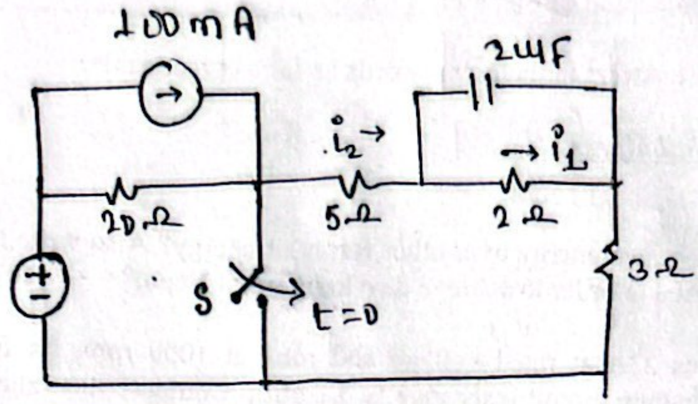
Q 1) Solⁿ Find (a) $i_1(0^-)$, $i_2(0^-)$

~~$i_2(0^+)$~~

(b) $I_1(0^+)$, $I_2(0^+)$

(c) $I_1(t)$ for $t > 0$



$\boxed{\text{Note}}$ → The term used in the qⁿ is 'switch' is closed at t = 0 after being opened for long time ; The significance of the statement is that capacitor has sufficient time to discharge or in other words it has enough time to reach D.C. steady state value, before we Turn on the switc

(a) Solⁿ Find $i_1(0^-)$ & $i_2(0^-)$

$\boxed{\text{Step 1}}$: For 100 mA we are going for PCS to PVS conversion

PCS → practical current source

PVS → practical voltage source.

$\boxed{\text{Step 2}}$: The capacitor is modelled as O.C. in D.C. steady state.

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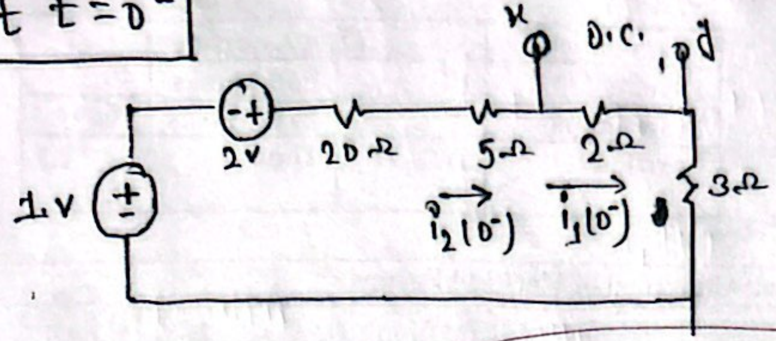
→ The eqv ckt after step 1 & step 2 is

$\boxed{\text{At } t = 0^-}$



By KVL

∴ At $t = 0^-$; $i_2(0^-) = i_1(0^-) = \dfrac{V}{R_{eq}} = \dfrac{1+2}{20+5+2+3}$

$$\boxed{i_1(0^-) = i_2(0^-) = \frac{3}{30} = 0.1\ A}$$

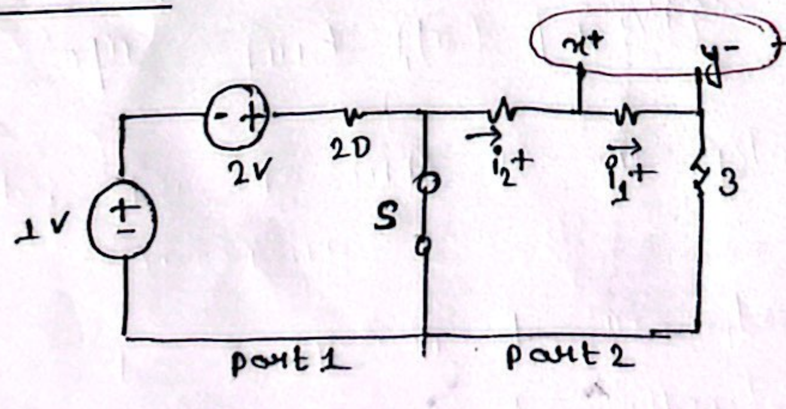
Note: we know voltage across capacitor will NOT change instantly, ∴ $V_{xy} = V_c(0^-) = 2 \times 0.1$

$= 0.2\ V =$

∴ $\boxed{V_c(0^+) = V_c(0^-) = 0.2\ V}$

(b) find $i_1(0^+)$ & $i_2(0^+)$

$\boxed{\text{At } t = 0^+}$ the eqv. circuit is



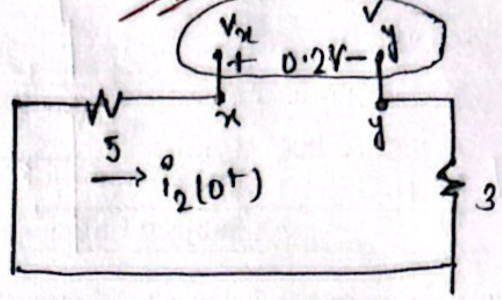
→ $V_{xy} = V_c(0^+) = 0.2\ V$

Note: The switch divides the circuit in 2 part. Hence, KVL in part ① has NO effect on KVL in part 2

Since, $V_{xy} = V_c(0^+) = 0.2\,V$

$\therefore \boxed{i_1(0^+) = \frac{0.2}{2} = 0.1\,A}$

KVL in part 2



$5i_2(0^+) + 0.2 + 3i_2(0^+) = 0$

$8i_2(0^+) = -0.2 \quad \therefore \boxed{i_2(0^+) = -\frac{0.2}{8} = -0.025\,A}$

Note → KCL at x, y gives $i_{3\Omega} = i_2(0^+) = -0.025\,A$

Note $\underline{i_1(0^-) = i_1(0^+)}$, But $\underline{i_2(0^-) \neq i_2(0^+)}$

Because 'C' is in parallel with 2Ω, through which i_1 flows.

i_2 is current through resistor (5Ω), for L, C only Inductor Current & capacitor voltage is a continuous fn of time (i.e. do not change instantly), but for Resistor (5Ω) we can certainly have instantaneous change in voltage & current, & there is nothing preventing that from happening i_2 current branch.

(c) let $x_f \rightarrow$ Final value

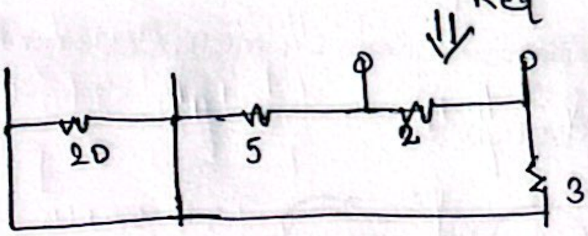
$x_0 \rightarrow$ Initial value

The general soln of the electrical circuit is

$$\boxed{x(t) = x_f + (x_0 - x_f)\, e^{-t/\tau}}$$

→ 1st : sketch the system for $(t \geq 0)$

→ 2nd : use thevenins theorem & find eqv Resistance as seen by energy storing element (ie. Req from capacitor point of view)



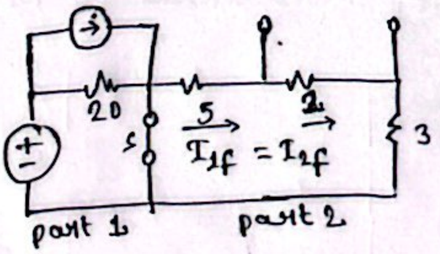
$R_{eq} = 8 \| 2$
$= 1.6\ \Omega$

∴ Time constant $\tau = R_{eq} \times C$ (for RC ckt)

$= 1.6 \times 2\ \mu F$

$= 3.2\ \mu s$

→ 3rd : $I_{1f} = ?$ → final value $(t \to \infty)$ sketch the circuit under DC steady state situation (The appropriate model of capacitor will be O.C.)



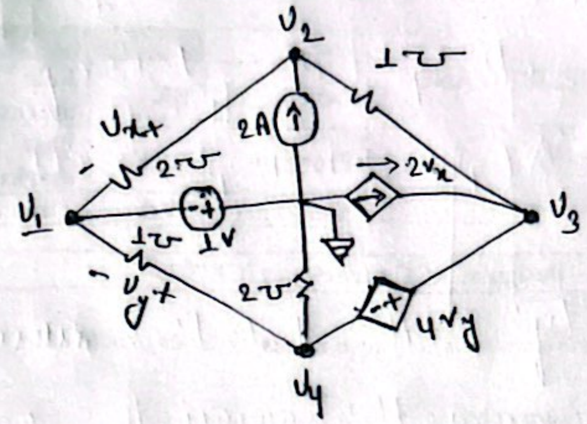
→ switch is closed, No interaction b/w part 1 & part 2 loop ∴ $I_{1f} = I_{2f}$

Since No any source is present in loop 2

∴ $i_1(t) = 0 + (0.1 - 0)\, e^{-t/3.2\mu s}$

$$\therefore\ \boxed{i_1(t) = 0.1\, e^{-3.2\,t/10^6}\ A}$$ Ans

(Q2) Obtain the Node voltage V_1, V_2, V_3, V_4



Sol^n Voltage b/w Node-1 & Ref Node is

$$V_1 = -1V \longrightarrow (1)$$

KCL at Node 2: $2 = (V_2 - V_1)\times 2 + (V_2 - V_3)\times 1$

$$2 = (V_2-(-1))\times 2 + (V_2 - V_3)$$

$$3V_2 - V_3 = 0 \longrightarrow (2)$$

KCL at Super Node (3) & (4)

$$2V_x = (V_3 - V_2)\times 1 + V_4\times 2 + (V_4 - V_1)\times 1$$

But $V_x = V_2 - V_1$

Then, $2(V_2 - V_1) = (V_3 - V_2)\times 1 + V_4 \times 2 + (V_4 - V_1)\times 1$

or, $V_1 - 3V_2 + V_3 + 3V_4 = 0$

$$-1 - 3V_2 + V_3 + 3V_4 = 0$$

$$-3V_2 + V_3 + 3V_4 = 1 \longrightarrow (3)$$

Voltage b/w Node (3) & (4) is; $V_3 - V_4 = 4V_y$

But, $V_y = V_4 - V_1$

Then, $V_3 - V_4 = 4(V_4 - V_1)$

or, $V_3 - 5V_4 = 4 \longrightarrow (4)$

solving (2), (3), (4) we get $V_2 = 1.89V$, $V_3 = 5.67V$ & $V_4 = 0.33V$

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