GATE-2023, EC-35

EE23BTECH11033- JASWANTH KILLANA

Question:
In the circuit shown below, switch S was closed for a long time. If the switch is opened at t=0, the maximum magnitude of the voltage V_R in volts is. (round off to nearest integer).
solution :

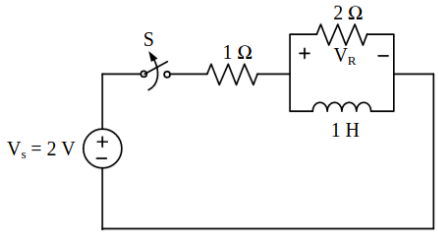

Fig. 0.

$$At, t = 0^- \tag{1}$$

inductor acts as wire
apply KVL in big loop

$$-2 + 1i\left(0^-\right) = 0 \tag{2}$$

$$i\left(0^-\right) = 2A \tag{3}$$

here after t=0,

parameter	description	value
$i(0^-)$	current at $t < 0$	2
V_R	voltage across 2Ω	-2i(t)
L	inductance	1
$i(t)$	current in small loop after $t = 0$	$\frac{V_R}{2}$
$I(s)$	$i(t)$ in laplace	–

TABLE 0
INPUT PARAMETERS

KVL,

$$2i\left(t\right) + L\frac{di}{dt} \tag{4}$$

apply laplace transform,

$$2I\left(s\right) - Li\left(0^-\right) + LsI\left(s\right) = 0 \tag{5}$$

$$\implies I\left(s\right) = \frac{i\left(0^-\right)}{s+2} \tag{6}$$

$$I\left(s\right) = \frac{2}{s+2} \tag{7}$$

applying inverse laplace transform

$$I\left(t\right) = 2 \cdot e^{-2t} \tag{8}$$

$$V_R = -2I\left(t\right) \tag{9}$$

$$\implies V_R = -4 \cdot e^{-2t} \tag{10}$$

As,

$$t \to 0 \tag{11}$$

$$e^{-2t} \to 1 \tag{12}$$

$$\left|V_R\left(max\right)\right| = 4 \tag{13}$$

This is the simulation for Vr vs time

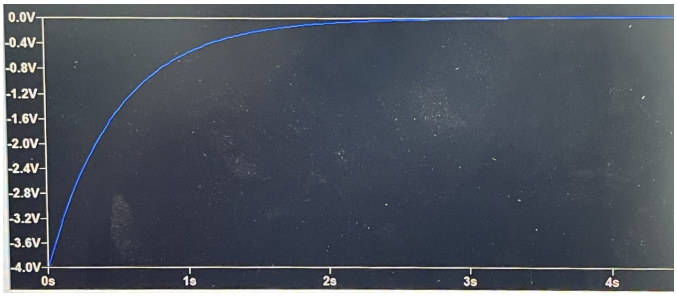

Fig. 0.

The magnitude of graph is max at $t = 0$ of magnitude $4V$and then decreases with t. Which supports the solution by doing laplace transform method.