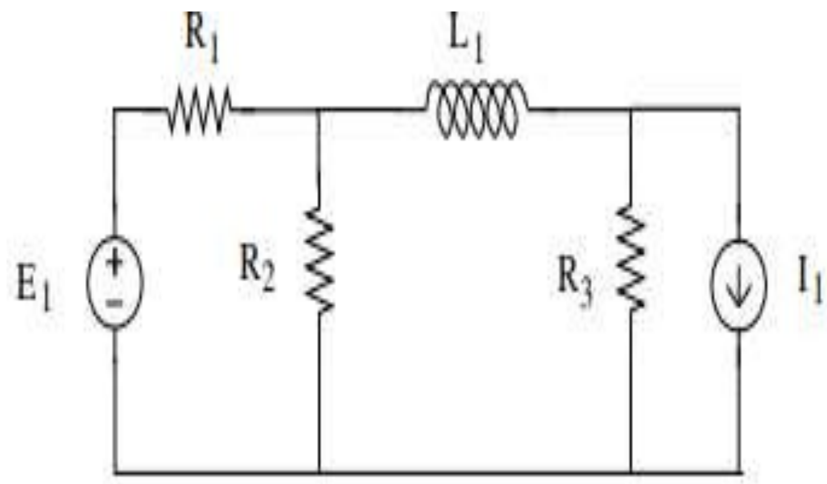
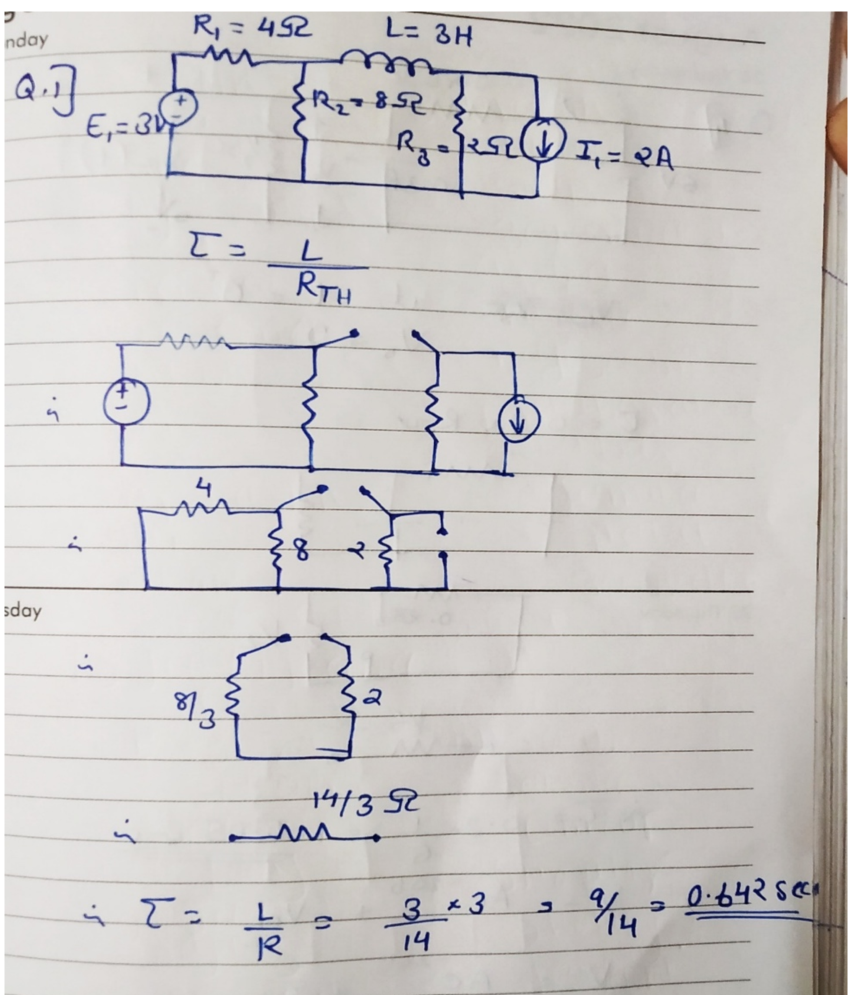
R-L and R-C DC Transient

CIRCUIT DIAGRAM and CALCULATIONS:

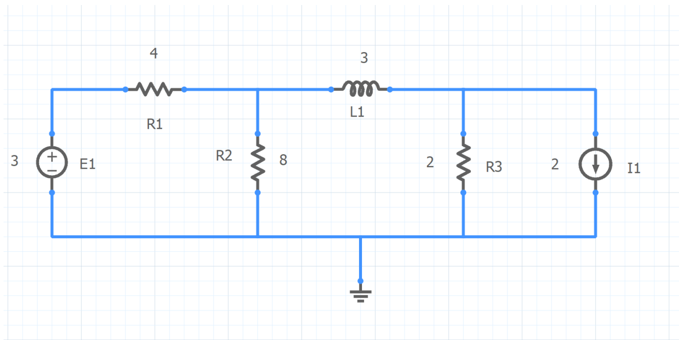
Problem 1: Calculate the time constant for the given circuit. R_1= 4, R_2=8, R_3=2, L_1=3H, E_1=3V, I1=2A



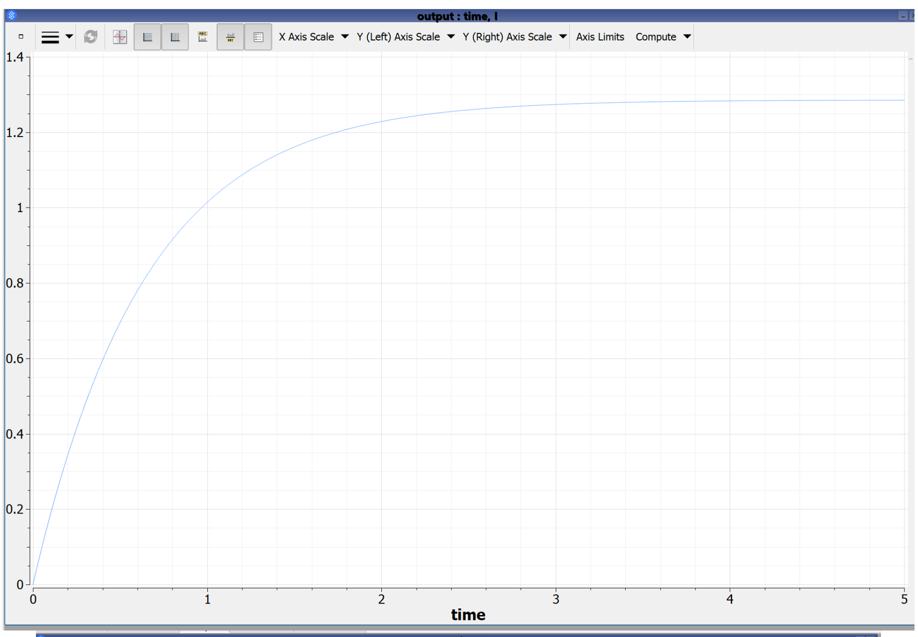
Solution: Theoretical solution:

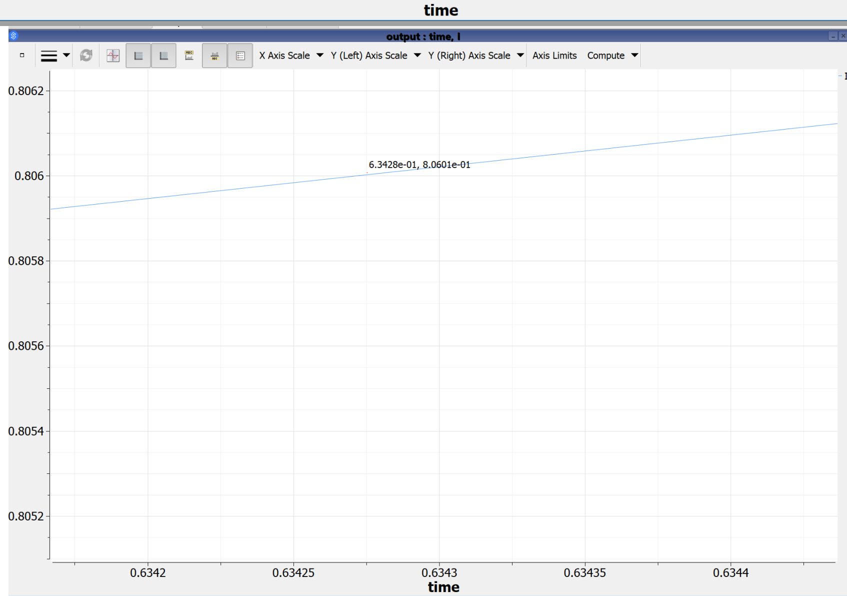


Simulation:
Circuit:

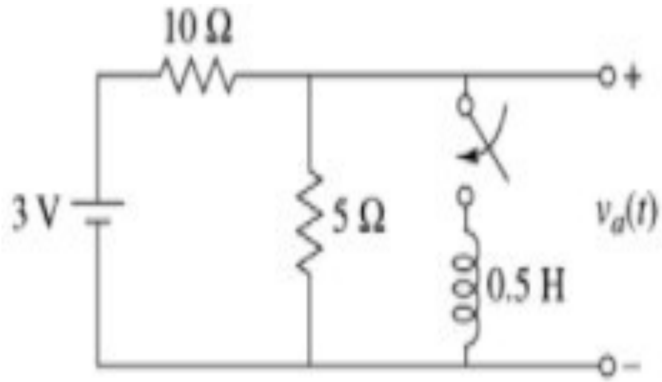


Graph:





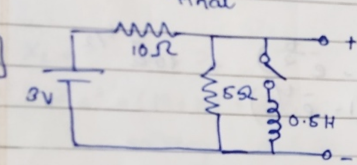
Problem 2. Steady state is achieved with switch is open. At t=0, Switch is closed. Find $v_a(t)$



Solution: Theoretical solution:

$V_{final} =$

Q.2}



<u>soln</u> :-

$$i_a(t) = i_{final}\,(1 - e^{-t/\tau}) + i_{initial}\,(e^{-t/\tau})$$

at $t = 0^+$

$i_{initial} = 0$ ∵ { no current is flowing across inductor }

at $t = \infty^-$

$\cancel{i_{final} = \frac{3}{10} A}$ $R_{TH} = \frac{10}{3}\,\Omega$

at $t = \infty^-$

$i_{final} = 0.3\,A$ $R_{TH} = \frac{10}{3}\,\Omega$ $\tau = \frac{0.5 \times 3}{10} = \underline{\underline{0.15\ sec}}$

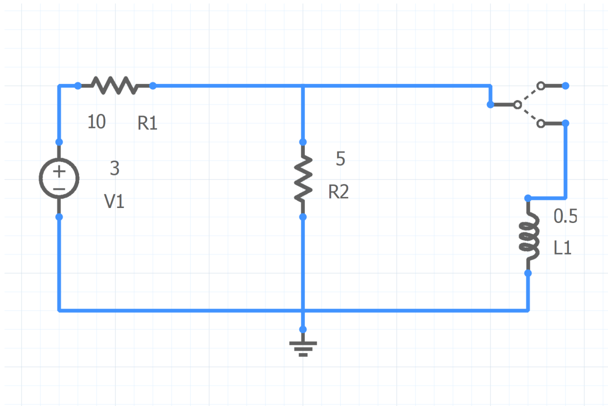
$$i_a(t) = 0.3(1 - e^{-\frac{t}{0.15}})$$

$$\therefore V_a(t) = \cancel{0.3 \times (} \; L\frac{di}{dt}$$

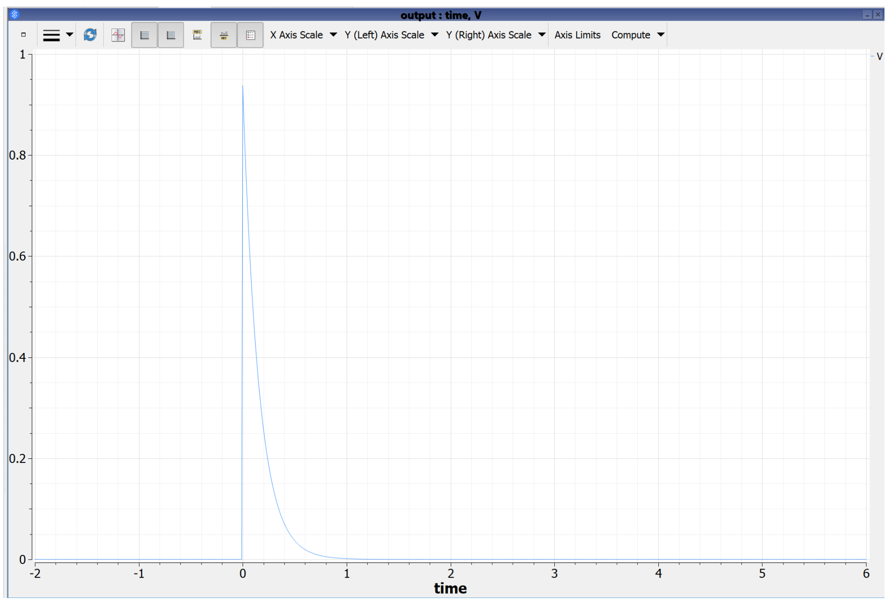
$$= \frac{0.5 \times 0.3}{0.15} \times e^{-\frac{t}{0.15}}$$

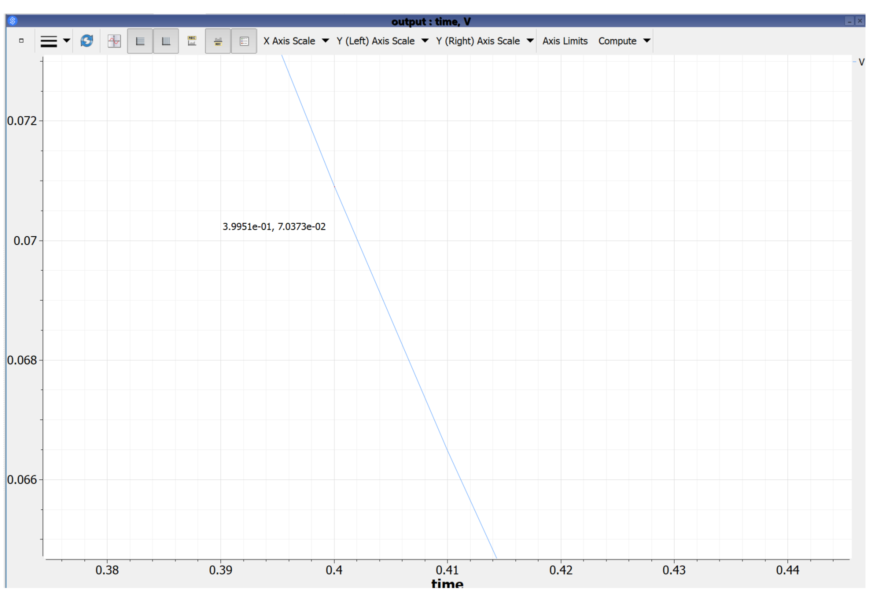
$$\boxed{V_a(t) = e^{-\frac{t}{0.15}}\,V}$$

Simulation:
Circuit:

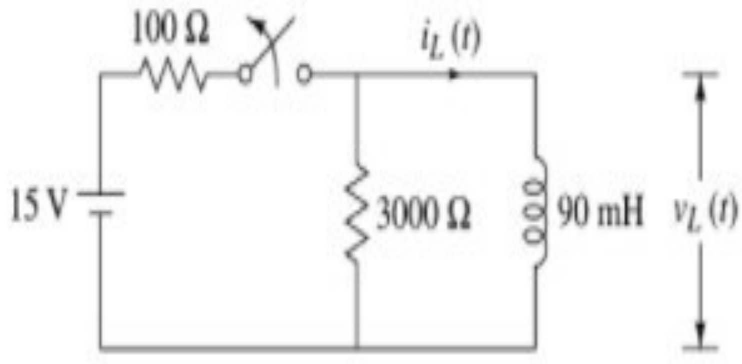


Graph:





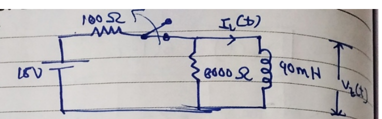
Problem 3: Steady-state is reached with the switch closed. It is opened at t=0. Obtain $i_L(t)$ and $v_L(t)$



Solution: Theoretical solution:

29 Monday

Q.3]



soln :

$$R_{TH} = \frac{1}{100} + \frac{1}{3000}$$

$$\boxed{R_{TH} = \frac{3000}{31}\ \Omega} \quad \therefore \underline{R_{TH} = 96.77}$$

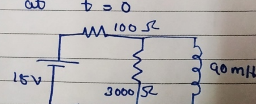
$$\tau = \frac{L}{R} = \frac{90 \times 10^{-3} \times 31}{3000}$$

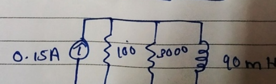
$$= 3 \times 10^{-5} \times 31$$

$$= \underline{9.3 \times 10^{-4}\ secs}$$

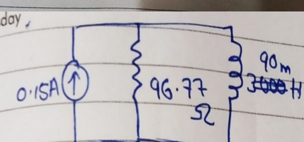
30 Tuesday

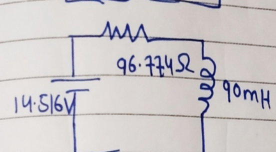
Now, at $t = 0^-$



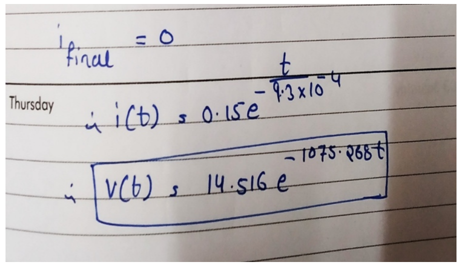


Wednesday





$$i_{initial} = \frac{14.51}{96.77} = \underline{0.15A}$$



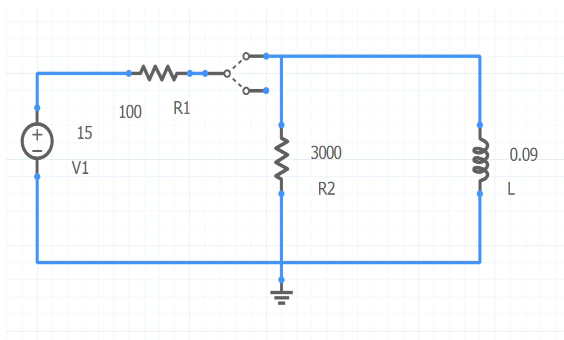
$i_{final} = 0$

Thursday

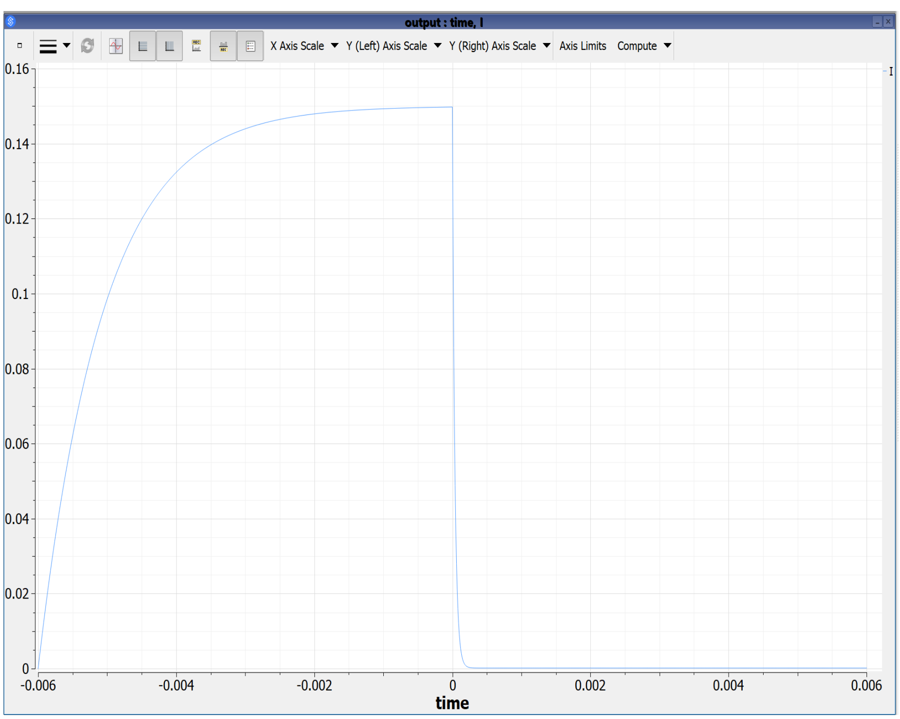
$\therefore i(t) = 0.15 e^{-\frac{t}{9.3\times10^{-4}}}$

$\therefore \boxed{v(t) = 14.516 e^{-1075.268t}}$

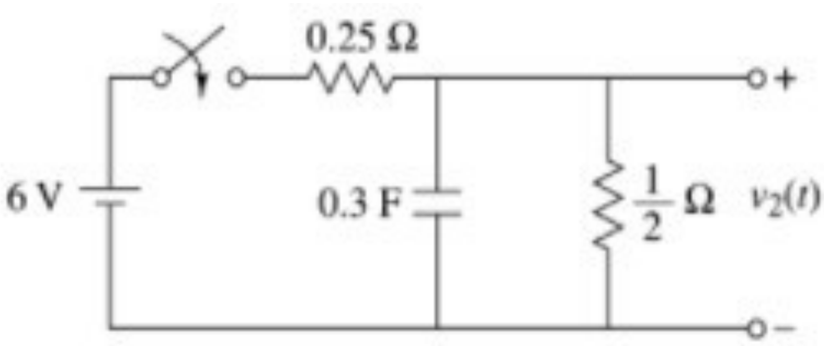
Simulation:
Circuit:



Graph:



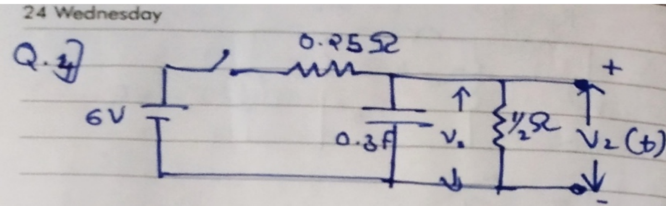
Problem 4: The switch is open for a long time and closed at t=0. Determine $v_2(t)$



Solution: Theoretical solution:

24 Wednesday

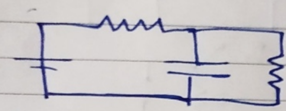
Q.4



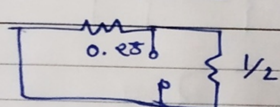
at $t = 0^-$

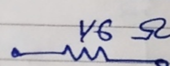
$V_0 = 0$

$\tau = 0.3 \times R_{TH}$



25 Thursday





$\therefore \tau = 0.3 \times \frac{1}{6} = 0.05$ sec

$V = Ae^{-20t} + V_\infty$

$V = Ae^{-20t} + 6$

at $t = 0$ $V = 0$

$\therefore 0 = A + 6$

$\therefore A = -6$

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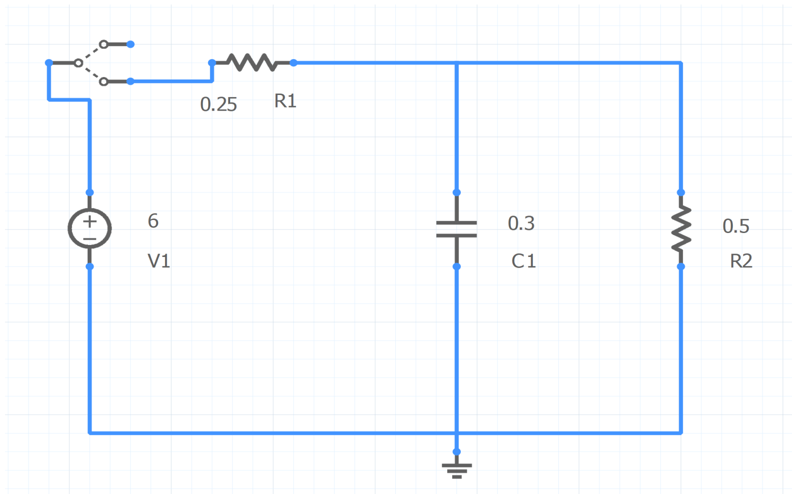
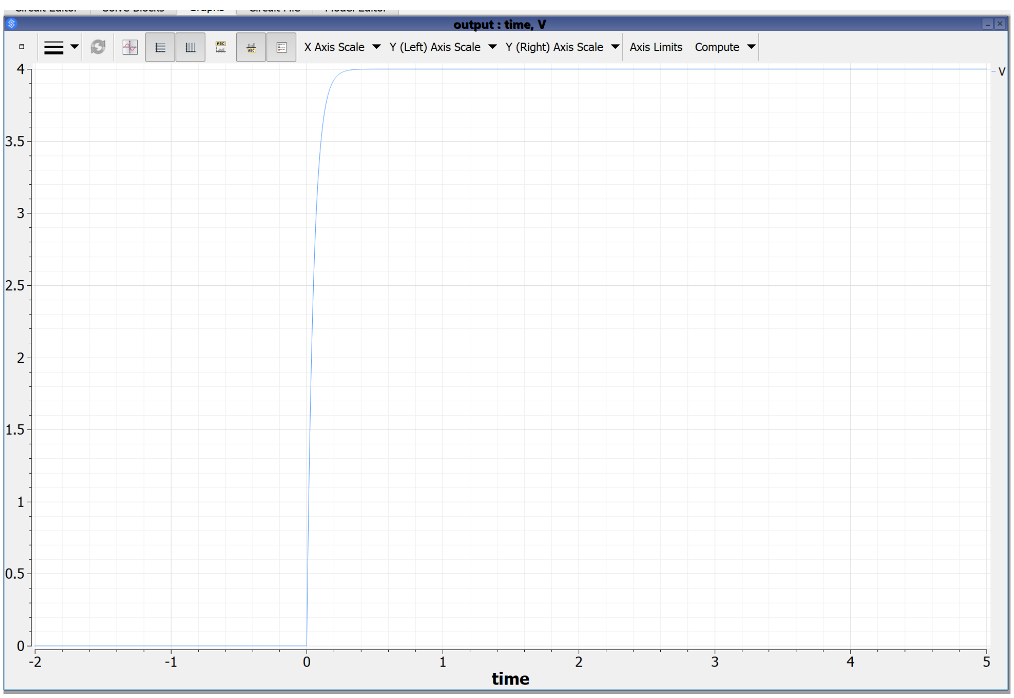
$\therefore \boxed{V_2(t) = 6(1 - e^{-20t})}$

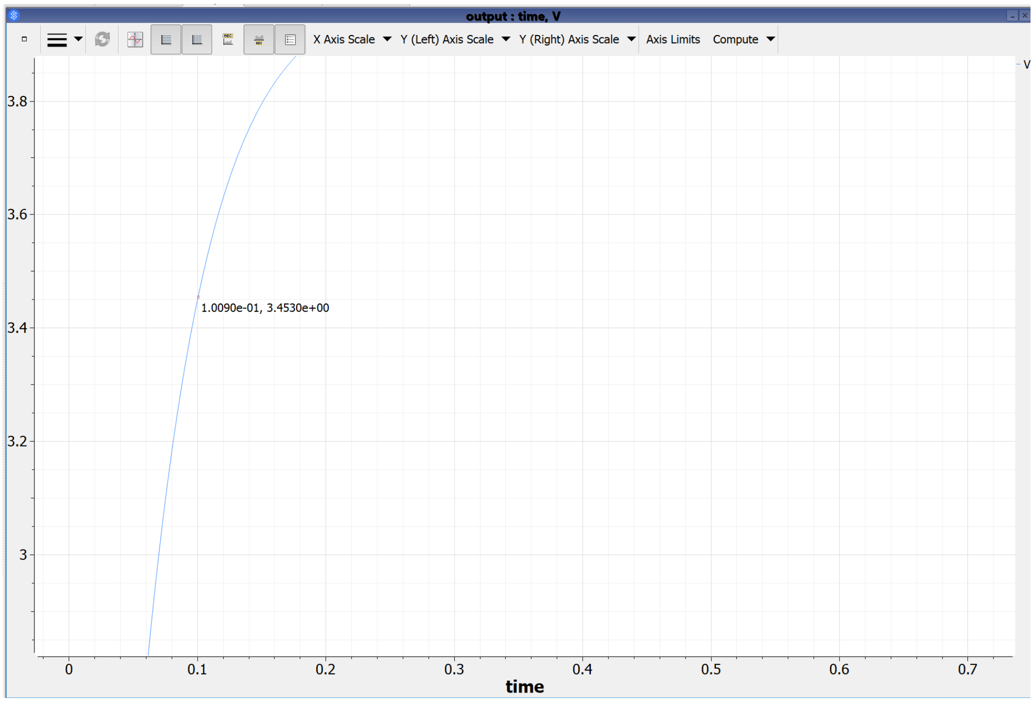
Simulation:

Circuit:

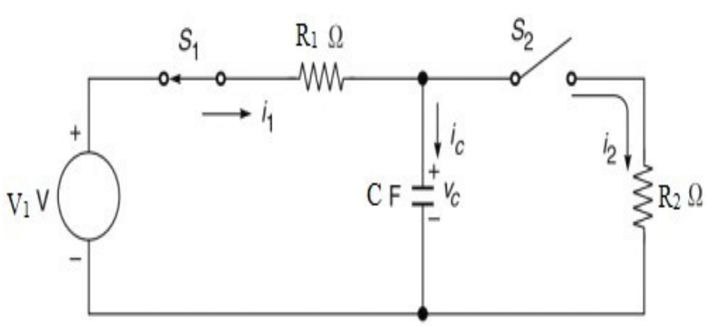


Graph:

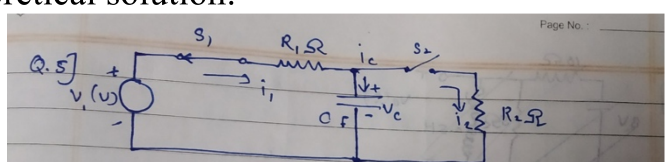




Problem 5: Switch S1 is closed for long time. At t=0 switch, S2 is closed. Compute V_C. R_1=4, R_2=4, V_1=10, C=1



Solution: Theoretical solution:



V_1 = 10 V , C = 1 F R_1 = 4Ω , R_2 = 4Ω

find V_c = ?

Soln:-

$$V_c(ini) = V_1 = 10V$$

at $t = \infty$

$$R_{TH} = 2\Omega$$

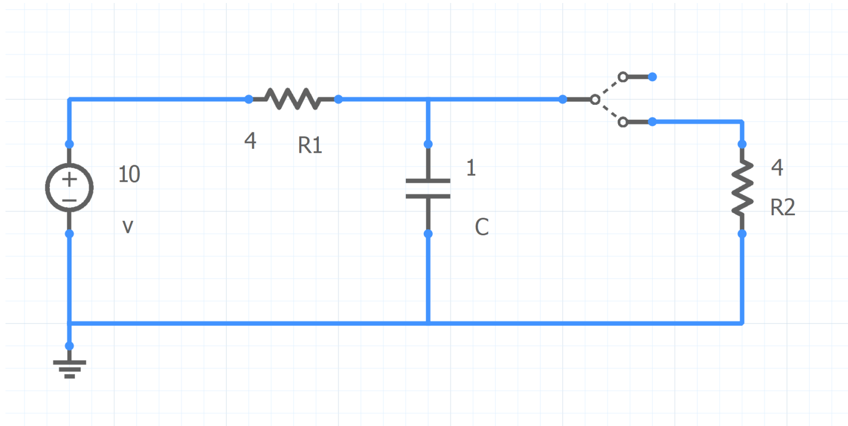
$$\tau = 2$$

$$\therefore V_c(t) = 5(1 - e^{-\frac{t}{2}}) + 10e^{-t/2}$$

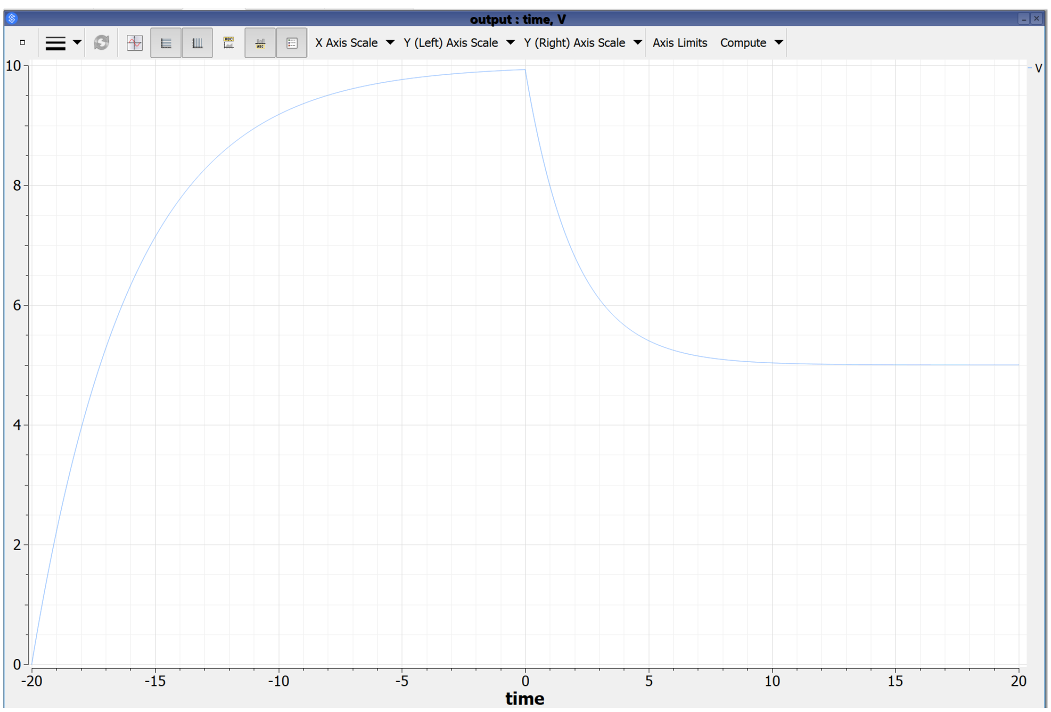
$$V_c(t) = 5(1 + e^{-t/2})$$

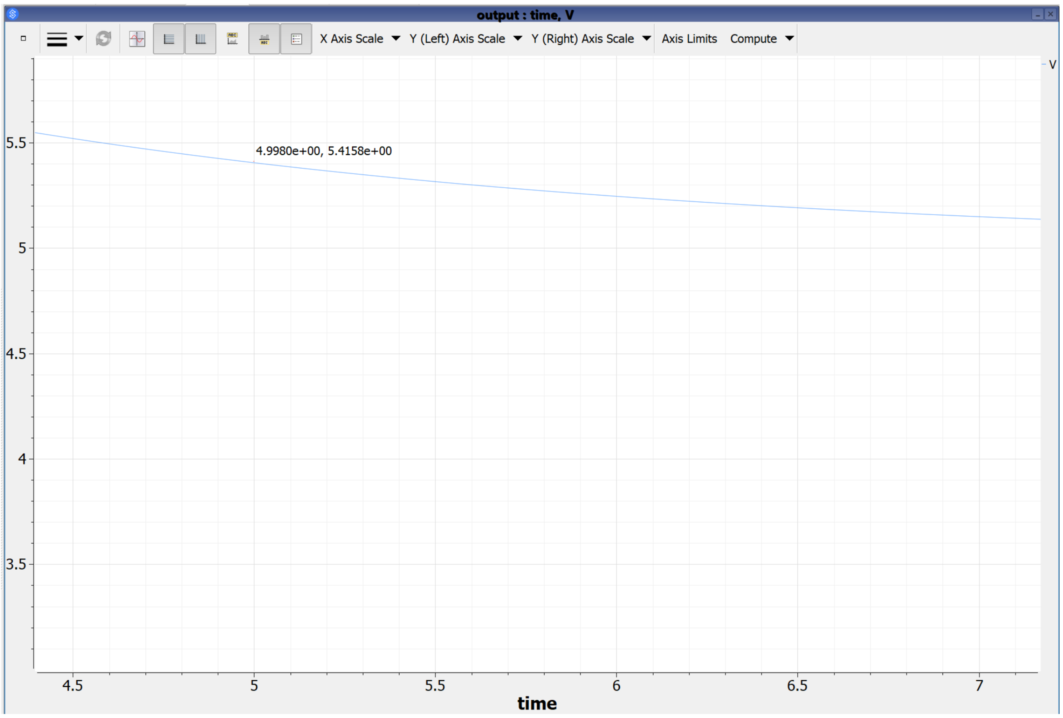
Simulation:

Circuit:



Graph:




output : time, V
X Axis Scale
Y (Left) Axis Scale
Y (Right) Axis Scale
Axis Limits
Compute
V
4.9980e+00, 5.4158e+00
5.5
5
4.5
4
3.5
4.5
5
5.5
6
6.5
7
time

NAME: Pranay Singhvi EXPERIMENT No: 4 DATE: 28/06/ 2022

R-L and R-C DC Transient response

AIM: To verify DC Transient response for the given R-L an R-C circuits.

APPARATUS AND COMPONENTS REQIRED: Sequel Simulator

THEORY: Write theory related with following questions:

1) Define time constant, initial condition, final condition, transient response, natural response, forced response.
Ans:
1. Time constant: a time which represents the speed with which a particular system can respond to change, typically equal to the time taken for a specified parameter to vary by a factor of 1− 1/ e (approximately 0.6321).
2. Initial Condition: Initial conditions in the circuit are the boundary values of the differential equation governing the circuit.
3. Final Condition: Final conditions in the circuit are the boundary values of the differential equation governing the circuit.
4. Transient response: A transient response of a circuit is a temporary change in the way that it behaves due to an external excitation, that will disappear with time. Damping oscillation is a typical transient response where the output value oscillates until finally reaching a steady-state value.
5. Natural response: The natural response of a circuit is what it does "naturally" as its internal energy moves around.
6. Forced response: Forced response is the system's response to an external stimulus with zero initial conditions.

PROCEDURE:

1) Solve the problems given in below table (as per your batch e.g. X1= A1/B1/C1) to obtain transient response of R-L and R-C circuits
2) Verify the solution of the problems solved in step 1 using Sequel software.

RESULT:

Problem no.	Parameter	Theoretical	Practical
1	Time Constant	0.6428 s	0.6348 s
2	V(t)	At t = 0.4s, V = 0.0694V	At t = 0.4 s, V = 0.0702 V

3	I(t)	At t = 0s, I = 0.15 A	At t = 0 s, I = 0.148 A
4	V(t)	At t = 1s, V = 3.2749V	At t = 1s, V = 3.5V
5	V(t)	At t = 5s, V = 5.41V	At t = 5s, V = 5.418 V

CONCLUSION:

We learned to find the time constant and we verified using sequel simulation. We also verified our current & voltage equation using sequel.