

# 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 :**

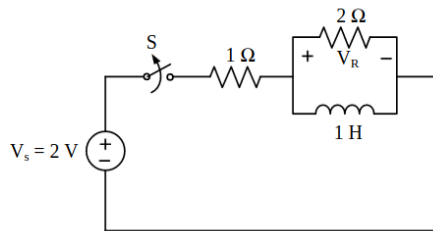


Fig. 0.

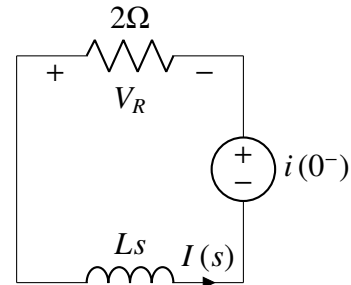


Fig. 0. s domain circuit

$$\text{At, } t = 0^- \quad (1)$$

inductor acts as wire  
apply KVL in big loop

$$-2 + 1i(0^-) = 0 \quad (2)$$

$$i(0^-) = 2A \quad (3)$$

here after  $t=0$ ,

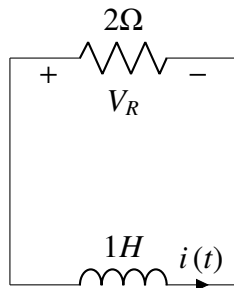


Fig. 0. steady state circuit

KVL,

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

apply laplace transform,

$$2I(s) - Li(0^-) + LsI(s) = 0 \quad (5)$$

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

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

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

TABLE 0

INPUT PARAMETERS

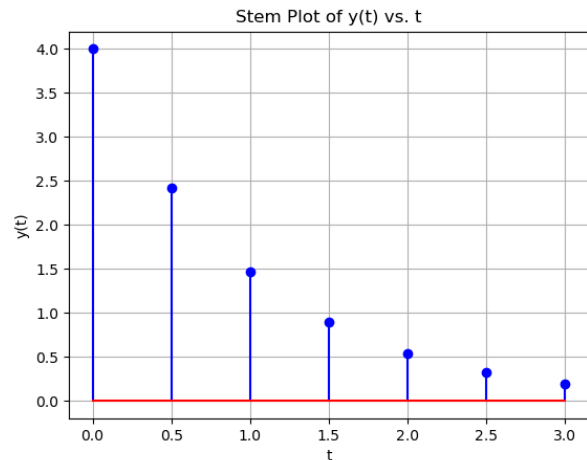


Fig. 0. plot of  $|V_R|$  vs  $t$

applying inverse laplace transform

$$i(t) = 2e^{-2t}u(t) \quad (8)$$

$$V_R(t) = -2i(t)u(t) \quad (9)$$

$$\implies V_R(t) = -4e^{-2t}u(t) \quad (10)$$

As,

$$t \rightarrow 0 \quad (11)$$

$$e^{-2t} \rightarrow 1 \quad (12)$$

$$|V_R(max)| = 4 \quad (13)$$