

PDSE 4001- Daniel Evans-

Assignment 1

by Daniel Evans

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PSDE 4001 -
Electrical and Electronic
Principles
Assignment 1

Daniel Evans

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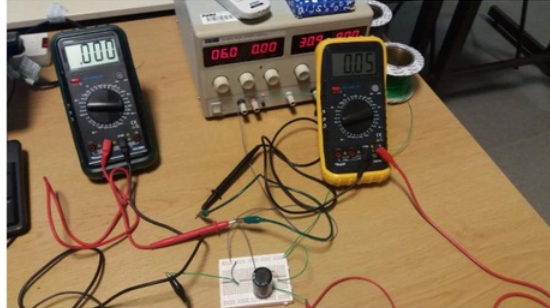
1. Introduction

The purpose of this assignment is to investigate the behaviour of RL and RC circuits when they are connected to a DC voltage source. This will be done through simulation, practical construction and testing and calculations. . Measurement instruments such as multimeters, probes and oscilloscopes will be used in order to demonstrate the characteristics of RC and RL circuits. Mathematical formulae will be manipulated in order to predict instantaneous values as final values. These values will be compared with the measured values from the practical and simulated circuits. Results of each method will be analysed and comparisons between all three methods will be made and a relevant conclusion will be made. Reasons will be given for any discrepancies with the results

2. Circuit testing

Task 1- Transient Behaviour for the Charging of a Capacitor

RC Circuit



The circuit components values have been selected due to there large time constant, therefore it's easy to take readings/measurements on the circuit.

DC power supply = 6V

Resistor value = 5.6k Ω

Capacitor value = 10000 μ F

In order to calculate the value of the time constant the following equation is used :-

$$t = R \times C$$

$$t = 5.6k\Omega \times 10000\mu F$$

$$t = 56s$$

The time period is the time taken for the capacitor to fully charge / discharge, the max growth of transient will be reached after the time period is reached. The time period is calculated by using the following equation

$$T = 5 \times t$$

$$T = 280s$$

The resistor and capacitor will have tolerances and this will affect the time constant/period along with the measured current and voltage values during the charge and discharge.

The resistor value will affect the maximum current in the circuit. The following equation is used to calculate the maximum current in the circuit.

$$I_{max} = \frac{V_s}{R}$$

$$I_{max} = \frac{6V}{5.6k\Omega}$$

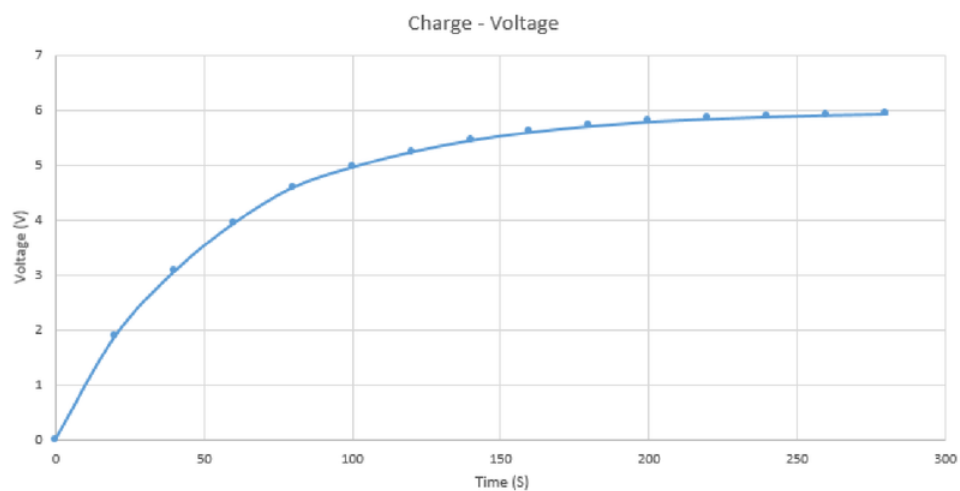
$$I_{max} = 1.07mA$$

Charge		
Time (s)	VC (V)	IC (mA)
0	0	1.07
20	1.88	0.75
40	3.07	0.529
60	3.95	0.375
80	4.61	0.253
100	4.98	0.19
120	5.26	0.138
140	5.47	0.101
160	5.62	0.073
180	5.73	0.054
200	5.81	0.041
220	5.86	0.031
240	5.9	0.024
260	5.93	0.019
280	5.95	0.015

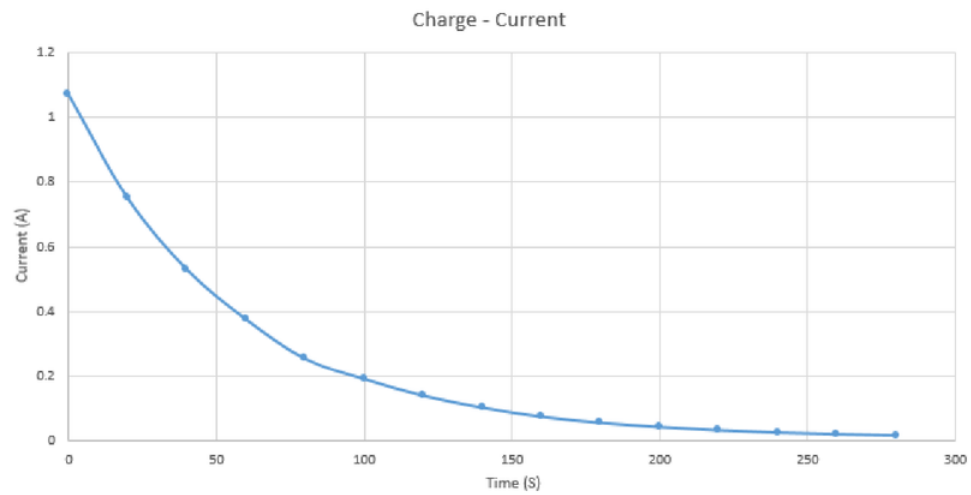
Practical charge circuit results

Readings of the voltage and current were taken every 20s until it reached the time period (i.e 280s)

The graph below shows the voltage across the capacitor increasing. It shows that the charging rate is fastest at the start and then tapers off at the end. After 1T the rate of change is fastest and at 5 time constants steady state has been reached.

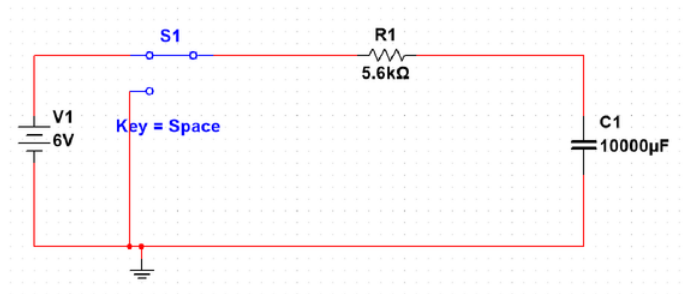


The graph below shows that the current charging the capacitor drops dramatically during the first time constant (60s) before tapering off at the end. At 1T the rate of change decreases and at 5 time constants steady state has been reached.



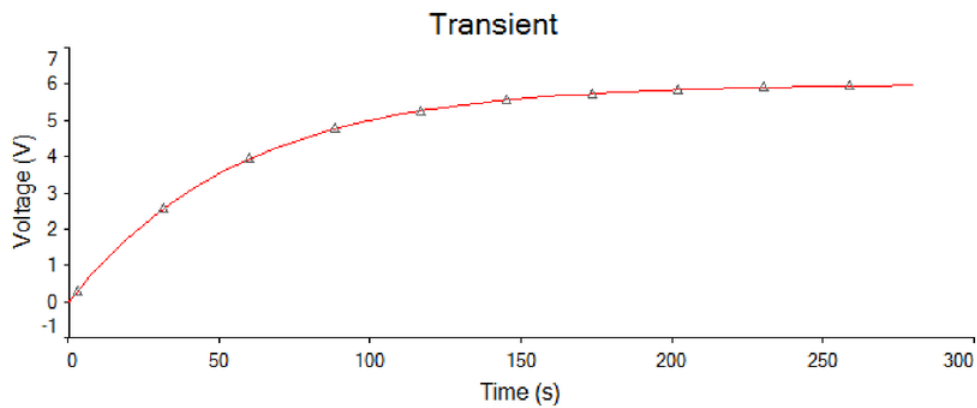
Multisim simulation

Shown below is the simulation set up which replicates the practical set up.



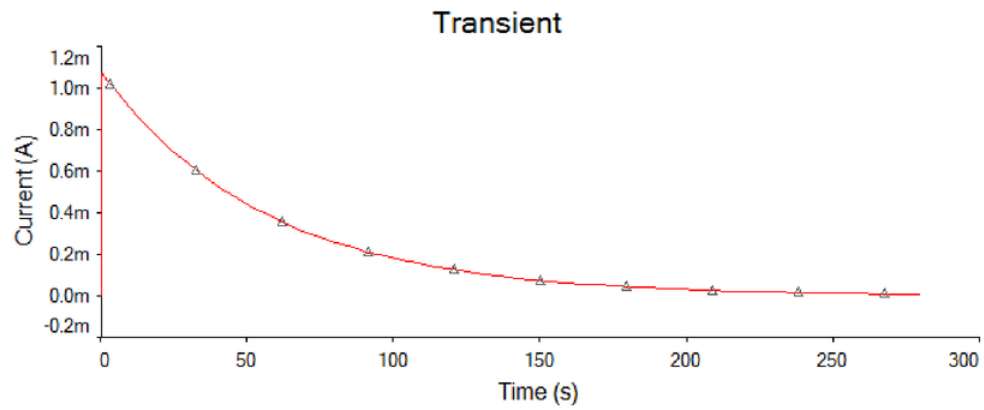
Voltage charge transient

Shown below is the simulated voltage charge transient for the circuit. We can see that the rate of change decreases after reaching 1T and completely flattens off when it reaches 5T or transient state. Once it has reached steady state (i.e after 5T) the voltage will not increase further.



Current charge transient

Shown below is the simulated current charge transient for the circuit. We can see that the rate of change decreases after reaching $1T$ and completely flattens off when it reaches $5T$ or transient state. Once it has reached steady state (i.e after $5T$) the current will not decrease further.



Instantaneous times- Voltage

60s

Calculated

$$V_c = V_{max}(1 - e^{\frac{-t}{\tau}})$$

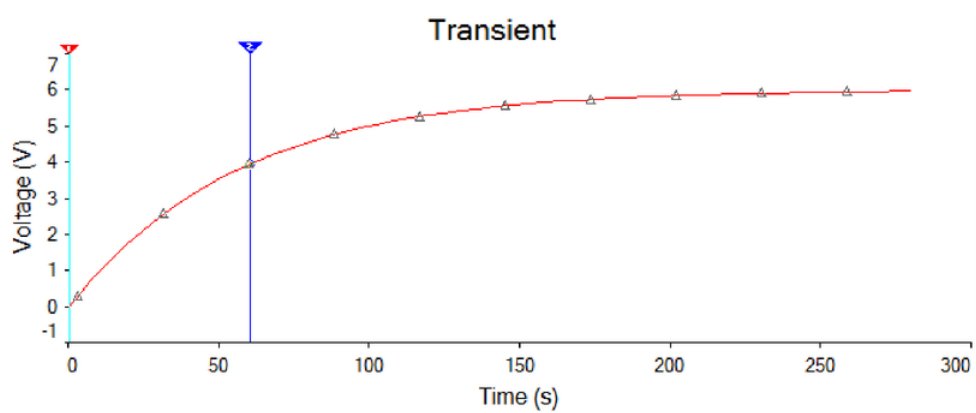
$$V_c = 6(1 - e^{\frac{-60}{56}})$$

$$V_c = 3.94V \text{ (2dp)}$$

Practical

$$60s = 3.95V$$

Simulated



$$60s = 3.94V$$

Cursor	
V(2)	
x1	0.0000
y1	0.0000
x2	60.0000
y2	3.9440
dx	60.0000
dy	3.9440
dy/dx	65.7340m
1/dx	16.6667m

120s

Calculated

$$V_c = V_{max}(1 - e^{-\frac{t}{T}})$$

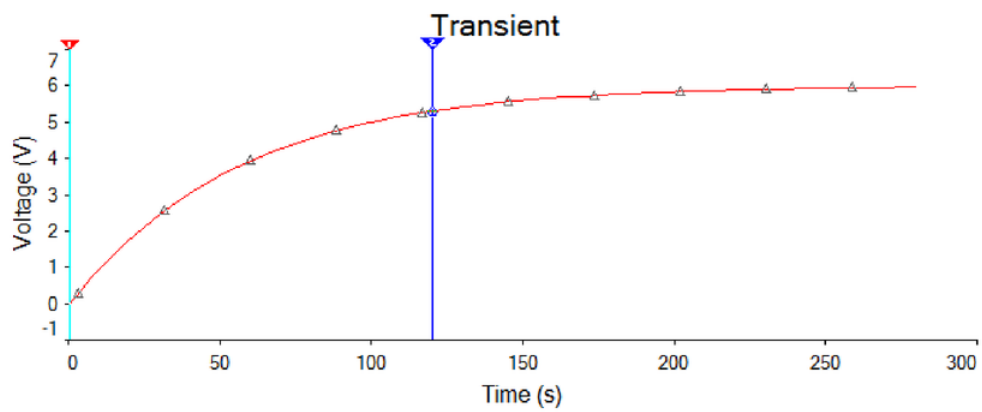
$$V_c = 6(1 - e^{-\frac{120}{56}})$$

$$V_c = 5.30\text{V (2dp)}$$

Practical

$$120s = 5.26\text{V}$$

Simulated



$$120s = 5.29\text{V}$$

Cursor	
V(2)	
x1	0.0000
y1	0.0000
x2	120.0000
y2	5.2968
dx	120.0000
dy	5.2968
dy/dx	44.1404m
1/dx	8.3333m

200s

Calculated

$$V_c = V_{max}(1 - e^{-\frac{t}{T}})$$

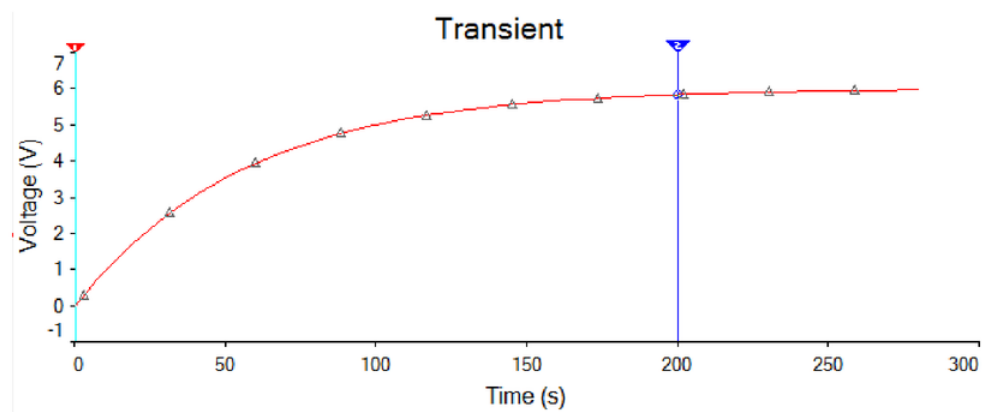
$$V_c = 6(1 - e^{-\frac{200}{56}})$$

$$V_c = 5.83V$$

Practical

$$200s = 5.81V$$

Simulated



$$200s = 5.83V$$

Cursor	
V(2)	
x1	0.0000
y1	0.0000
x2	200.0000
y2	5.8316
dx	200.0000
dy	5.8316
dy/dx	29.1579m
1/dx	5.0000m

Comparison table – Voltage			
Time	Calculated values	Practical values	Simulated values
60	3.94V	3.95V	3.94V
120	5.30V	5.26V	5.29V
200	5.83V	5.81V	5.83V

As shown in the table above, the maximum error is 0.04V. This would suggest that the calculations done are correct, and the practical circuit and the simulated circuit have functioned as intended. The probable cause for this error is rounding errors in both the simulated and calculated calculations.

Instantaneous times- Current

60s

Calculated

$$I_{max} = \frac{V_s}{R}$$

$$I_{max} = \frac{6V}{5.6k\Omega}$$

$$I_{max} = 1.07mA$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

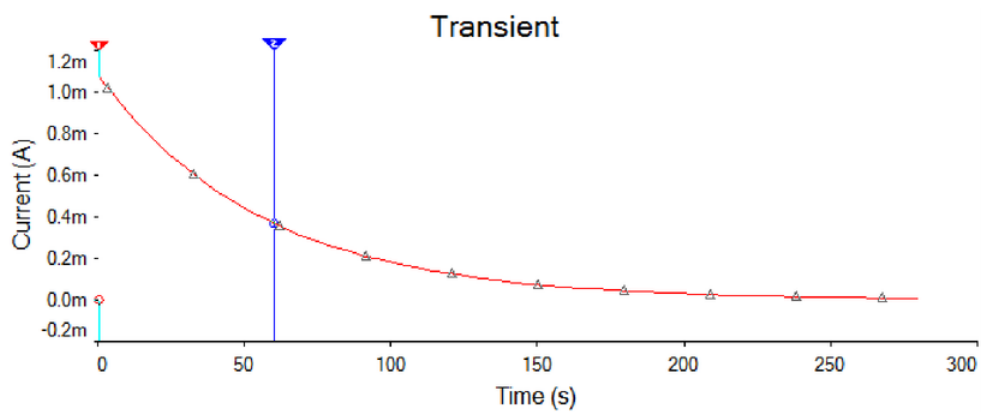
$$I_c = 1.07mA (e^{\frac{-60}{56}})$$

$$I_c = 0.367mA \text{ (3dp)}$$

Practical

$$60s = 0.375mA$$

Simulated



$$60s = 0.367mA$$

Cursor	
I (C1)	
x1	0.0000
y1	0.0000
x2	60.0000
y2	367.1362μ
dx	60.0000
dy	367.1362μ
dy/dx	6.1189μ
1/dx	16.6667m

120s

Calculated

$$I_{max} = 1.07\text{mA}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

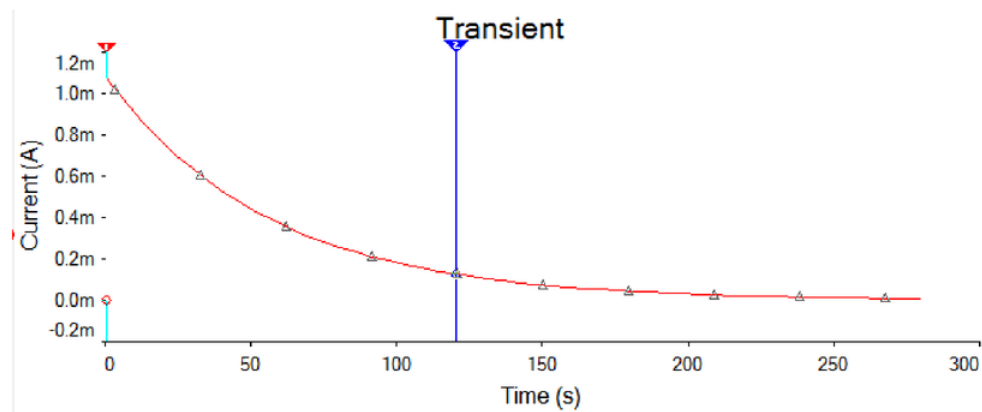
$$I_c = 1.07\text{mA}(e^{\frac{-120}{56}})$$

$$I_c = 0.126\text{mA (3dp)}$$

Practical

$$\underline{120s} = 0.138\text{mA}$$

Simulated



$$120s = 0.126\text{ mA}$$

Cursor		x	
		I (C1)	
x1	0.0000		
y1	0.0000		
x2	120.0000		
y2	125.5626μ		
dx	120.0000		
dy	125.5626μ		
dy/dx	1.0464μ		
1/dx	8.3333m		

200s

Calculated

$$I_{max} = 1.07 \text{ mA}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

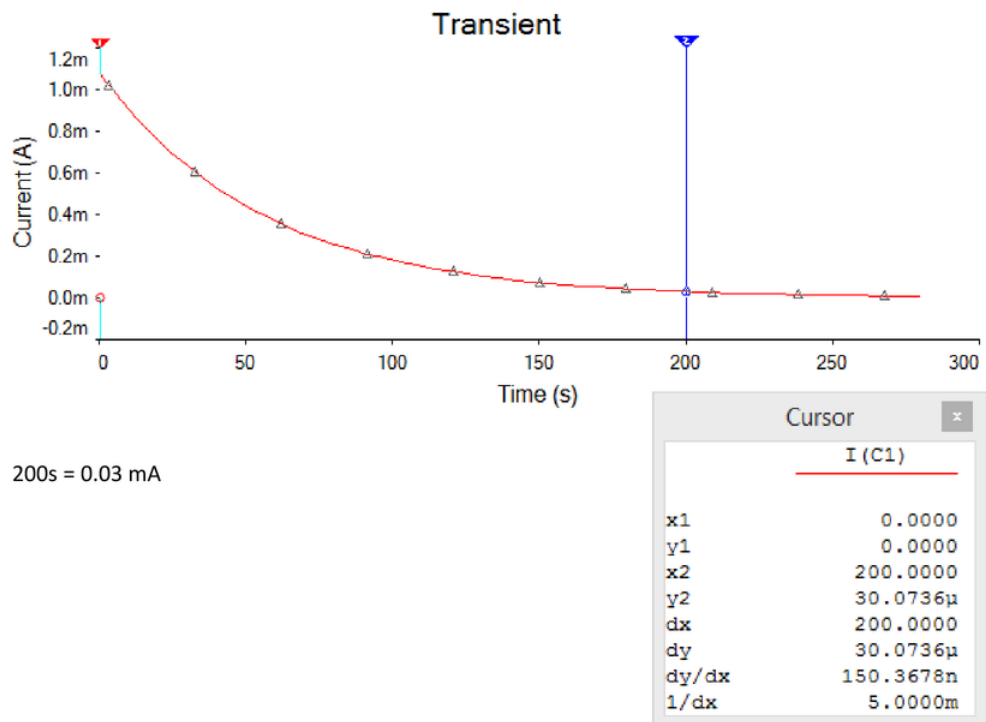
$$I_c = 1.07 \text{ mA}(e^{\frac{-200}{56}})$$

$$I_c = 0.030 \text{ mA (3dp)}$$

Practical

$$200\text{s} = 0.041 \text{ mA}$$

Simulated



$$200\text{s} = 0.03 \text{ mA}$$

Comparison table – Current			
Time	Calculated values	Practical values	Simulated values
60	0.367mA	0.375mA	0.367mA
120	0.126mA	0.138mA	0.126mA
200	0.030mA	0.041mA	0.030mA

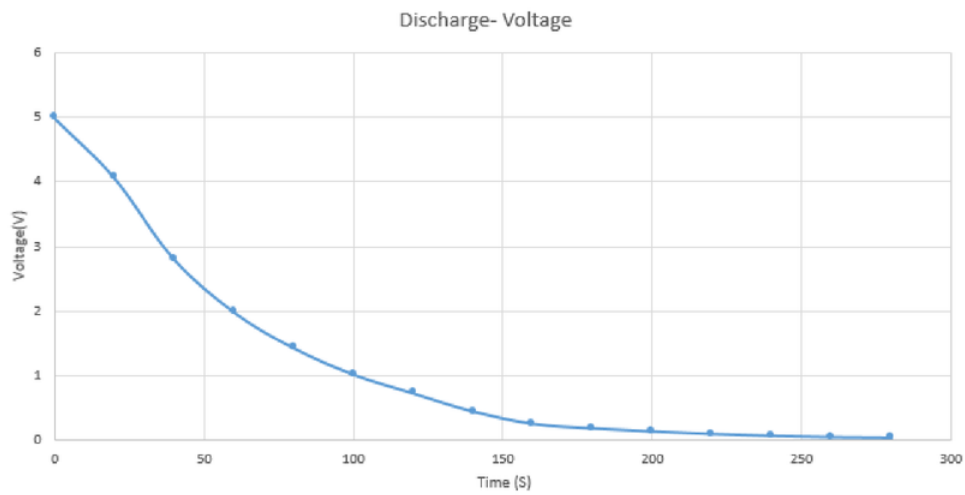
As shown in the table above, the maximum error is 0.012mA. Looking at the table, the calculated values and simulated values are identical. This means there was probably a slight error with the practical circuit. This could be down to a component or an error with a measuring device (i.e the multimeter)

Task 2- Transient Behaviour for discharging a Capacitor

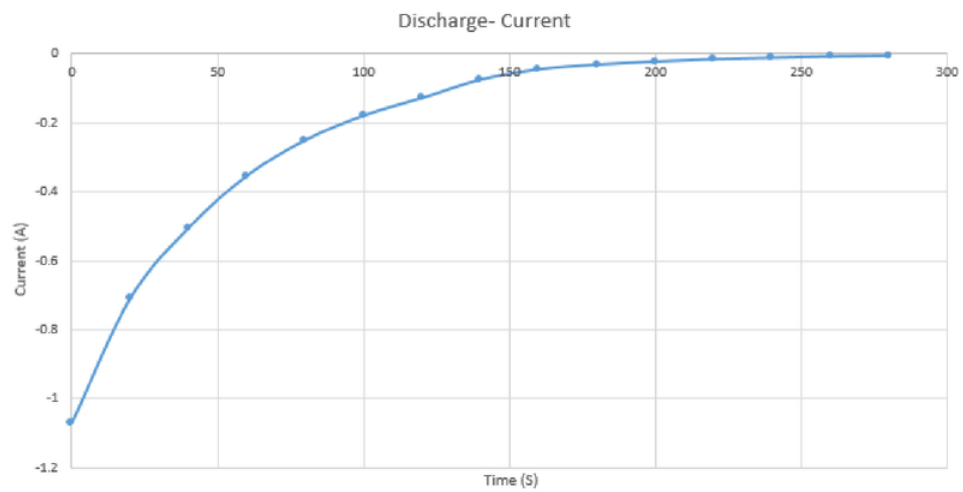
The table below contains the practical results for both voltage and current during discharge. The current results are negative due to the fact that the current goes through the circuit in the opposite direction during discharge.

Discharge		
Time (s)	VC (V)	IC (mA)
0	5	0
20	4.07	-0.710
40	2.81	-0.506
60	1.99	-0.355
80	1.43	-0.252
100	1.02	-0.181
120	0.73	-0.130
140	0.45	-0.077
160	0.26	-0.047
180	0.19	-0.033
200	0.14	-0.024
220	0.1	-0.017
240	0.07	-0.013
260	0.05	-0.009
280	0.04	-0.007

The graph below shows the voltage discharge transient using the practical circuit testing results.



The graph below shows the current discharge transient using the practical circuit testing results. The current results are negative due to the fact that the current goes through the circuit in the opposite direction during discharge.



Instantaneous times- Voltage

20s

Calculated

$$V_c = V_s(e^{\frac{-t}{T}})$$

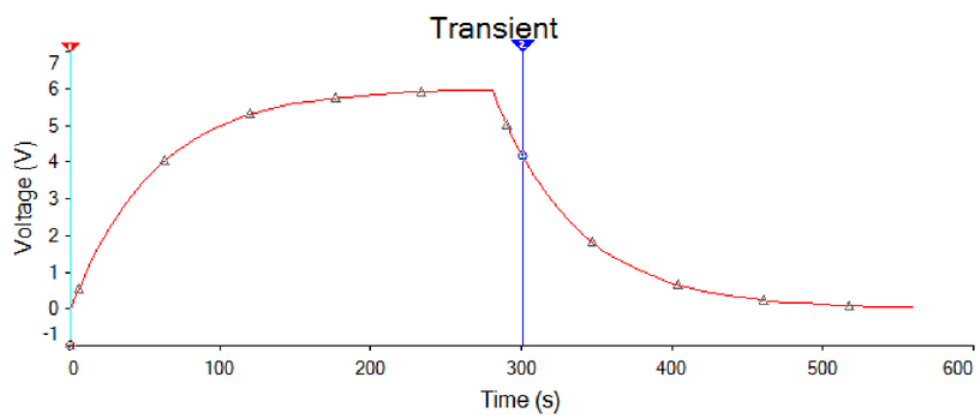
$$V_c = 6(e^{\frac{-20}{56}})$$

$$V_c = 4.20V \text{ (2dp)}$$

Practical

$$20s = 4.07V$$

Simulated



$$20s = 4.19V$$

Cursor	
V (2)	
x1	0.0000
y1	0.0000
x2	300.0000
y2	4.1852
dx	300.0000
dy	4.1852
dy/dx	13.9508m
1/dx	3.3333m

120s

Calculated

$$V_c = V_s(e^{\frac{-t}{T}})$$

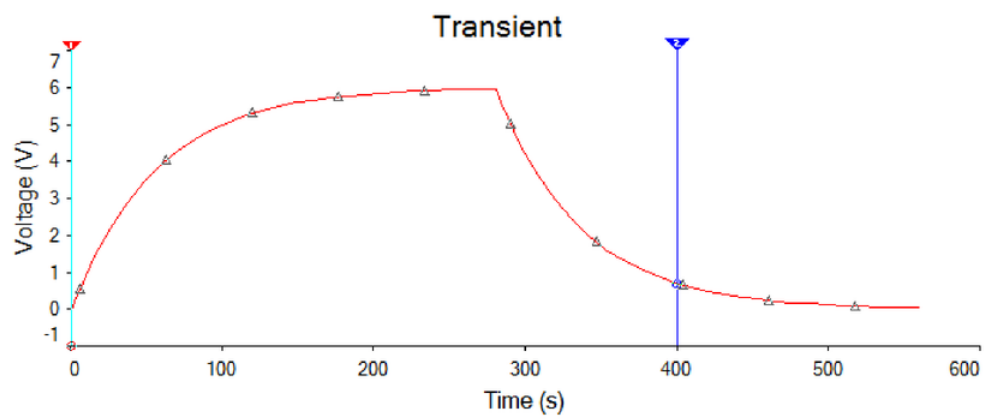
$$V_c = 6(e^{\frac{-120}{56}})$$

$$V_c = 0.70V \text{ (2dp)}$$

Practical

$$120s = 0.73V$$

Simulated



$$120s = 0.70V$$

Cursor	
V (2)	
x1	0.0000
y1	0.0000
x2	400.0000
y2	697.0735m
dx	400.0000
dy	697.0735m
dy/dx	1.7427m
1/dx	2.5000m

180s

Calculated

$$V_c = V_s(e^{\frac{-t}{T}})$$

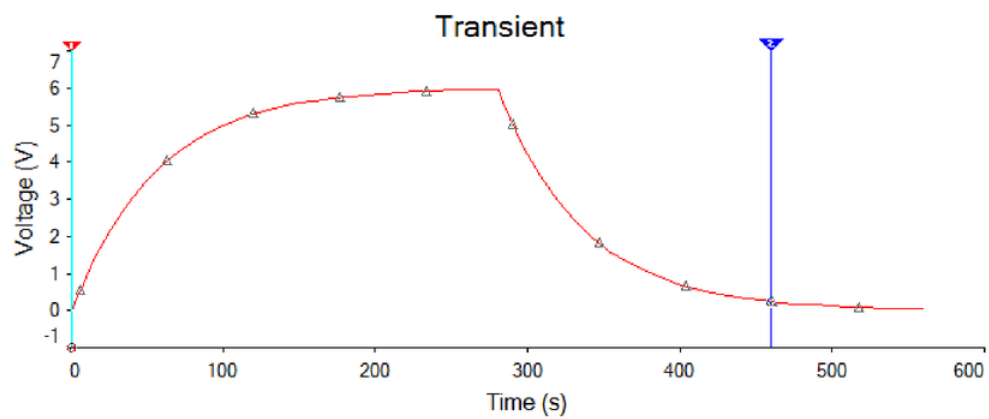
$$V_c = 6(e^{\frac{-180}{56}})$$

$$V_c = 0.24V \text{ (2dp)}$$

Practical

$$180s = 0.19V$$

Simulated



$$180s = 0.24V$$

Cursor	
V (2)	
x1	0.0000
y1	0.0000
x2	460.0000
y2	238.3115m
dx	460.0000
dy	238.3115m
dy/dx	518.0686µ
1/dx	2.1739m

Instantaneous times- Current

40s

Calculated

$$I_{max} = \frac{V_s}{R}$$

$$I_{max} = \frac{6}{5.6k\Omega}$$

$$I_{max} = 1.07mA$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

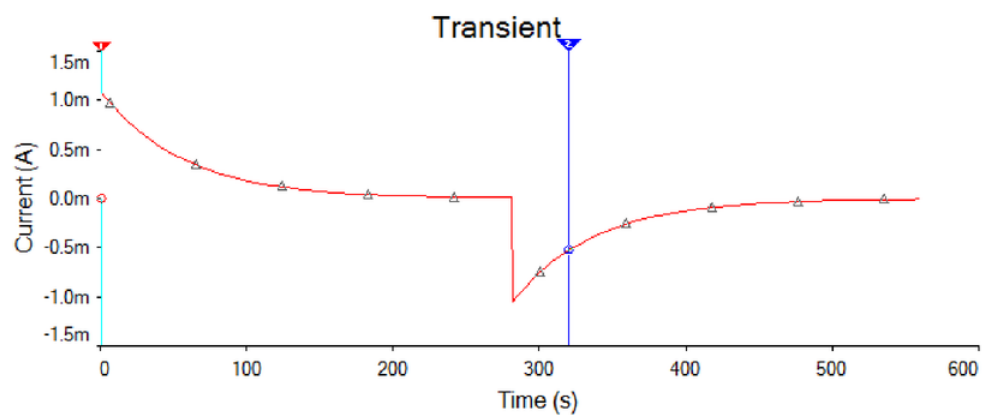
$$I_c = 1.07mA(e^{\frac{-40}{56}})$$

$$I_c = 0.524 \text{ mA (3dp)}$$

Practical

$$40s = -0.506 \text{ mA}$$

Simulated



$$40s = -0.521mA$$

Cursor	
I (C1)	
x1	0.0000
y1	0.0000
x2	320.0000
y2	-520.8632μ
dx	320.0000
dy	-520.8632μ
dy/dx	-1.6277μ
1/dx	3.1250m

140s

Calculated

$$I_{max} = 1.07\text{mA}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

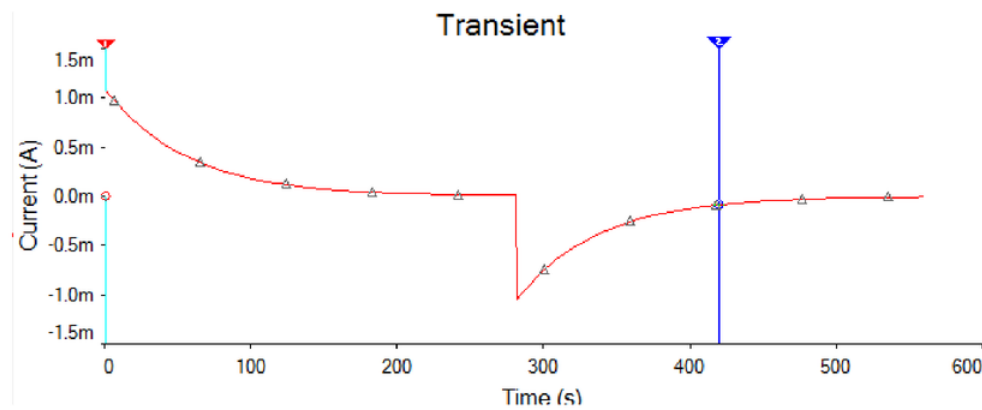
$$I_c = 1.07\text{mA}(e^{\frac{-140}{56}})$$

$$I_c = 0.088\text{ mA (3dp)}$$

Practical

$$140\text{s} = -0.077\text{mA}$$

Simulated



$$140\text{s} = -0.087\text{mA}$$

Cursor	
I (C1)	
x1	0.0000
y1	0.0000
x2	420.0000
y2	-86.7060μ
dx	420.0000
dy	-86.7060μ
dy/dx	-206.4429n
1/dx	2.3810m

200s

Calculated

$$I_{max} = 1.07\text{mA}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

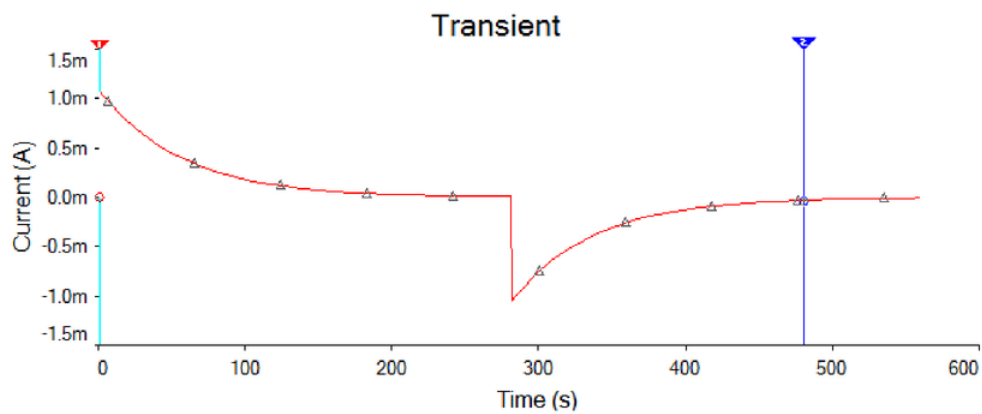
$$I_c = 1.07\text{mA}(e^{\frac{-200}{56}})$$

$$I_c = 0.030\text{ mA (3dp)}$$

Practical

$$200\text{s} = -0.024\text{mA}$$

Simulated



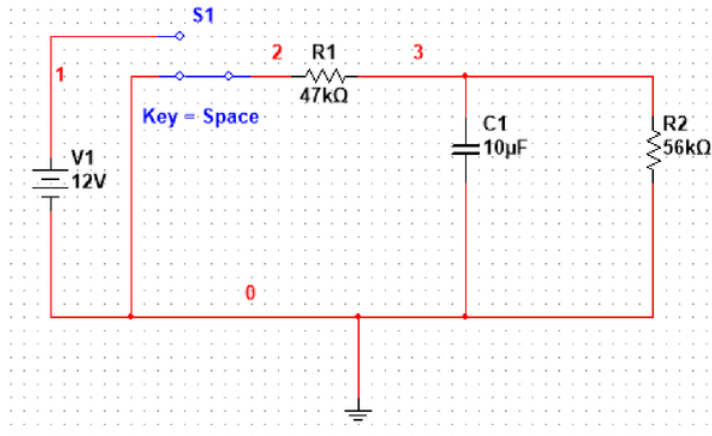
$$200\text{s} = 0.030\text{mA}$$

Cursor	
I (C1)	
x1	0.0000
y1	0.0000
x2	480.0000
y2	-29.7262μ
dx	480.0000
dy	-29.7262μ
dy/dx	-61.9297n
1/dx	2.0833m

3. Testing and results discussion

Task 3

The purpose of this task is to carry out an investigation into complex RC circuits. Time constants will be calculated using necessary formula in order to predict instantaneous values of voltage and current.



Calculating the time constant / period

In order to calculate the time constant, the first thing that has to be done is calculate the total resistance in the circuit. This is done using the following equation

$$R_t = \frac{\text{Product}}{\text{Sum}}$$

$$R_t = \frac{47k\Omega \times 56k\Omega}{47k\Omega + 56k\Omega}$$

$$R_t = 25,553.39806\Omega$$

$$R_t = 25.6k\Omega$$

Having calculated the total resistance in the circuit, the time constant for this circuit is calculated using the following formula

$$\text{Time constant} = R_t \times C$$

$$\text{Time constant} = 25.6k\Omega \times 10 \times 10^{-6}$$

$$\text{Time constant} = 0.256 \text{ s}$$

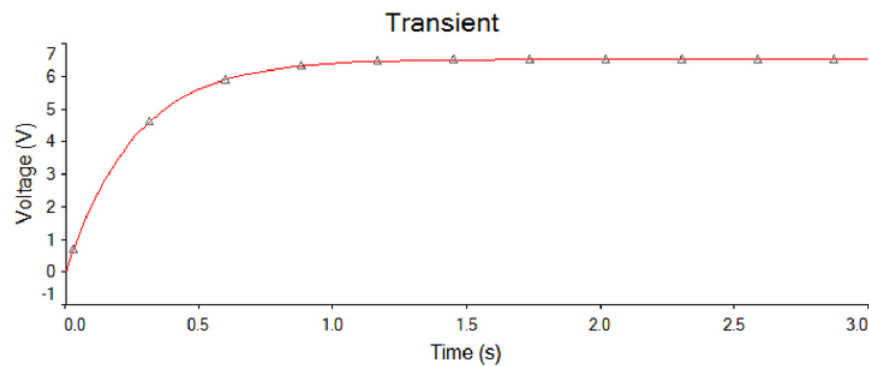
The transient period can now be calculated using the following formula

$$\text{Time Period} = 5 \times T$$

$$\text{Time Period} = 5 \times 0.256 \text{ s}$$

$$\text{Time Period} = 1.28 \text{ s}$$

The circuit will now be simulated using multisim in order to show voltage charge characteristics for the circuit. The voltage charge characteristic is shown below.



As shown in the transient above, the voltage never reaches the 12V supply voltage. The voltage dropped across C1 and R2 is calculated using the following formula

$$V2 = \frac{R2}{R1 + R2} \times V_s$$

$$V2 = \frac{56k\Omega}{47k\Omega + 56k\Omega} \times 12V$$

$$V2 = 6.52V \text{ (2dp)}$$

The voltage dropped across R1 is calculated using the following formula

$$V1 = \frac{R1}{R1 + R2} \times V_s$$

$$V1 = \frac{47k\Omega}{47k\Omega + 56k\Omega} \times 12V$$

$$V1 = 5.48V \text{ (2dp)}$$

Instantaneous charge voltages

0.5s

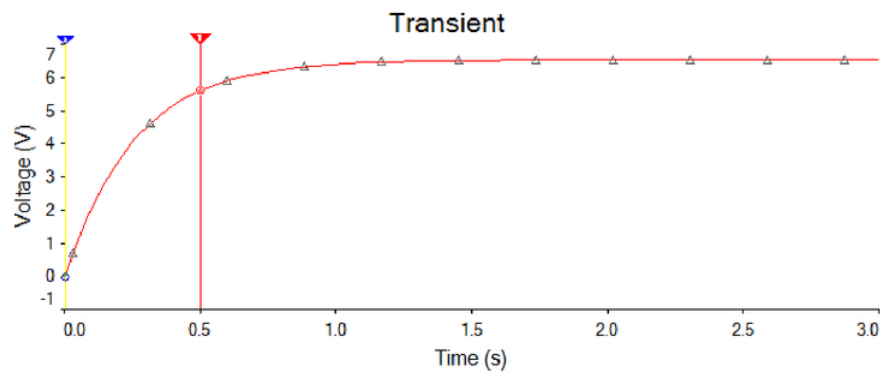
Calculated

$$V_c = V_2 (1 - e^{-\frac{t}{T}})$$

$$V_c = 6.52V (e^{\frac{-0.5}{0.256}})$$

$$V_c = 5.60V \text{ (2dp)}$$

Simulated



$$0.5s = 5.61V \text{ (2dp)}$$

Cursor	
V (3)	
x1	500.0000m
y1	5.6084
x2	0.0000
y2	0.0000
dx	-500.0000m
dy	-5.6084
dy/dx	11.2167
1/dx	-2.0000

1s

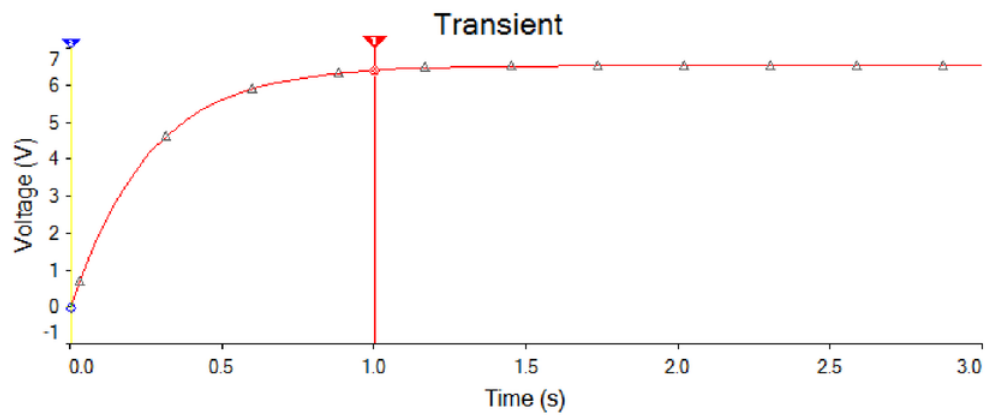
Calculated

$$V_c = V_2 (1 - e^{-\frac{t}{T}})$$

$$V_c = 6.52V (e^{-\frac{1}{0.256}})$$

$$V_c = 6.39 \text{ (2dp)}$$

Simulated



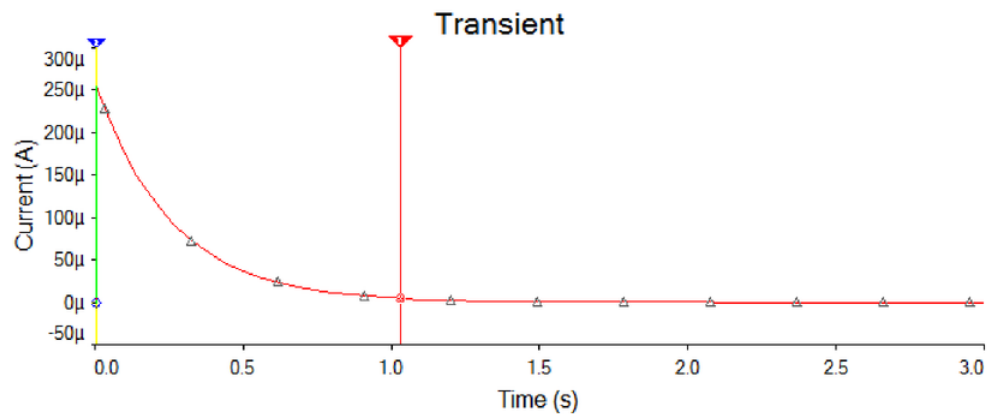
1s = 6.40V (2dp)

Cursor	
V(3)	
x1	1.0000
y1	6.3953
x2	0.0000
y2	0.0000
dx	-1.0000
dy	-6.3953
dy/dx	6.3953
1/dx	-1.0000

Voltage charge circuits		
Time	Simulated values	Calculated values
0.5s	5.61V	5.60V
1s	6.40V	6.39V

As shown in the table above, the maximum error is 0.01V. This would suggest that the calculations done are correct. The probable cause for this error is rounding errors in both the simulated and calculated calculations.

The circuit will now be simulated again using multisim in order to show current charge characteristics for the circuit. The current charge transient is shown below.



The reason for a large amount of current being drawn through the capacitor is due to it having a low resistance at the start and therefore the majority of the current is going through C1 and only a very small proportion goes through R2, therefore it can be said that C1 is acting like a short circuit. As the capacitor charges its resistance increases and therefore the current being drawn through C1 decreases until time period is reached. At this point the majority of the current is going through R2 and only a small proportion goes through C1, therefore it can be said that C1 is acting like an open circuit.

Instantaneous current charge

0.1s

Calculated

$$I_{max} = \frac{V_s}{R_1}$$

$$I_{max} = \frac{12V}{47k\Omega}$$

$$I_{max} = 0.255mA \text{ (3dp)}$$

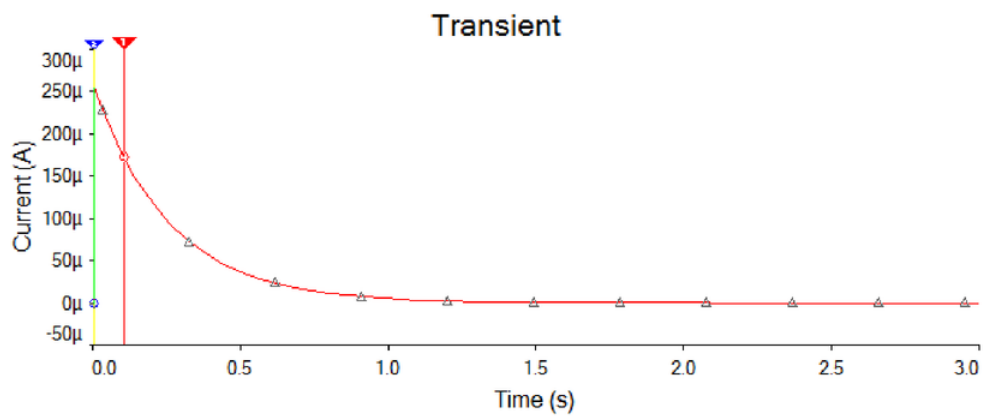
The reason R_1 is used instead of the total resistance is because initially the capacitor acts like a short circuit and R_2 is bypassed. Therefore initially all the current goes through R_1 .

$$I_c = I_{max}(e^{\frac{-t}{\tau}})$$

$$I_c = 0.255mA (e^{\frac{-0.1}{0.256}})$$

$$I_c = 0.173mA \text{ (3dp)}$$

Simulated



$$0.1s = 0.174mA \text{ (3dp)}$$

Cursor	
I (C1)	
x1	100.0000m
y1	173.6264µ
x2	0.0000
y2	0.0000
dx	-100.0000m
dy	-173.6264µ
dy/dx	1.7363m
1/dx	-10.0000

0.6s

Calculated

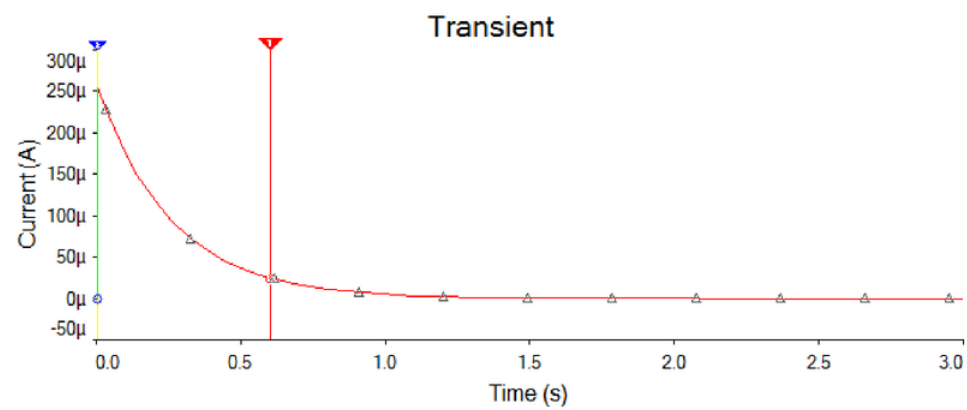
$$I_{max} = 0.255\text{mA (3dp)}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

$$I_c = 0.255\text{mA} (e^{\frac{-0.6}{0.256}})$$

$$I_c = 0.024\text{mA (3dp)}$$

Simulated



Cursor	
I (C1)	
x1	600.0000m
y1	24.3002μ
x2	0.0000
y2	0.0000
dx	-600.0000m
dy	-24.3002μ
dy/dx	40.5003μ
1/dx	-1.6667

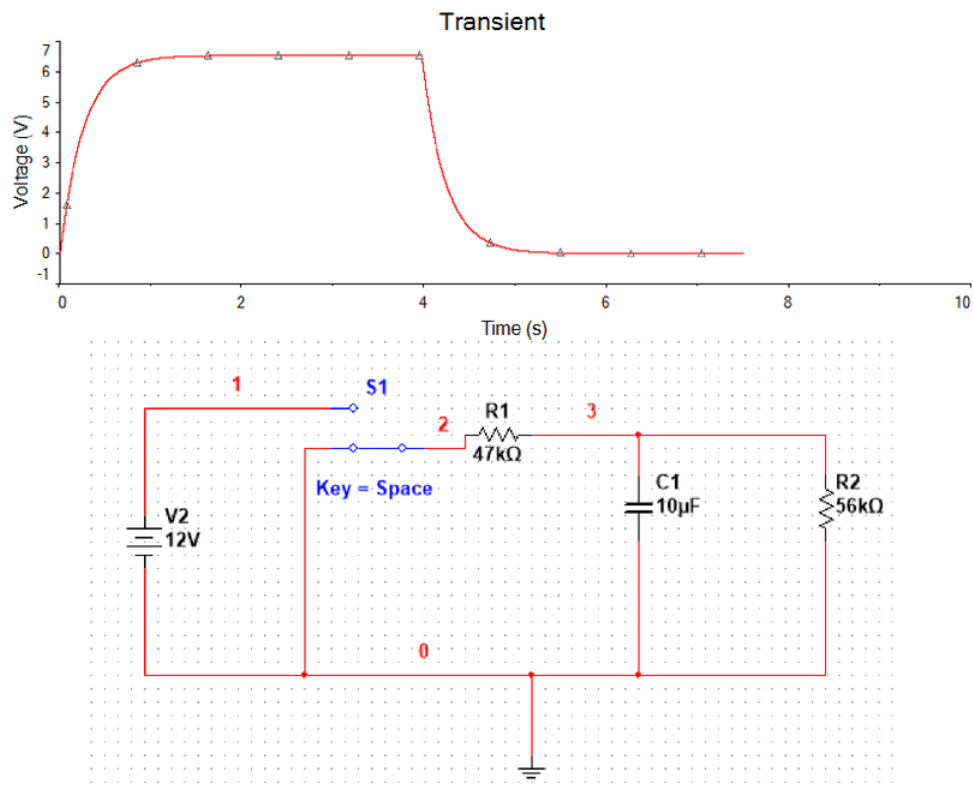
Current charge circuits		
Time	Simulated values	Calculated values
0.1s	0.174mA	0.173mA
0.6s	0.024mA	0.024mA

Shown in the table above, the maximum error is 0.001mA. This would suggest that the calculations done are correct and the simulated circuit has functioned as intended. The probable cause for this error is rounding errors in both the simulated and calculated calculations.

Discharge

Voltage

The circuit will now be simulated using multisim in order to show voltage discharge characteristics for the circuit. The voltage charge and discharge characteristic is shown below. The capacitor is being charged between approximately 0-4s before S1 is switched. The voltage stored in the capacitor is then discharged across R1 and R2 until the voltage in the circuit has reached 0v. The max voltage stored in the capacitor is equal to V2. This is due to the voltage being dropped across R1 is not allowing the capacitor to charge up to the 12V supply.



Instantaneous times- Discharge Voltage

0.3s

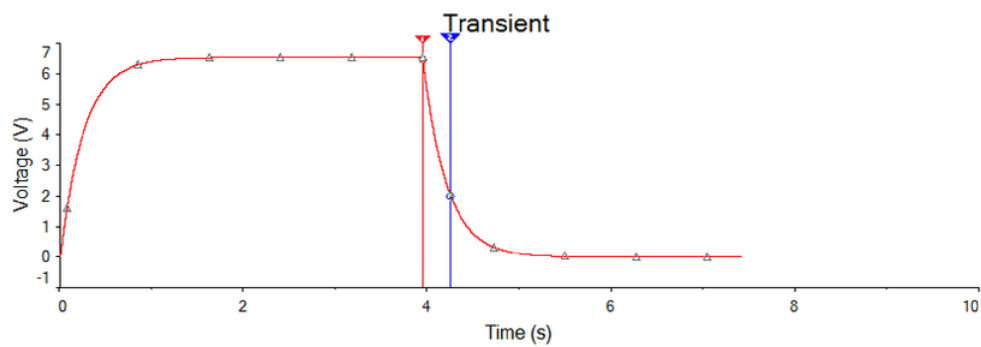
Calculated

$$V_c = V_2(e^{\frac{-t}{T}})$$

$$V_c = 6.52V(e^{\frac{-0.3}{0.256}})$$

$$V_c = 2.02V \text{ (2dp)}$$

Simulated



$$0.3s = 2.00V \text{ (2dp)}$$

Cursor	
V(3)	
x1	3.9484
y1	6.4615
x2	4.2484
y2	1.9973
dx	300.0129m
dy	-4.4642
dy/dx	-14.8801
1/dx	3.3332

0.5s

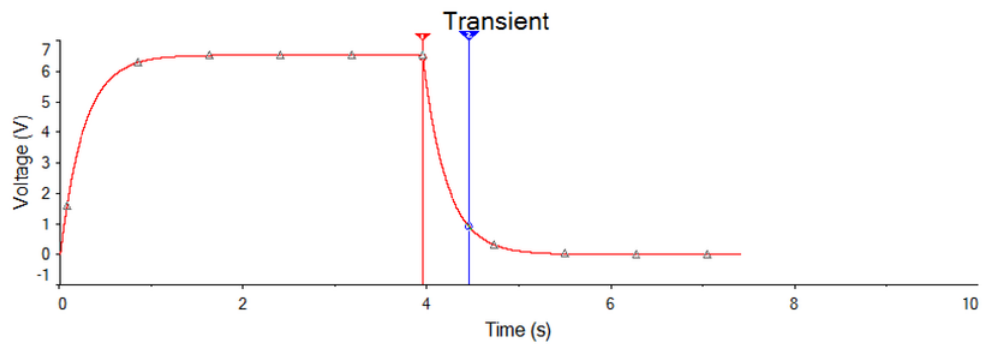
Calculated

$$V_c = V_2(e^{\frac{-t}{T}})$$

$$V_c = 6.52V(e^{\frac{-0.5}{0.256}})$$

$$V_c = 0.92V \text{ (2dp)}$$

Simulated



$$0.5s = 0.91V \text{ (2dp)}$$

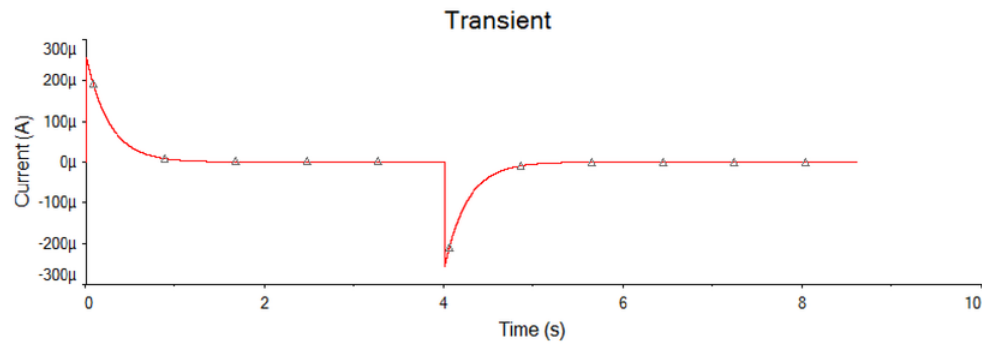
Cursor	
V (3)	
x1	3.9484
y1	6.4615
x2	4.4484
y2	913.1348m
dx	500.0129m
dy	-5.5484
dy/dx	-11.0965
1/dx	1.9999

Voltage discharge circuits		
Time	Simulated values	Calculated values
0.3s	2.00V	2.02V
0.5s	0.91V	0.92V

Shown in the table above, the maximum error is 0.02V. This would suggest that the calculations done are correct and the simulated circuit has functioned as intended. The probable cause for this error is rounding errors in both the simulated and calculated calculations.

Current

The circuit will now be simulated using multisim in order to show current discharge characteristics for the circuit. The current charge and discharge characteristic is shown below. The current is flowing through the capacitor between approximately 0-4s before S1 is switched. The current then flows through R1 and R2 until the voltage in the circuit has reached 0v. The – Ve values show that the current is flowing though in the opposite direction.



Instantaneous times- Current discharge

0.2s

Calculated

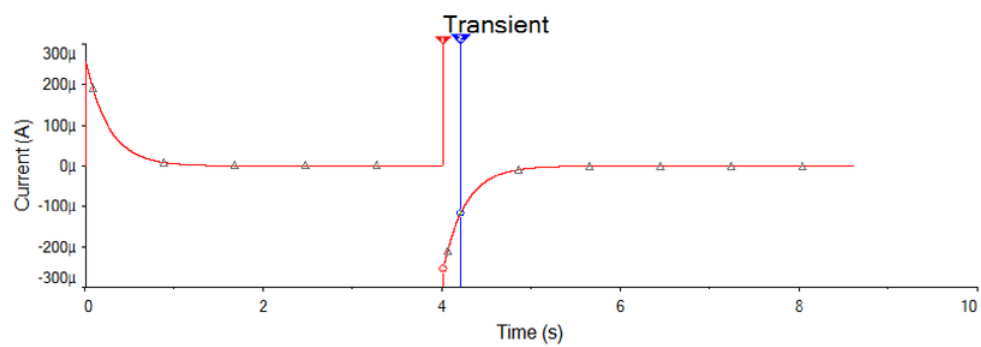
$$I_{max} = 0.255\text{mA (3dp)}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

$$I_c = 0.255\text{mA} (e^{\frac{-0.2}{0.256}})$$

$$I_c = 0.117\text{ mA (3dp)}$$

Simulated



$$40\text{s} = -0.115\text{mA}$$

Cursor	
I (C1)	
x1	4.0053
y1	-252.5318μ
x2	4.2053
y2	-115.4551μ
dx	199.9950m
dy	137.0766μ
dy/dx	685.4004μ
1/dx	5.0001

0.7s

Calculated

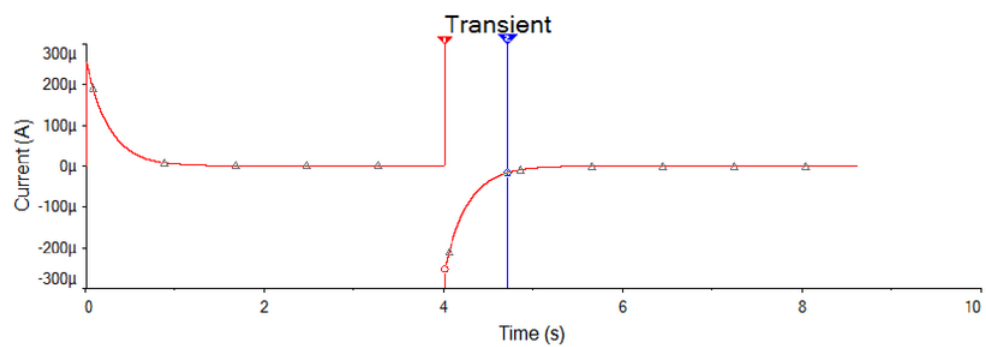
$$I_{max} = 0.255\text{mA} \text{ (3dp)}$$

$$I_c = I_{max}(e^{\frac{-t}{T}})$$

$$I_c = 0.255\text{mA} (e^{\frac{-0.2}{0.256}})$$

$$I_c = 0.017 \text{ mA (3dp)}$$

Simulated



$$0.7s = -0.016\text{mA}$$

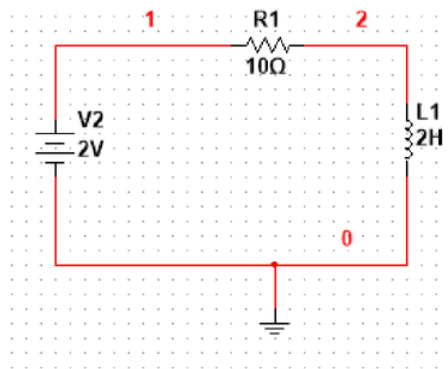
Cursor	
I (C1)	
x1	4.0053
y1	-252.5318μ
x2	4.7053
y2	-16.3168μ
dx	699.9950m
dy	236.2150μ
dy/dx	337.4524μ
1/dx	1.4286

Current discharge circuits		
Time	Simulated values	Calculated values
0.2s	-0.115mA	0.117mA
0.7s	-0.016mA	0.017mA

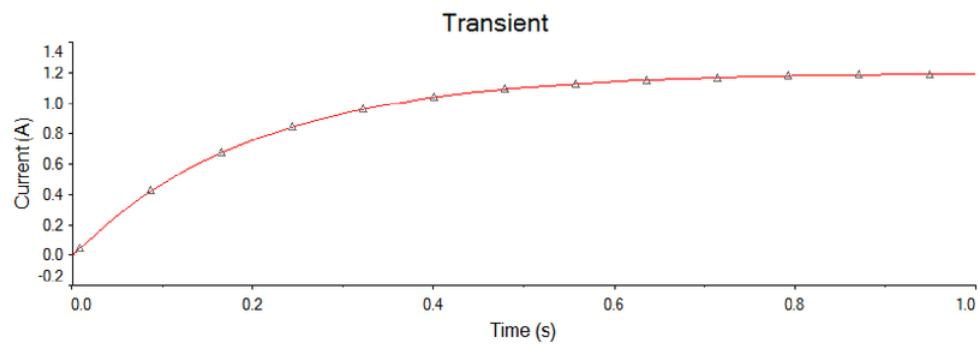
Shown in the table above, the maximum error is 0.002mA. This would suggest that the calculations done are correct and the simulated circuit has functioned as intended. The probable cause for this error is rounding errors in both the simulated and calculated calculations.

The simulated values are in -Ve due to the capacitor characteristics. This means that the exponential decay is the same toward the zero point. In both charge and discharge, both the current curves are exponentially equal. This means that the rate of change is the same.

Task 4- Transient Behaviour for the Inductive Circuit



- i) The current growth for the first one second once the switch is closed is shown in the transient below



ii.

The following equation is used to calculate the current flowing through the circuit at a given time

$$I_L = I_{max}(e^{\frac{-R}{L} \times T})$$

In order to calculate I_{max} the following equation is used

$$I_{max} = \frac{V_s}{R}$$

$$I_{max} = \frac{2V}{10\Omega}$$

$$I_{max} = 0.2A$$

Current flowing after 0s

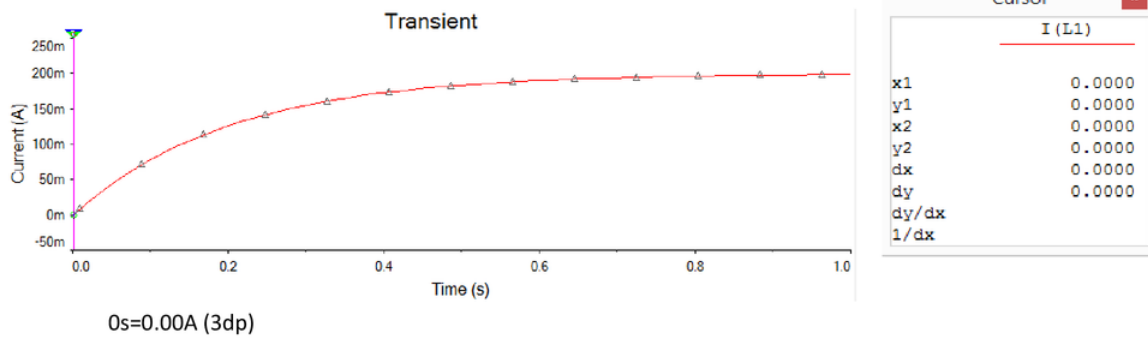
Calculation Value

$$I_L = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$I_L = 0.2A(e^{-\frac{10}{2} \times 0})$$

$$I_L = 0A$$

Simulated Value



Current flowing after 0.25s

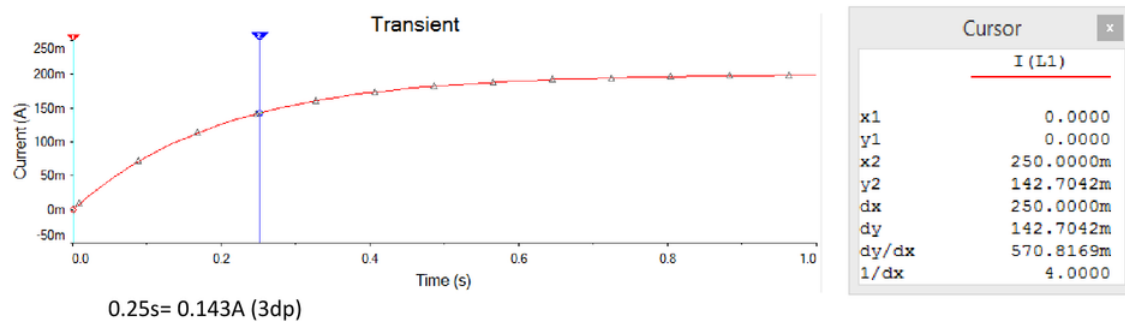
Calculation Value

$$I_L = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$I_L = 0.2A(e^{-\frac{10}{2} \times 0.25})$$

$$I_L = 0.143A \text{ (3dp)}$$

Simulated Value



Current flowing after 0.5s

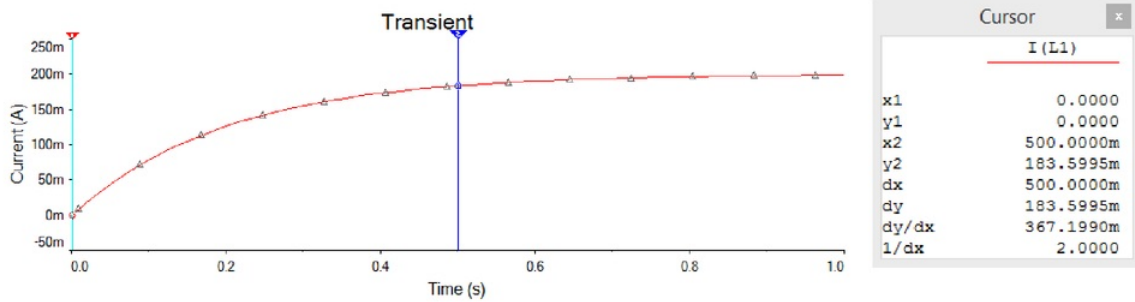
Calculation Value

$$IL = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$IL = 0.2A(e^{-\frac{10}{2} \times 0.5})$$

$$IL = 0.184A \text{ (3dp)}$$

Simulated Value



$$0.5s = 0.184A \text{ (3dp)}$$

Current flowing after 0.75s

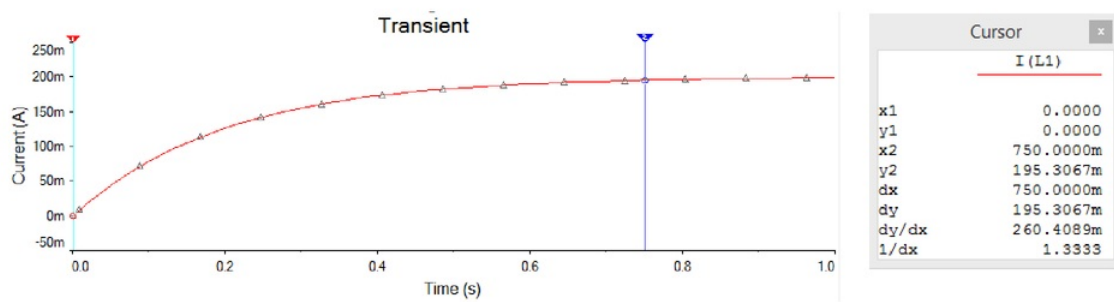
Calculation Value

$$IL = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$IL = 0.2A(e^{-\frac{10}{2} \times 0.75})$$

$$IL = 0.195A \text{ (3dp)}$$

Simulated Value



$$0.75s = 0.195A \text{ (3dp)}$$

Current flowing after 1s

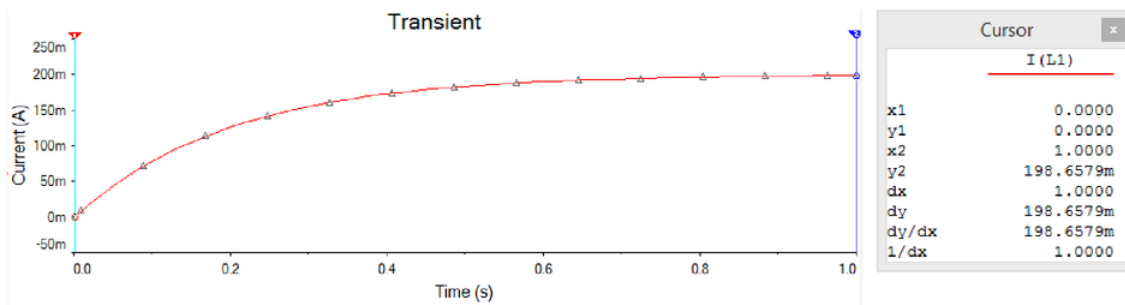
Calculation Value

$$IL = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$IL = 0.2A(e^{-\frac{10}{2} \times 1})$$

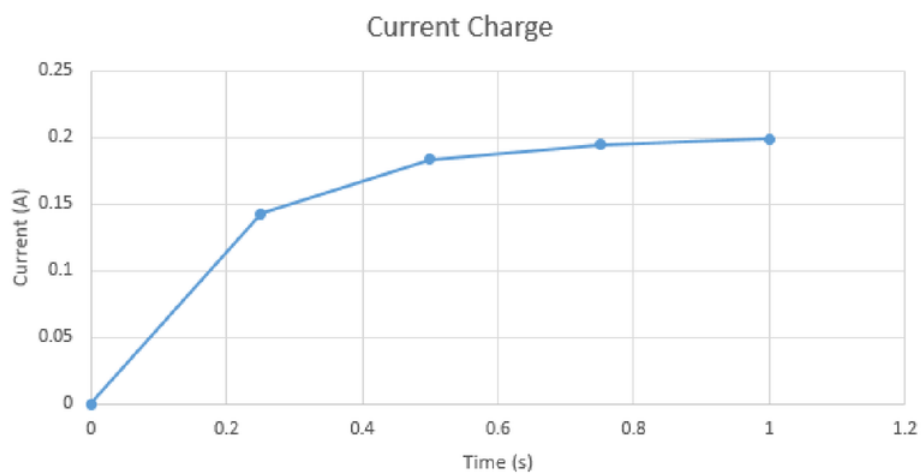
$$IL = 0.199A \text{ (3dp)}$$

Simulated Value



$$1s=0.199A \text{ (3dp)}$$

The graph below shows the relationship between current and time in the circuit using the calculated results.



The table below shows both the calculated current and the simulated current during the charge of the circuit. All results are to 3dp's.

Time	Simulated Current (A)	Calculated Current (A)
0	0	0
0.25	0.143	0.143
0.5	0.184	0.184
0.75	0.195	0.195
1	0.199	0.199

iii.

In order to determine the current flowing in the circuit immediately before the switch is changed over. Both simulation and calculations will be used to determine this value.

Calculations

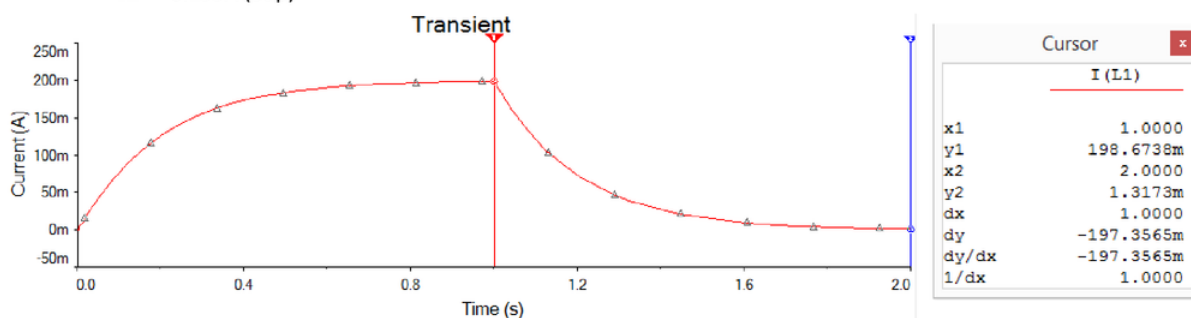
Current flowing after 1s

Calculation Value

$$IL = I_{max}(1 - e^{-\frac{R}{L} \times T})$$

$$IL = 0.2A(e^{-\frac{10}{2} \times 1})$$

$$IL = 0.199A \text{ (3dp)}$$



Simulated value

After exactly 1s, the switch is changed.

The current at 1s= 0.199A (3dp)

Having used both simulation and calculation, it can be said that if the switch changes state after exactly 1s, the current flowing through the circuit immediately before it will be 0.199A.

iv.

Estimating the time constant

Using the graph, the circuit reaches its steady state at approximately 1.07s.

Therefore the time period for this graph would be 1.07s

$$\text{Time Constant} = \frac{\text{Time period}}{5}$$

$$\text{Time Constant} = \frac{1.07s}{5}$$

$$\text{Time Constant} = 0.214s$$

Calculating the time constant

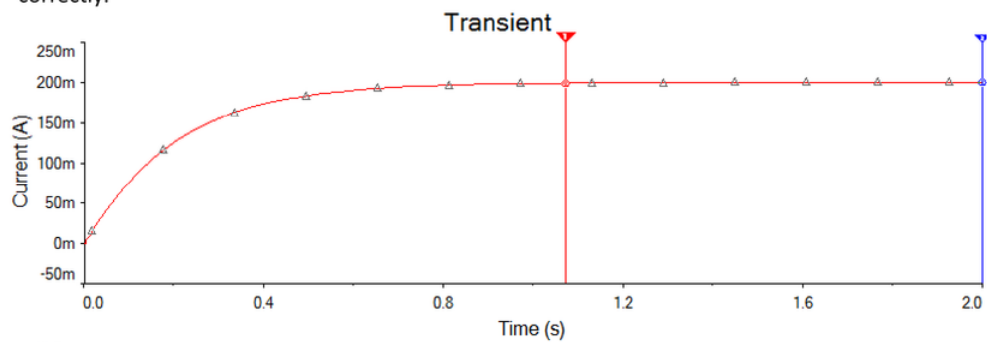
In order to calculate the time constant, the following equation is used.

$$T = \frac{L}{R}$$

$$T = \frac{2H}{10\Omega}$$

$$T = 0.2s$$

Therefore it can be said that the calculated time constant is within 0.014s of the estimated time period. This would suggest that the calculated time constant is correct and the simulation is working correctly.



Cursor	
I (L1)	
x1	1.0716
y1	199.0698m
x2	2.0000
y2	199.9912m
dx	928.3820m
dy	921.3957μ
dy/dx	992.4748μ
1/dx	1.0771

4. Conclusions and recommendations

To conclude, overall the simulated were very accurate with little to no error when comparing them to the calculated values. The practical results were also fairly accurate except for the current charge where the error was slightly bigger than expected however was still within an acceptable tolerance. By having multiple ways of getting the required values (i.e simulating, calculating and doing it practically) this reduces the chance of most common errors due to being able to compare and contrast with the other results.

Multisim was a very valuable resource with multiple functions and an exceptional library of components with multiple ways of testing and active analysis. One recommendation would be for it to be able give us the time constant and time period when doing transients. This would reduce time and also reduce human error when calculating it.

5. Appendix

PDSE 4001- Daniel Evans- Assignment 1

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

59/100

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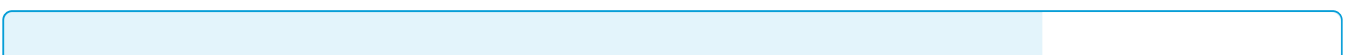
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GRADING FORM: CSG-RUBIC



RESEARCH-INFORMED LITERATURE

KNOWLEDGE AND UNDERSTANDING

 Understanding demonstrated, but there are errors.

15/25

ANALYSIS

 There are errors and needs more clear explanations.

24/40

PRACTICAL APPLICATION AND DEP.

 Theory is tied in with prac, but lacks explanations.

14/25

SKILLS FOR PROFESSIONAL PRAC.

 Report is good

6