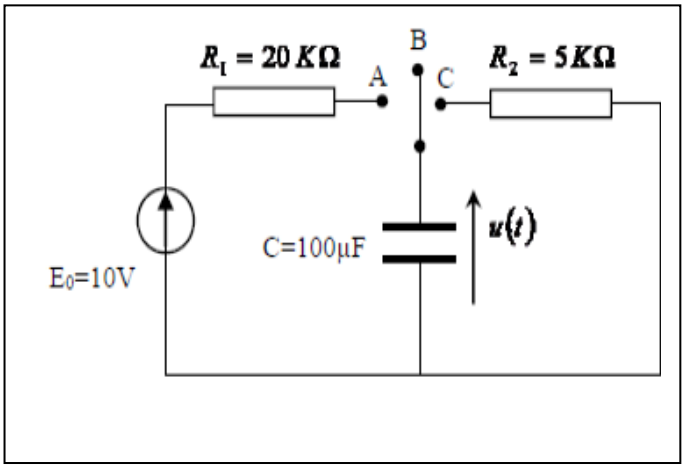
Tutorial 2

Exercise 1:

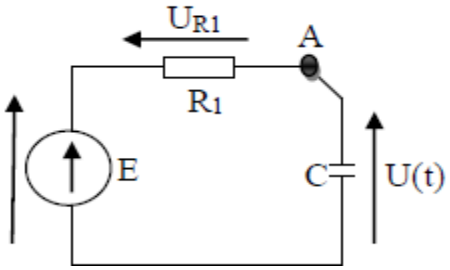
In the circuit shown in the following figure, the switch is initially located in the position B and the capacitor is discharged. At time t = 0 , we toggle the in position A. After 10 seconds, it is switches to position C.

- Plot the evolution of the voltage u(t).



Correction 1:

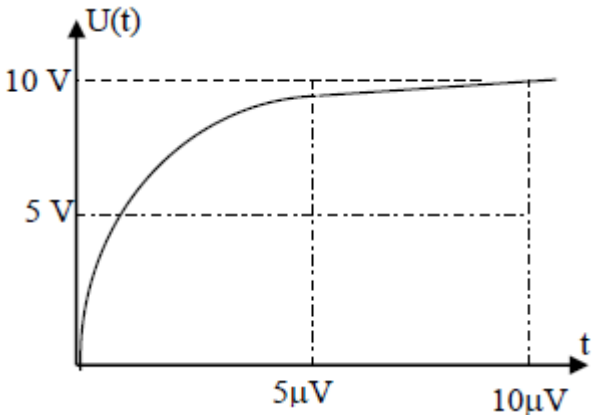
1) The switch in position A :
The assembly becomes as follows :



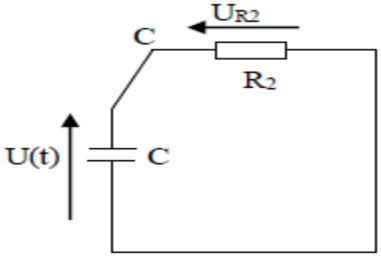
Law of meshes : $E = U_{R1} + U(t) = R_1C.dU(t)/dt + U(t)$
Is a 1st order differential equation with the solution :
$U(t) = E(1-\exp(-t/\tau))$,
with $\tau = 2.10^4.10^{-4} = 2s$, and E = 10 V.
Therefore, $U(t) = 10(1- \exp(-t/2))$

t	0	0.5	1	2	2.5	3	4	5	6	7	8	9	10
U(t)	0	2.2	3.8	5.2	6.3	7.2	8.7	9.2	9.5	9.7	9.8	9.8	9.9

Graph of U(t):



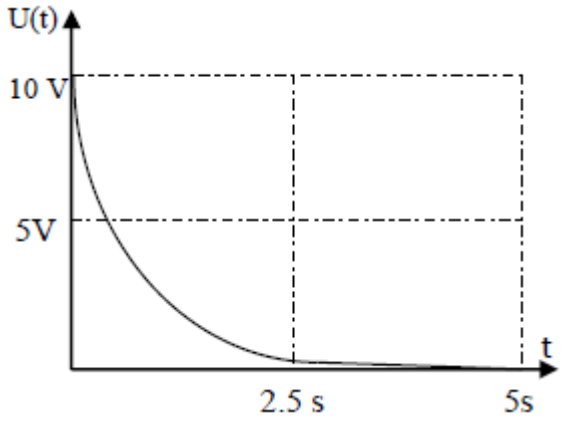
2) The switch in position C:
The assembly becomes as follows :



Law of meshes : $U_{R1} + U(t) = R_1C.dU(t)/dt + U(t) = 0$
is a 1st order differential equation with the solution :
$U(t) = E\exp(-t/\tau)$, $\tau = 5.10^3.10^{-4} = 0,5$ s, et E = 10 V.
$U(t) = 10.\exp(-2t)$

The graph of U(t)

t	0	0.5	1	2	2.5	3	4	5
U(t)	10	3.7	1.3	0.18	0.06	0.02	0.003	0.0004



Exercise 2 :

Same set-up and data from the previous year.
- Plot the evolution of the current i(t).

Exercise 3 :

1) Calculate the percentage of charge of a capacitor C = 100 μF charged through a resistor R = 20 KΩ for t = τ.
E = 10 V.

2) Determine how to increase the charging speed.

Correction 3 :

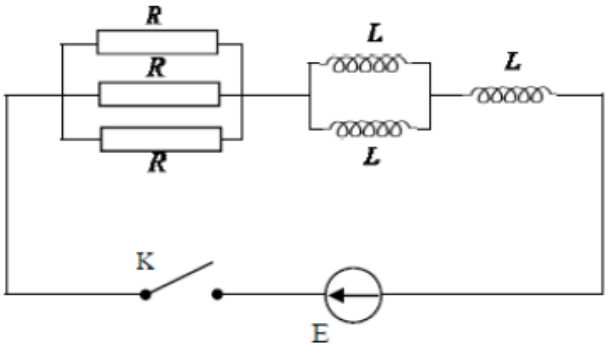
1) $\tau = R.C = 2.10^{4}.10^{-4} = 2s.$
$U(t = \tau) = U(\tau) = E(1 - \exp(-t/\tau)) = 10(1-\exp(-1)) = 10 - 10/\exp(1)\ 10 - 10/2.72$
$U(\tau) = 6.33$ V.

10 V → 100 %
6.33 → x %

$x\ \% = (6.33 \times 100) / 10 = 63.3\ \%$

2) To increase the charging speed, you have to decrease τ (τ = RC).

Exercise 4 :



At t = 0 we close the switch:

We give: R = 6000 Ω, L = 30mH, E = 6V.

1. Applying Kirchhoff's Law to Nodes

2. Applying Kirchhoff's Law to the Principal Mesh

3. Find the expression of the generating current.

Correction 4 :

1. There are 4 nodes (A, B, C, and D):
   At point A : $i(t) = I_R + I_R + I_R$, At point B : $I_R + I_R + I_R = i(t)$
   At point C : $i(t) = I_L + I_L$, At point D: $I_L + I_L = i(t)$

2. $E = Leq.di/dt + Req.i(t)$.

   $Leq = Leq1 + L = L/2 + L = 3L/2$

   $Req = R/3$

   Therefore, $(3L/2).di/dt + (R/3).i(t) = E$ (Differential equation of order 1)

   solution : $i(t) = E(1 – exp(-3t/RL))$.

   D.A : $i(t) = 6(1 – exp(-t/60)$.