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).

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

TABLE 0
INPUT PARAMETERS

solution :

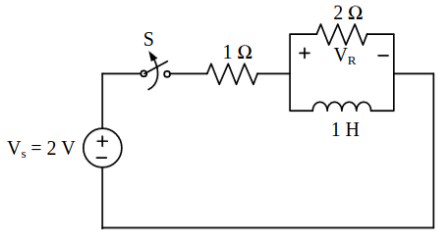

Fig. 0.

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

inductor acts as wire
apply KVL in big loop

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

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

here after t=0,

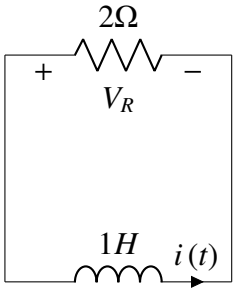

Fig. 0. steady state circuit

KVL,

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

apply laplace transform,

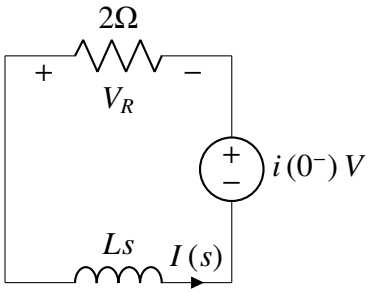

Fig. 0. s domain circuit

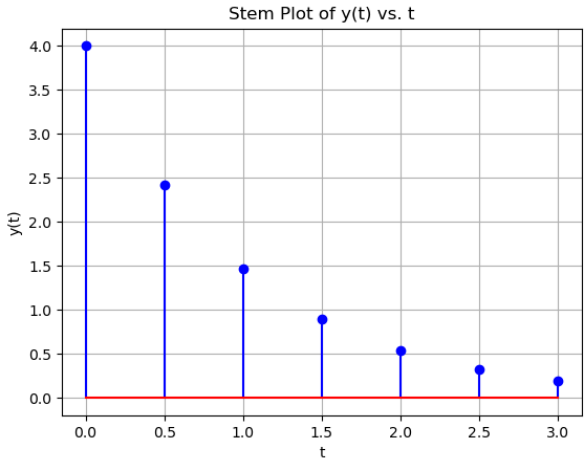

Fig. 0. plot of $|V_R|$ vs t

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

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

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

applying inverse laplace transform

$$i(t) = 2e^{-2t}u(t)\,A \tag{8}$$
$$V_R(t) = -2i(t) \tag{9}$$
$$\implies V_R(t) = -4e^{-2t}u(t)\,V \tag{10}$$

As,

$$t \to 0 \tag{11}$$
$$\implies e^{-2t} \to 1 \tag{12}$$
$$|V_R(max)| = 4V \tag{13}$$