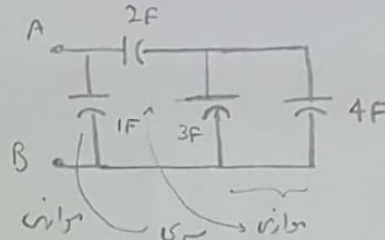


ت=0 در لحظه

B و A در دو سر و ولتاژ اولیه

$$\begin{aligned} V_1(0^-) &= 1V \\ V_2(0^-) &= 2V \\ V_3(0^-) &= 3V \\ V_4(0^-) &= 4V \end{aligned}$$



$t > 0$

$$C'_1 = 4 + 3 = 7F$$

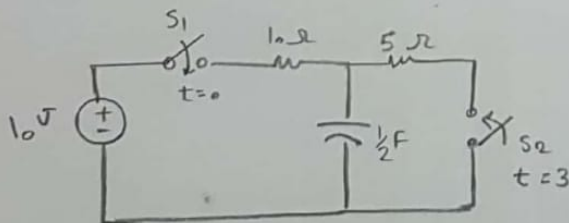
$$C'_2 = \frac{7 \times 2}{7 + 2} = \frac{14}{9}F$$

$$C'_3 = 1 + \frac{14}{9} = \frac{23}{9}F \quad \text{فرمانت کل}$$

$$V'_1 = \frac{C_3 V_3 + C_4 V_4}{C_3 + C_4} = \frac{3 \times 3 + 4 \times 4}{3 + 4} = \frac{25}{7}V$$

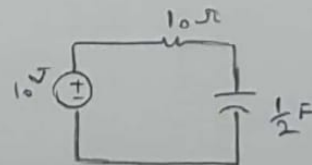
$$V'_2 = V_2 + V'_1 = 2 + \frac{25}{7} = \frac{39}{7}V$$

$$V'_3 = \frac{C_1 V_1 + V'_2 C'_2}{C_1 + C'_2} = \frac{1 \times 1 + \frac{39}{7} \times \frac{14}{9}}{1 + \frac{14}{9}} = \frac{1 + \frac{78}{9}}{\frac{23}{9}} = \frac{87}{23}V \quad \text{ولتاژ اولیه کل}$$



آندزنده گزینان!

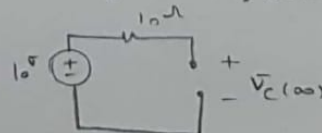
$$V_C(0) = 0$$



$0 < t < 3$

$$V(t) = V(\infty) + (V(0) - V(\infty))e^{-\frac{t}{RC}} \quad \text{ناب: زمان}$$

$$R = 10\Omega, C = \frac{1}{2}F, V(0) = 0V, V(\infty) = ? \Rightarrow \text{وازن} \Rightarrow V(\infty) = 10V$$

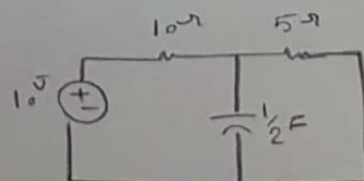


$$V(t) = 10 + (0 - 10)e^{-\frac{t}{10 \times \frac{1}{2}}}$$

$$0 < t < 3 \rightarrow V(t) = 10 - 10e^{-\frac{t}{5}}$$

$$V(t) = V(\infty) + (V(3) - V(\infty))e^{-\frac{(t-3)}{RC}}$$

$$R = 10 || 5 = \frac{10 \times 5}{10 + 5} = \frac{50}{15} = \frac{10}{3}\Omega$$



$3 < t$

$$C = \frac{1}{2}F, V(3) = 10 - 10e^{-\frac{3}{5}}, V(\infty) = ?$$

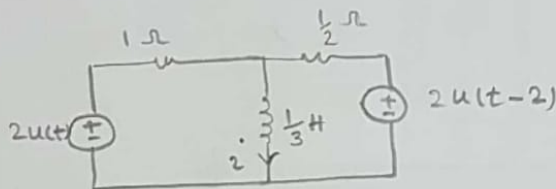
$$v(\infty) = \frac{5}{10+5} (10^5) = \frac{5}{15} = \frac{10}{3} \text{ V}$$

← منبع معادله

$$v(t) = \frac{10}{3} + (10 - e^{-\frac{3}{5}t} - \frac{10}{3}) e^{-\frac{1}{3} \times \frac{1}{2} t}$$

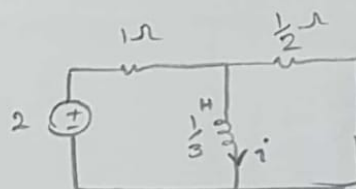
$$v(t) = \frac{10}{3} + (10 - e^{-\frac{3}{5}t} - \frac{10}{3}) e^{-\frac{3(t-3)}{5}} \leftarrow t \geq 3$$

$$i_c(t) = C \frac{dv(t)}{dt} = \begin{cases} \frac{1}{2} \times (-10) \left(-\frac{1}{5}\right) e^{-\frac{t}{5}} & \leftarrow 0 \leq t \leq 3 \\ \frac{1}{2} \times (10 - 10e^{-\frac{3}{5}t} - \frac{10}{3}) \times \left(-\frac{3}{5}\right) e^{-\frac{3}{5}(t-3)} & \leftarrow t \geq 3 \end{cases}$$



- 14  
 $I_L(t) = 3$

$$i(t) = i(\infty) + (i(0) - i(\infty)) e^{-\frac{t}{\tau_R}}$$



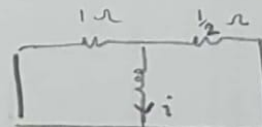
$0 \leq t \leq 2$   
منبع ولتاژ  
صفر افتاد کوتاه.  
مهر سرد.

$$R = 1 \parallel \frac{1}{2} = \frac{(1)(\frac{1}{2})}{1 + \frac{1}{2}} = \frac{1}{3} \Omega$$

در بسته

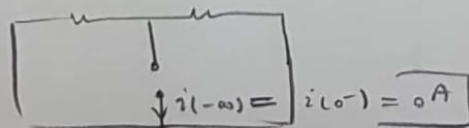
از دین تلف

$$L = \frac{1}{3} \text{ H} \quad \text{و} \quad i(0) = ? \rightarrow t < 0 \Rightarrow$$



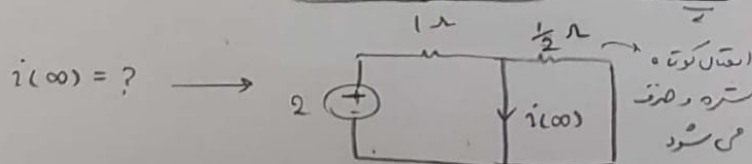
در وجود منبع تلف در معادله کوتاه مهر سرد اما در این وجود منبع تلف فرد چون منبع ولتاژ کل می کند که در  $\infty$  جریان آن صفر شده و افتاد باز مهر سرد.

$$t < 0 \approx t \rightarrow -\infty$$



$$i(0^-) = i(0^+) = 0 \text{ A}$$

لحظه جریانی منبع ولتاژ است.

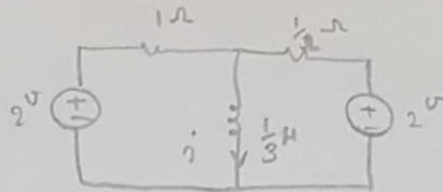


$$i(\infty) = \frac{2}{1} = 2 \text{ A}$$

$$i(t) = 2 + (0 - 2) e^{-t} = 2(1 - e^{-t}) \leftarrow 0 \leq t \leq 2$$

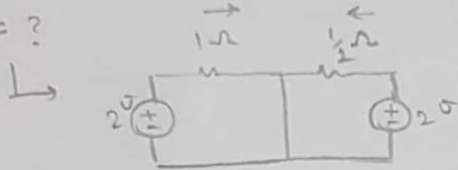
$$R = 1 \parallel \frac{1}{2} = \frac{1}{3} \Omega$$

$$L = \frac{1}{3} H \quad i(2^-) = 2 - 2e^{-2}$$



$$t \geq 2$$

$$i(\infty) = ?$$

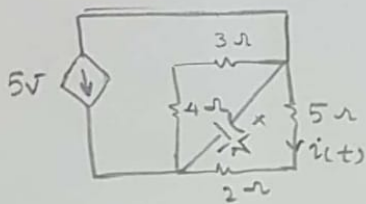


$$i(\infty) = \begin{cases} 2 / \frac{1}{2} = 4 A \\ 2 / 1 = 2 A \end{cases} \Rightarrow i(\infty) = 6 A$$

$$i(t) = 6 + (2 - 2e^{-t} - 6)e^{-(t-2)}$$

$$t \geq 2$$

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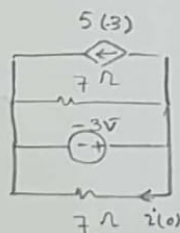
$$C = 4mF$$

$$V_C(0^-) = 3V$$

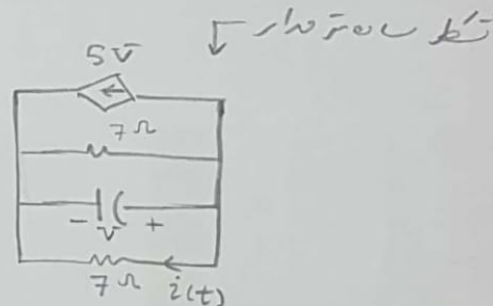
$$i(t) = ?$$

$$i(0) = ?$$

حالت در لحظه اولی همچون  
صنع ولتاژ با مقدار شارژ  
اولی است.

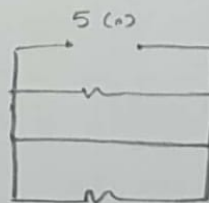


$$i(0) = -\frac{3}{7} A$$



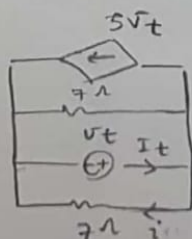
$$i(\infty) = ?$$

ما باید منبع مستقل در مدار حذف در به اتصال باز  
است (ما می بینیم وجود منبع حاد خود مثل یک منبع  
ولتاژ می کشیم که در مدار آن صورت می گیرد  
پس اتصال کوتاه می شود.



$t(\infty) = 0$  و بدون وجود هیچ منبع  
عین صورت خواهد بود

$$R_{th} = ? \rightarrow$$



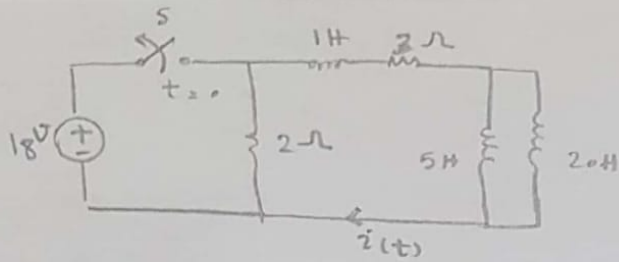
$$i = \frac{v_t}{7}, \quad KCL: 5V_t + \frac{v_t}{7} + \frac{v_t}{7} - I_t = 0$$

$$37V_t = 7I_t$$

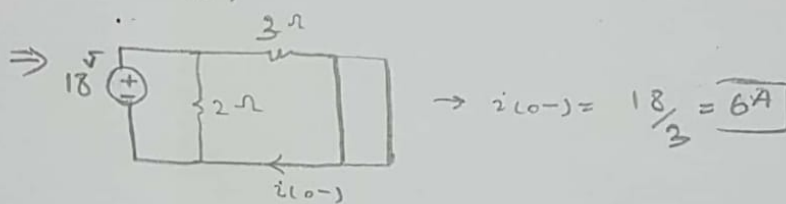
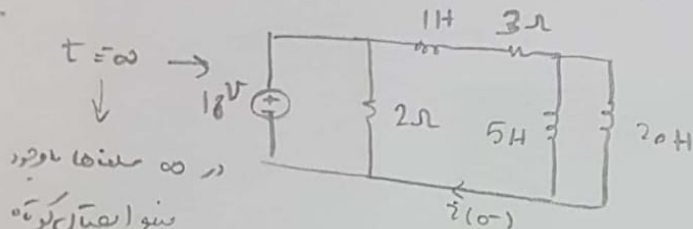
$$\frac{V_t}{I_t} = \frac{7}{37} \Omega \leftarrow R_{th}$$

$$i(t) = 0 + (-\frac{3}{7} - 0)e^{\frac{-t}{\frac{7}{37} \times 10^{-3}}} = -\frac{3}{7} e^{\frac{-37 \times 10^3 t}{28}} \quad t \geq 0$$

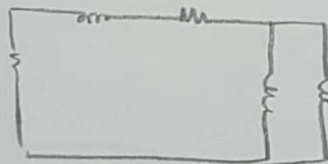
22. یک مدار به صورت زیر بوده است.  
 $t = \infty$   
 $i(t) = ?$



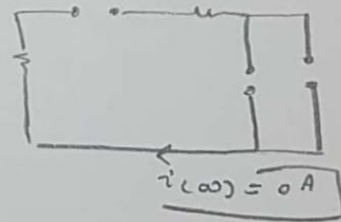
باب به شرح مدار  
 دو سلف خواهیم داشت  
 که چون یک حلقه می توان  
 یافت که در آن بیش از یک سلف وجود دارد پس فرقی ندار = 2 - 1 = 1



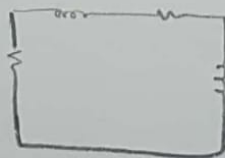
$t > 0 \rightarrow$



$t = +\infty$   
 در سلفها بدون  
 منع اتصال کوتاه



$R_{th} = ?$



$$R_{th} = 2\Omega + 3\Omega = 5\Omega$$

$$L = \frac{5 \times 20}{5 + 20} + 1 = 5H$$

$$\tau = L/R$$

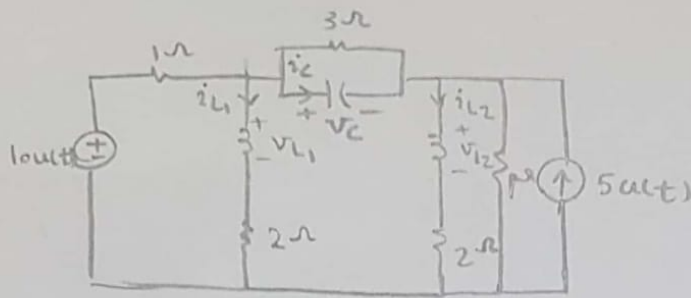
$$\tau = 5/5 = 1$$

$$i(t) = 0 + (6 - 0)e^{-t}$$

$$t > 0$$

$$i(t) = 6e^{-t} u(t)$$





$$V_{L1}(0+) = ? = 28$$

$$V_{L2}(0+) = ?$$

$$V_C(\infty) = ?$$

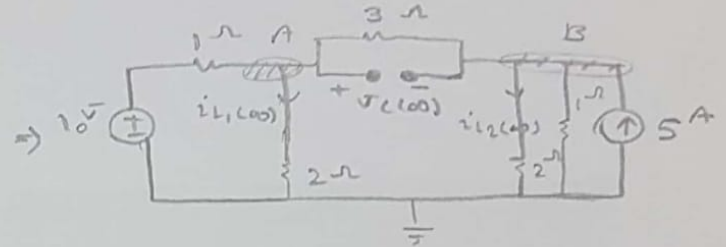
$$i_C(0+) = ?$$

$$i_{L1}(\infty) = ?$$

$$i_{L2}(\infty) = ?$$

$$\begin{cases} V_C(0+) = 0V \\ i_{L1}(0+) = 0A \\ i_{L2}(0+) = 0A \end{cases}$$

$t \rightarrow \infty$   
حالت (ثبات) است  
لذا افتاد می شود



$$KCL @ A: \frac{V_A - 10}{1\Omega} + \frac{V_A - 0}{2\Omega} + \frac{V_A - V_B}{3\Omega} = 0$$

$$KCL @ B: \frac{V_B - V_A}{3\Omega} + \frac{V_B - 0}{1\Omega} + \frac{V_B - 0}{2\Omega} - 5A = 0$$

$$\begin{aligned} & \rightarrow 6V_A - 60 + 3V_A + 2V_A - 2V_B = 0 \\ & \rightarrow V_B = \frac{-60 + 11V_A}{2} = -30 + 5.5V_A \end{aligned}$$

$$2V_B - 2V_A + 6V_B + 3V_B - 30 = 0$$

$$V_A = \frac{-30 + 11V_B}{2} = -15 + 5.5V_B$$

$$V_B = -30 + 5.5(-15 + 5.5V_B)$$

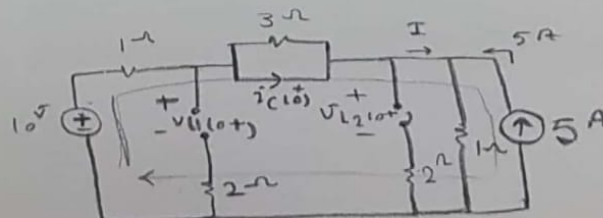
$$\rightarrow V_B = -26.425 \text{ V}, V_A = 0.65 \text{ V}$$

$$i_{L1}(\infty) = \frac{0.65}{2} = 0.325A$$

$$i_{L2}(\infty) = \frac{-26.425}{2} = -13.2125A$$

$$V_C(\infty) = 0.65 - (-26.425) = 27.075V$$

$t=0+ \Rightarrow$   
حالت: منبع ولتاژ شل شده است  
لذا: منبع جریان صاف می شود



$$KVL: -10V + I + 1\Omega(I + 5) = 0$$

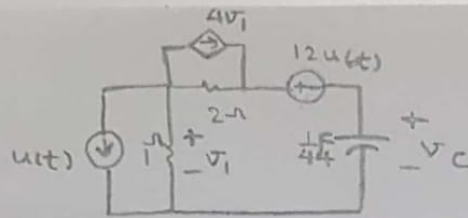
$$2I = 5 \rightarrow I = 2.5A$$

$$I + 5 = 7.5A$$

$$V_{L2}(0+) = (7.5A)(1\Omega) = 7.5V$$

$$V_{L1}(0+) = 10 - 2.5 = 7.5V$$

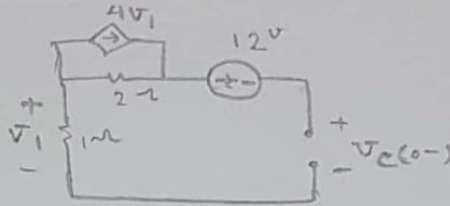
$$i_C(0+) = I = 2.5A$$



$$V_C(t) = ? \quad .35$$

تعیین شرایط

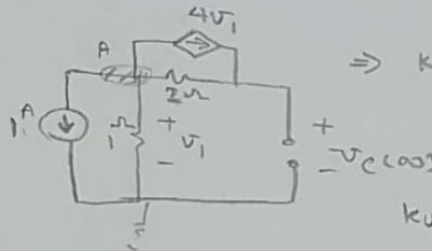
$t < 0 \approx t = -\infty \Rightarrow$    
 گذشت انتقال باشد



$$i_1 = 0 \rightarrow V_1 = 0 \rightarrow V_C(0-) = 12V = V_C(0+)$$

$t = +\infty \Rightarrow$

$\Rightarrow$



$$\Rightarrow KCL: \frac{V_A - 0}{1\Omega} + \frac{V_A - V_C}{2\Omega} + 4V_1 + 1A = 0$$

$$V_A = V_1$$

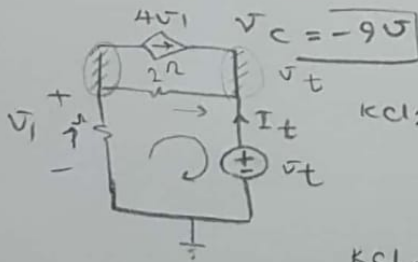
$$KVL: V_C - V_1 - 4V_1(2) = 0$$

$$V_C = 9V_1$$

$$\Rightarrow 2V_A + V_A - V_C + 8V_A + 2 = 0$$

$$11V_A - V_C = -2 \Rightarrow 11V_1 - 9V_1 = -2 \Rightarrow V_1 = -1V$$

$R_{th} = ?$



$$KCL: -I_t - 4V_1 + \frac{V_t - V_1}{2} = 0$$

$$-2I_t - 8V_1 + V_t - V_1 = 0$$

$$KCL: 4V_1 + \frac{V_1 - V_t}{2\Omega} + \frac{V_1}{1\Omega} = 0 \rightarrow$$

$$8V_1 + V_1 - V_t + 2V_1 = 0$$

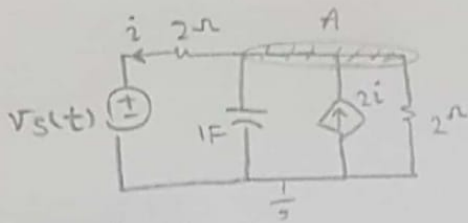
$$11V_1 = V_t \rightarrow V_1 = \frac{V_t}{11}$$

$$\Rightarrow -2I_t + V_t - 9V_1 = 0 \Rightarrow -2I_t + V_t - \frac{9}{11}V_t = 0$$

$$2I_t = \frac{2}{11}V_t \Rightarrow \frac{V_t}{I_t} = R_{th} = \frac{11\Omega}{5}$$

$$V_C(t) = -9 + (-12 + 9)e^{-\frac{t}{11 \times \frac{1}{44}}}$$

$$V_C(t) = -9 - 3e^{-4t}$$



37. پاسخ به صورت:  $i = v_c$

KCL @ A:  $\frac{v_A - 0}{2} - 2i + i + \frac{dv_c}{dt} = 0$

$i = \frac{v_A - v_s}{2}$  ,  $v_A = v_c$

$v_c - 2v_c + 2v_s + v_c + v_s + 2\frac{dv_c}{dt} = 0$

$\frac{dv_c}{dt} = -\frac{v_s}{2}$

$v_c(0^+) = v_c(0^-) = 0V$

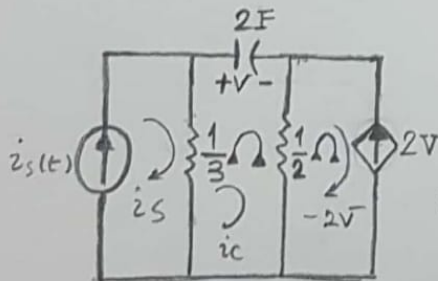
$v_s = u(t)$  } پاسخ به شرایط اولیه صفر

$\frac{dv_c}{dt} = -\frac{1}{2} \Rightarrow v_c = -\frac{1}{2}t + A$

$\hookrightarrow v_c(0) = 0 \Rightarrow -\frac{1}{2}(0) + A = 0 \Rightarrow A = 0$

پاسخ به  $\rightarrow v_c(t) = -\frac{1}{2}t u(t)$

پاسخ صریح  $\Rightarrow h(t) = -\frac{1}{2}u(t) - \frac{1}{2}t\delta(t) \Rightarrow h(t) = -\frac{1}{2}u(t)$



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$i_c = 2\frac{dv}{dt} = 2\frac{dv}{dt}$

KVL:  $\frac{1}{3}(i_c - i_s) + v + \frac{1}{2}(i_c + 2V) = 0$

$\Rightarrow \frac{5}{6}i_c - \frac{1}{3}i_s + v + v = 0$

$\Rightarrow \frac{5}{3}\frac{dv}{dt} + 2v = \frac{1}{3}i_s \Rightarrow \frac{dv}{dt} + \frac{6}{5}v = \frac{1}{5}i_s$

$\frac{dv}{dt} + \frac{6}{5}v = \frac{1}{5}$

پاسخ به  $\Rightarrow k + \frac{6}{5} = 0 \Rightarrow k = -\frac{6}{5}$

$v_g = A e^{-6/5 t}$  پاسخ صریح  $\Rightarrow v_p = k \Rightarrow 0 + \frac{6}{5}k = \frac{1}{5} \Rightarrow k = \frac{1}{6}$

$v = v_g + v_p = A e^{-6/5 t} + \frac{1}{6}$  استفاده از شرایط اولیه  $v(0) = 0 \Rightarrow A(1) + \frac{1}{6} = 0$

$\Rightarrow v = (-\frac{1}{6}e^{-6/5 t} + \frac{1}{6})u(t)$  پاسخ به  $A$  آوردن  $A = -\frac{1}{6}$

$\int_{0^-}^{0^+} \frac{dv}{dt} dt + \int_{0^-}^{0^+} \frac{6}{5}v dt = \int_{0^-}^{0^+} \frac{1}{5}\delta(t) dt$

$v(0^+) - v(0^-) + 0 = \frac{1}{5} \Rightarrow v(0^+) = \frac{1}{5}$

$i_s = \delta(t)$  } پاسخ صریح  
شرایط اولیه صفر است  
پاسخ صریح است به پاسخ ورودی صفر است

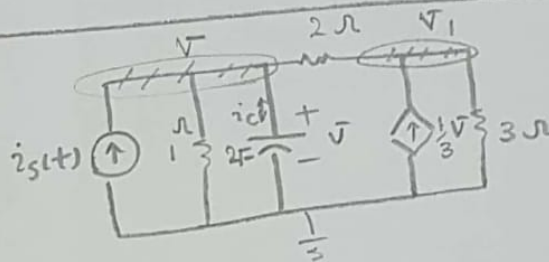
$$v(t) = k e^{-\frac{6}{5}t} \Rightarrow v(0+) = k(1) = \frac{1}{5} \Rightarrow \boxed{k = \frac{1}{5}}$$

$$\boxed{v(t) = \frac{1}{5} e^{-\frac{6}{5}t} u(t)} \leftarrow \text{مطلوب}$$

ارتباط بین خروجی و ورودی

$$\Rightarrow \text{مطلوب} = \text{مطلوب} \Rightarrow h(t) = \left(-\frac{1}{6}\right) \left(-\frac{6}{5}\right) e^{-\frac{6}{5}t} u(t) + \underbrace{\left(-\frac{1}{6} e^{-\frac{6}{5}t} + \frac{1}{6}\right)}_0 \delta(t) \Big|_{t=0}$$

$$\Rightarrow \boxed{h(t) = \frac{1}{5} e^{-\frac{6}{5}t} u(t)}$$



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$$\text{KVL @ } v: -i_s + v + 2 \frac{dv}{dt} + \frac{v - v_1}{2} = 0$$

$$\text{KVL @ } v_1: \frac{v_1}{3} - \frac{1}{3}v + \frac{v_1 - v}{2} = 0 \Rightarrow 2v_1 - 2v + 3v_1 - 3v = 0$$

$$\boxed{v_1 = v}$$

$$\Rightarrow \frac{dv}{dt} + \frac{1}{2}v = \frac{1}{2}i_s$$

$$\frac{dv}{dt} + \frac{1}{2}v = \frac{1}{2}u(t) \quad t \geq 0 \leftarrow \text{مطلوب}$$

$$v_g = ? \Rightarrow \frac{dv}{dt} + \frac{1}{2}v = 0 \Rightarrow k + \frac{1}{2} = 0 \Rightarrow k = -\frac{1}{2}$$

$$\Rightarrow v_g = k e^{-\frac{1}{2}t}$$

$$v_p = A \Rightarrow 0 + \frac{1}{2}A = \frac{1}{2} \Rightarrow \boxed{A = 1}$$

$$v = v_g + v_p = k e^{-\frac{1}{2}t} + 1 \quad \xrightarrow{v(0+) = 0} \quad k(1) + 1 = 0 \Rightarrow \boxed{k = -1}$$

$$\boxed{s(t) = v = (-e^{-\frac{1}{2}t} + 1)u(t)} \leftarrow \text{مطلوب}$$

$$\int_0^+ \frac{dv}{dt} dt + \int_0^+ \frac{1}{2}v dt = \int_0^+ \frac{1}{2}\delta(t) dt = \frac{1}{2}(1)$$

$\leftarrow \text{مطلوب}$

$$\Rightarrow v(0+) - v(0^-) + 0 = \frac{1}{2}$$

$$v(0+) = \frac{1}{2}$$

$$h(t) = k e^{-\frac{1}{2}t} u(t)$$

$$h(0+) = k(1) = \frac{1}{2}$$

$$\Rightarrow h(t) = \frac{1}{2} e^{-\frac{1}{2}t} u(t)$$

$$h(t) = \frac{ds(t)}{dt} = \left(\frac{1}{2} e^{-\frac{1}{2}t}\right)u(t) + \underbrace{\left(-e^{-\frac{1}{2}t} + 1\right)}_0 \times \underbrace{\delta(t)}_{t=0} = \frac{1}{2} e^{-\frac{1}{2}t} u(t)$$