PP First order circuits 011

Unlimited Attempts.

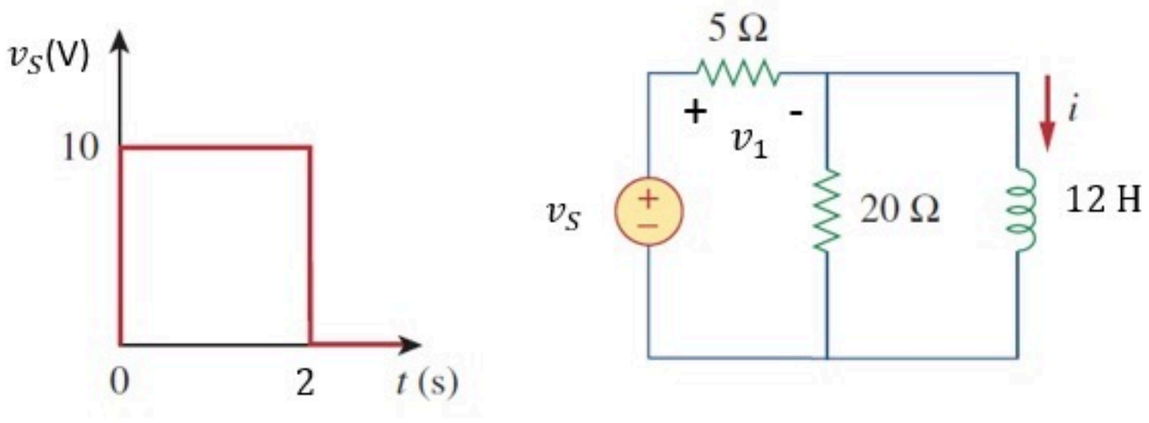
The voltage source behaves as shown (and assume it has been zero for a long time for $t < 0$).

Find $v_1(t) = D$ for $t = 0^-$

$= A_1 \cdot e^{-t/\tau 1} + B_1$ for $0 < t < 2$ s

$= A_2 \cdot e^{-(t-2\,s)/\tau 2} + B_2$ for 2 s $< t$

Note, for your calculations, use: $e^{-1/1.5} \approx 0.5$



Given Variables:

. : . .

Calculate the following:

D (V) :

0 ✓

A1 (V) :

-8 ✓

B1 (V) :

10 ✓

tau1 (s) :

3 ✓

A2 (V) :

4 ✓

B2 (V) :

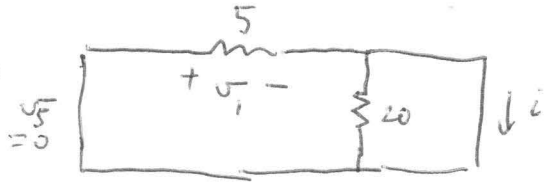
0 ✓

tau2 (s) :

3 ✓

Hint: Find the result of the first transition first.

(a) $v_s = 0$ $\quad t = 0^-$:



$v_1(0^-) = 0\,V$

$i(0^-) = 0\,A$

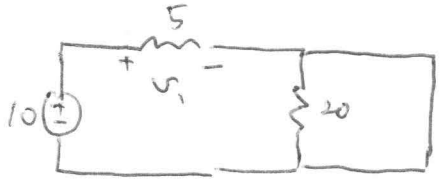
$D = 0\,V$

(b) $v_s = 10$ $\quad t = 0^+$:

$i(0^+) = 0\,A \rightsquigarrow$ open

$v_1(0^+) = 10 \cdot \frac{5}{5+20} = 2\,V$

$t = \infty$:



$i(\infty) = \frac{10}{5} = 2\,A$

$v_1(\infty) = 10\,V$

R_{TH}: $R_{TH} = 5 \| 20 = 4\,\Omega \Rightarrow \tau = \frac{L}{R} = \frac{12}{4} = 3\,s$

$A_1 = -8\,V$

$B_1 = 10\,V$

$\tau_1 = 3\,s$

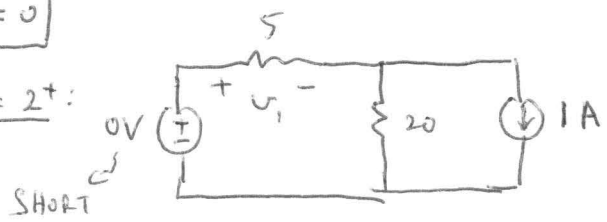
$v_1(t) = -8e^{-\frac{t}{3}} + 10, \quad 0 < t < 2$

$i(t) = -2e^{-\frac{t}{3}} + 2, \quad 0 < t < 2$

$t = 2^-$: $i(2^-) = -2e^{-\frac{2}{3}} + 2 = -2e^{-\frac{1}{1.5}} + 2 = -2 \cdot \frac{1}{2} + 2 = 1\,A$

(c) $v_s = 0$

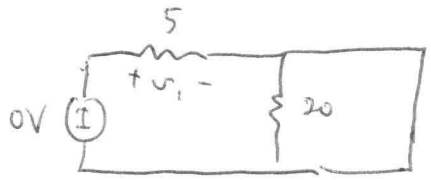
$t = 2^+$:



$i(2^+) = i(2^-) = 1\,A$

$v_1 = 1 \cdot (5 \| 20) = 1 \cdot 4 = 4\,V$

$t = \infty$:



$i(\infty) = 0$

$v_1(\infty) = 0\,V$

R_{TH}: SAME AS BEFORE $\Rightarrow \tau = 3\,s$

$A_2 = 4\,V$

$B_2 = 0\,V$

$\tau_2 = 3\,s$

$v_1(t) = 4e^{-\frac{t}{3}} + 0$