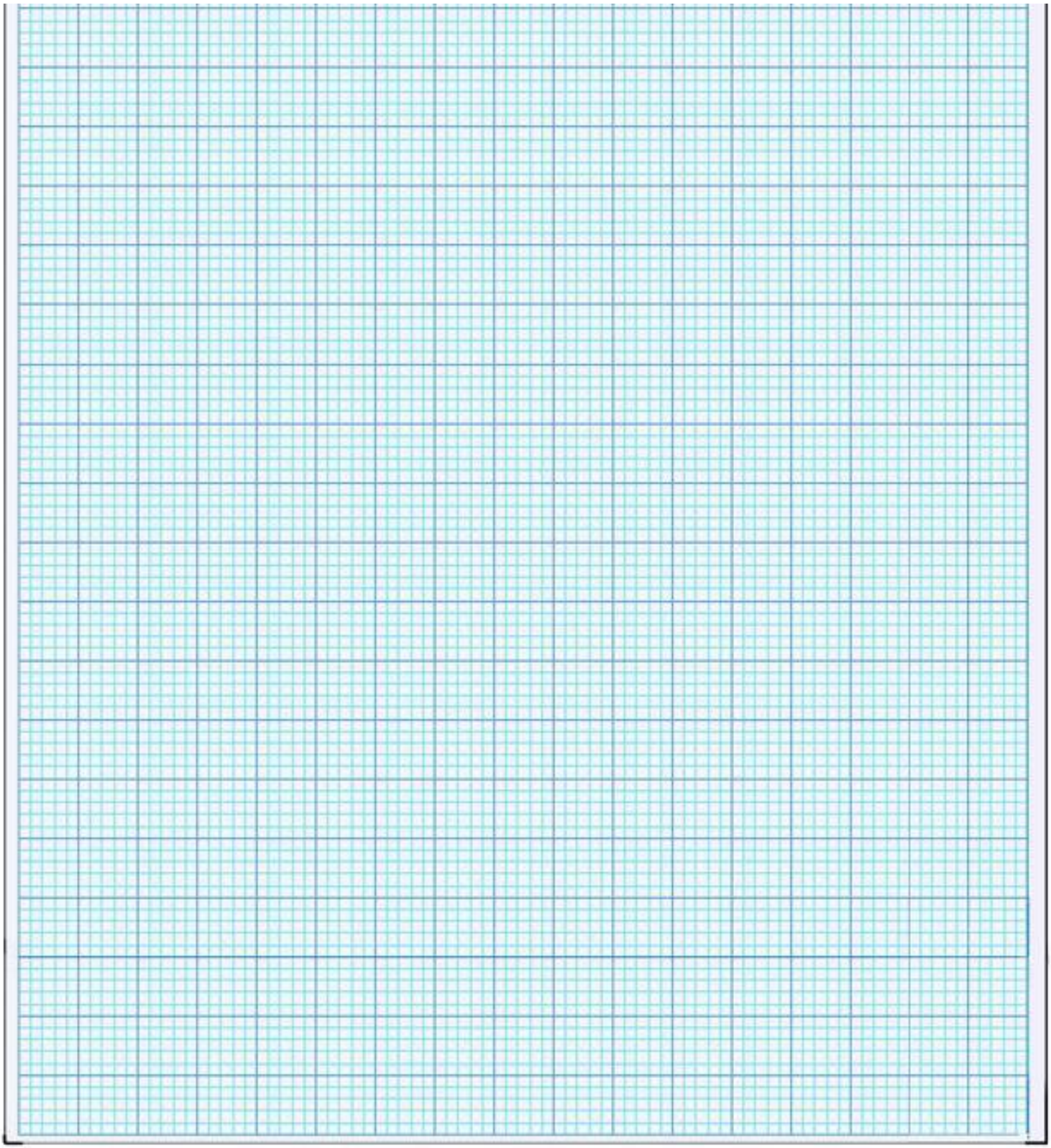
3. Use time domain transient in simulation profile, set the runtime to 6 seconds
4. Run simulation then plot the relation between V(C1:2)-V(C1:1) and time
5. Run simulation then plot the relation between I(L1) and time
6. Fill the table with voltage and current readings from simulation and calculation
7. Plot the voltage and current in time domain

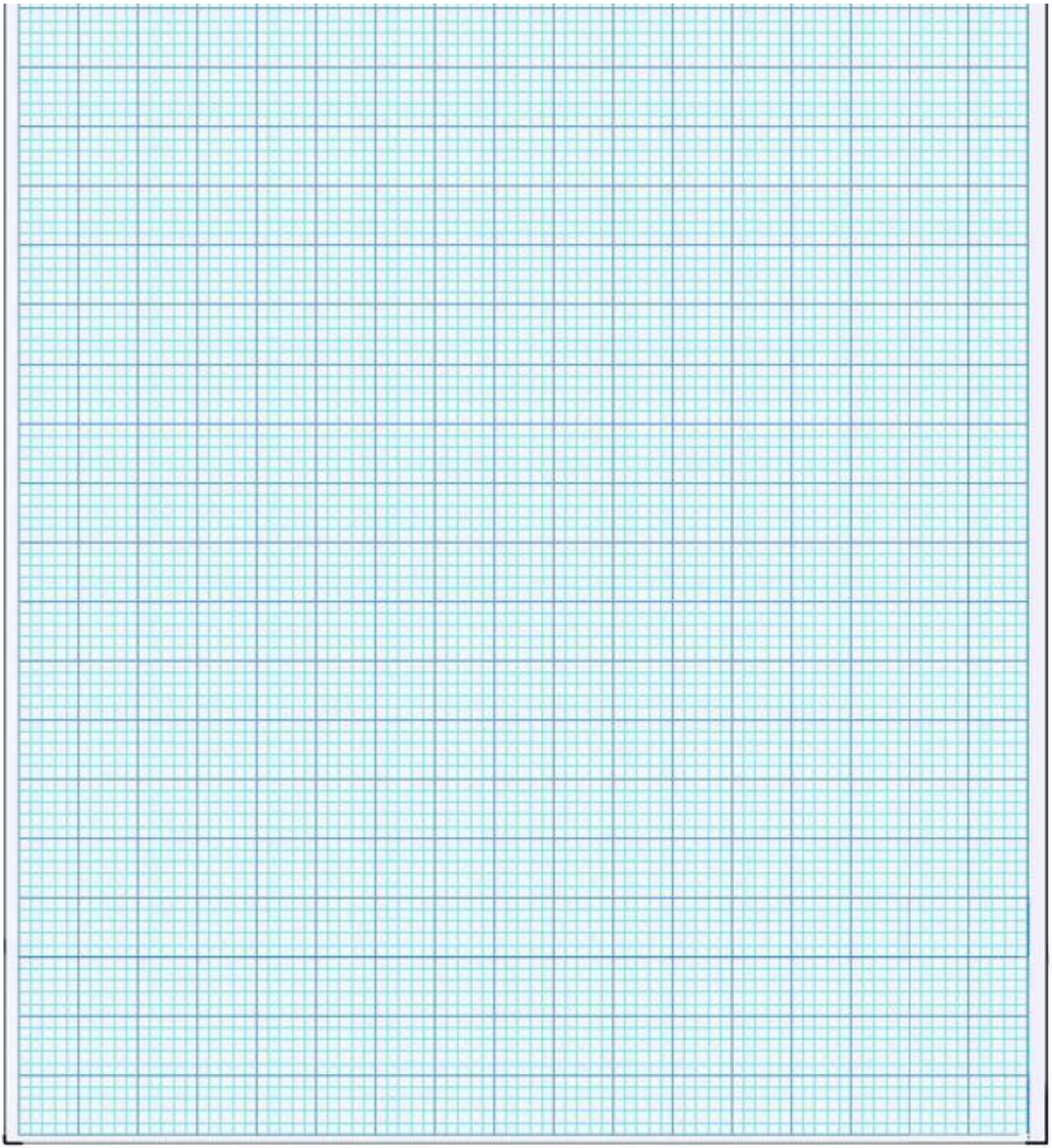
Results and data analysis

Time (sec)	Vc (simulated)	Vc (calculated)
0.0		
0.5		
1.5		
2.0		

2.5		
3.0		
3.5		
4.0		
4.5		
5.5		
6.0		

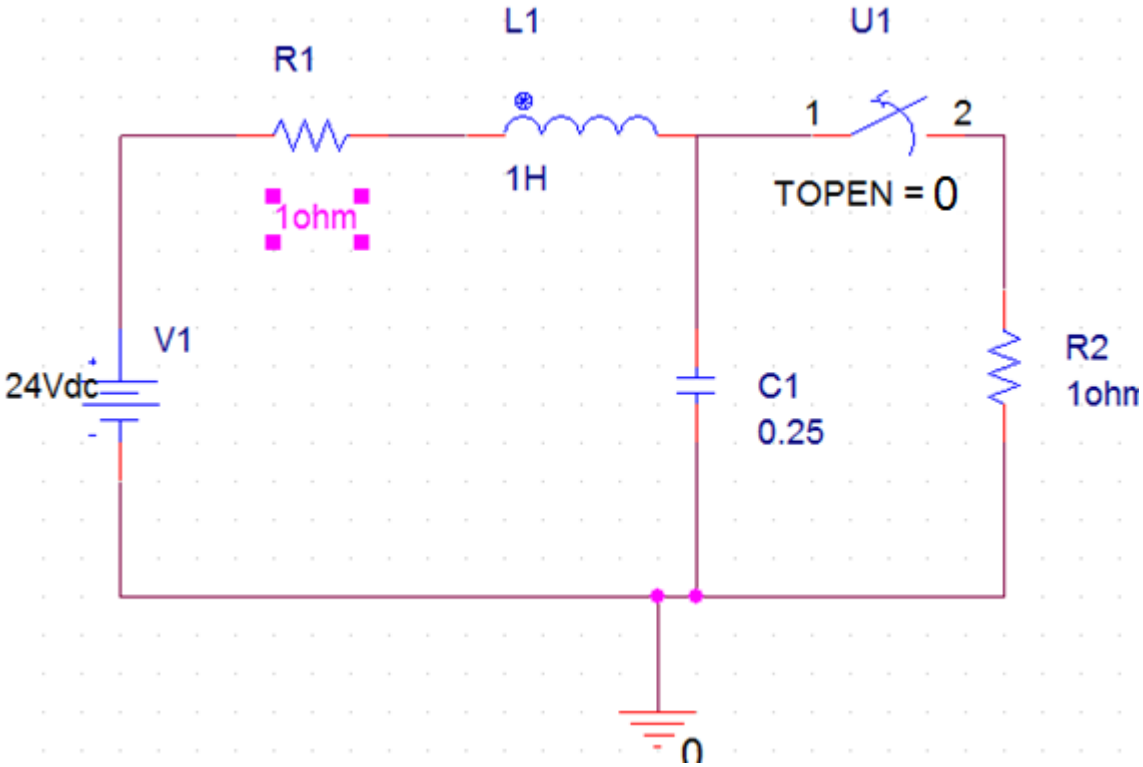
Time (sec)	Ic (simulated)	Ic (Calculated)
0.0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
5.5		
6.0		





Part 3

1. Build the following schematic using orcad pspice



2. from lecture 06 we find the voltage and current equations in time domain as follows

$$v(t) = 24 + (21.694 \sin 1.936t - 12 \cos 1.936t)e^{-0.5t} \text{ V}$$

$$i(t) = (3.1 \sin 1.936t + 12 \cos 1.936t)e^{-0.5t} \text{ A}$$

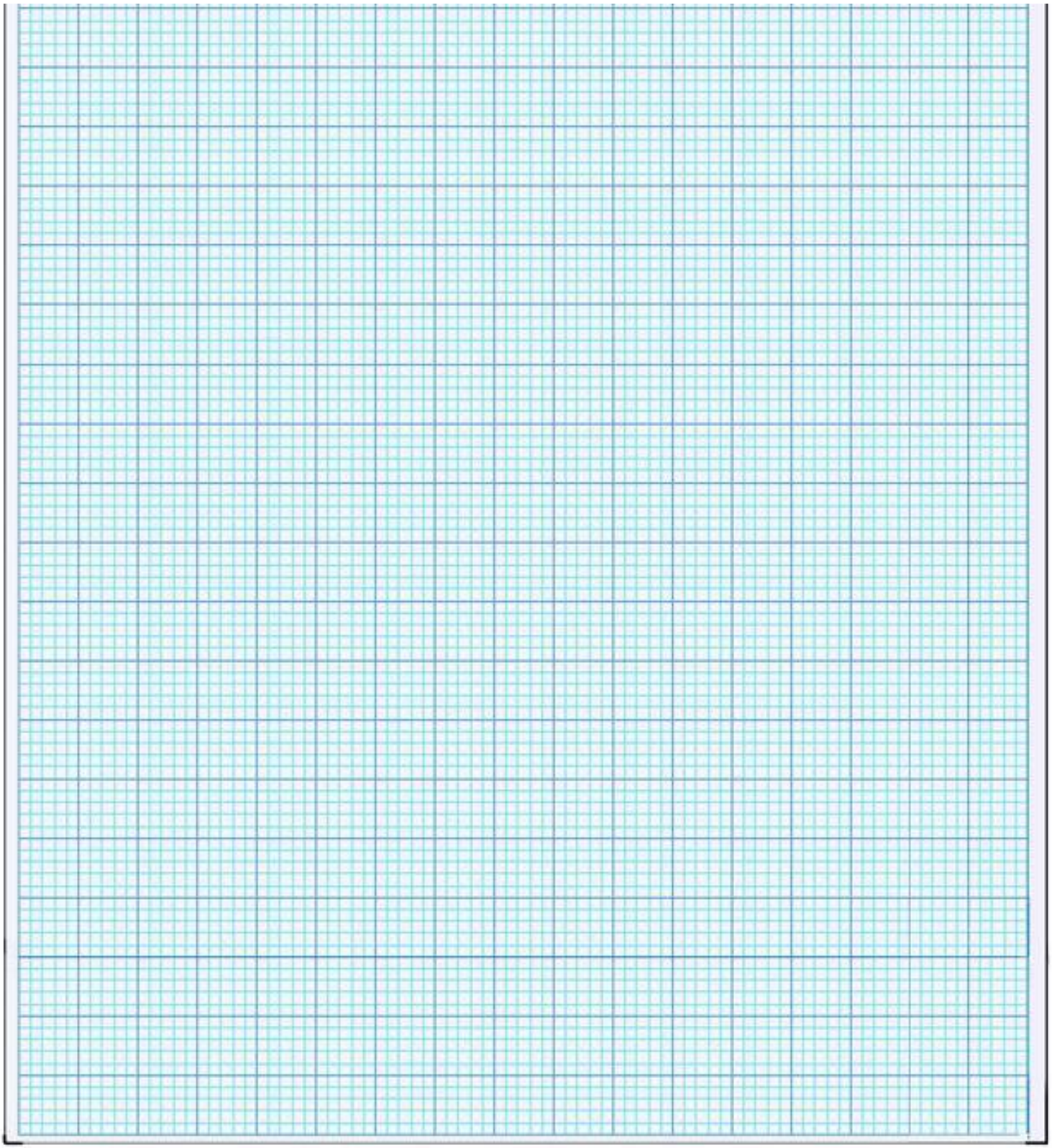
3. Run simulation then plot the relation between V(C1:2)-V(C1:1) and time
4. Run simulation then plot the relation between I(L1) and time
5. Fill the table with voltage and current readings from simulation and calculation
6. Plot the voltage and current in time domain

Results and data analysis

Time (sec)	Vc (simulated)	Vc (calculated)
0.0		
0.5		

1.5		
2.0		
2.5		
3.0		
3.5		
4.0		

Time (sec)	Ic (simulated)	Ic (Calculated)
0.0		
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		



Questions and Conclusions

1. Calculate the damping factor and resonant frequency of part 1, name the response type?

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2. Calculate the damping factor and resonant frequency of part 2, name the response type?

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3. calculate the damping factor and resonant frequency of part 1, name the response type?

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