EECS2200 Electric Circuits

Chapter 5 Part 2

Activities

Activity 1

Look at the inductor equation again:

$$v(t) = L\frac{di(t)}{dt}$$

Suppose i(t) is constant, what is v(t)?

A. L

B. 0

C. Undefined

Activity 2

So, if the current in an inductor is constant, its voltage drop is 0, so the inductor can be replaced by:

A. A short circuit.

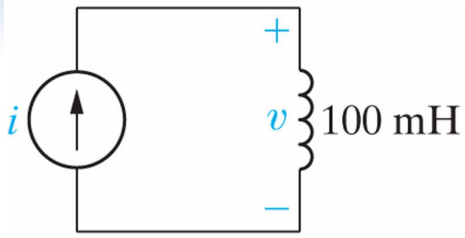
B. An open circuit.

C. A resistor.

Activity 3

Given the following conditions,

1. Sketch the current waveform.
2. Find v(t) and sketch voltage waveform.

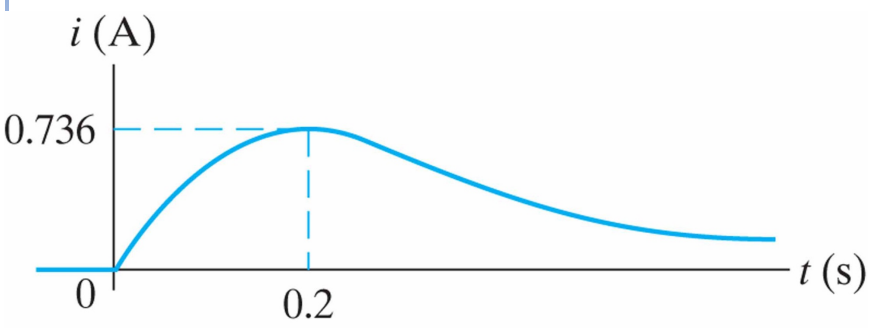


$$i = 0, \qquad t < 0$$

$$i = 10te^{-5t}\text{A}, \qquad t > 0$$

Solution

1. i(t) waveform



Solution

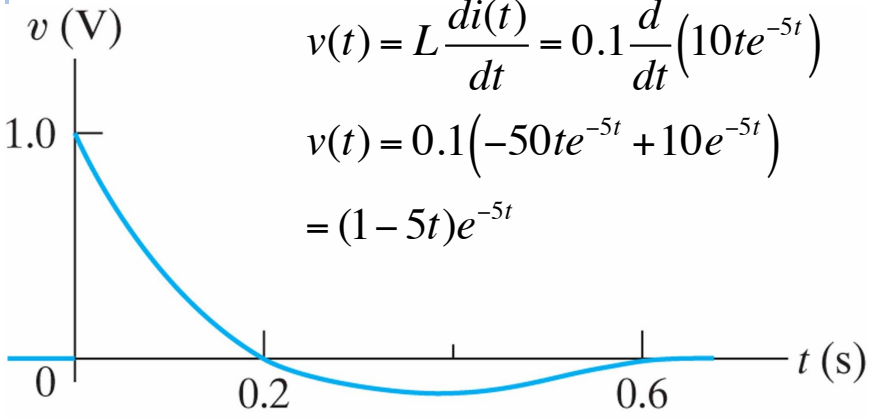
2. v(t)

$$i(t) = \begin{cases} 0 & t < 0 \\ 10te^{-5t}\,\text{A} & t \geq 0 \end{cases}$$

$$v(t) = L\frac{di(t)}{dt} = 0.1\frac{d}{dt}\left(10te^{-5t}\right)$$

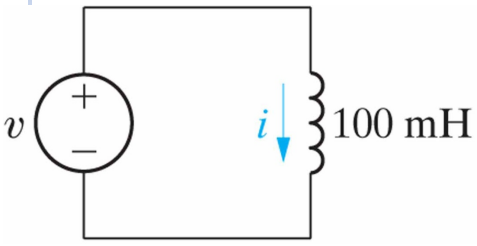
$$v(t) = 0.1\left(-50te^{-5t} + 10e^{-5t}\right)$$

$$= (1 - 5t)e^{-5t}$$



Activity 4

1. Sketch the voltage as function of time
2. Find i(t)



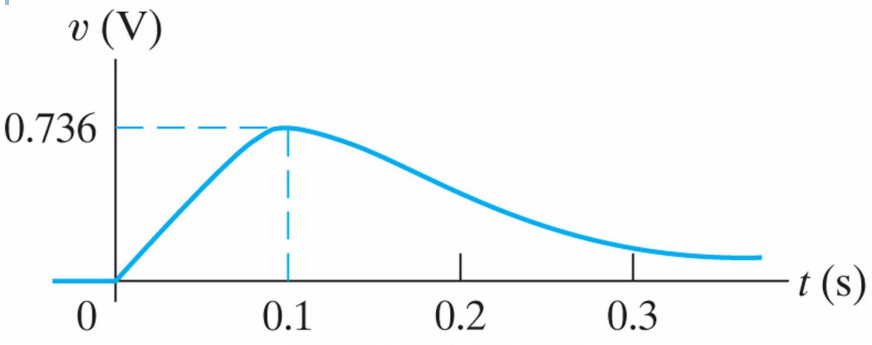
$$v = 0, \qquad t < 0$$

$$v = 20te^{-10t}\ \text{V}, \qquad t > 0$$

Solution

1. Sketch v(t)

$$v(t) = 20te^{-10t}$$

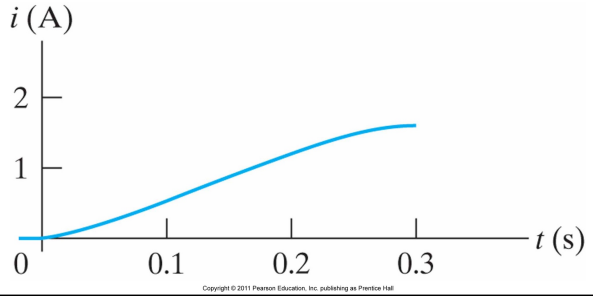


Solution

2. Find i(t)

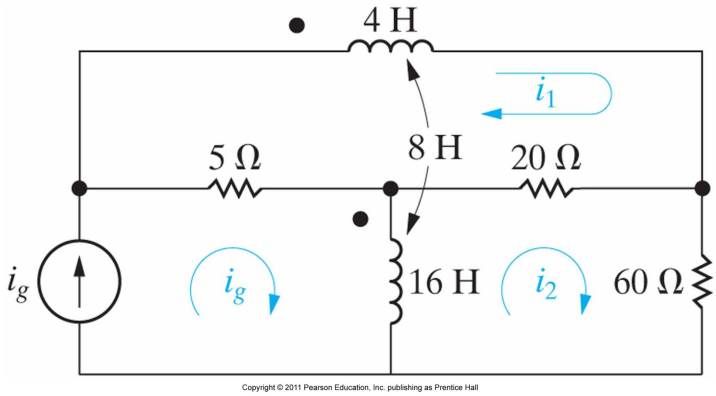
$$i(t) = \frac{1}{0.1}\int_0^t 20\tau e^{-10\tau}\, d\tau = 200\left[\frac{-e^{-10\tau}}{100} + 1\right]_0^t$$

$$= 2(1 - 10te^{-10t} - e^{-10t})A$$



Activity 5

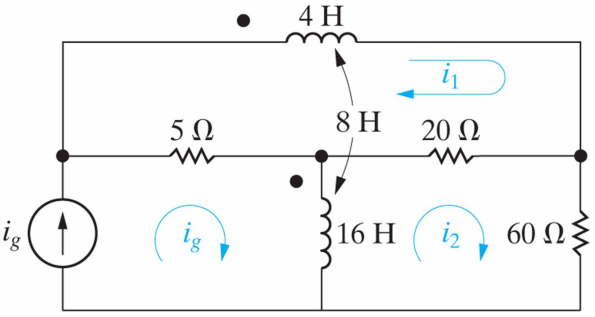
Write a set of mesh-current equations.



Solution

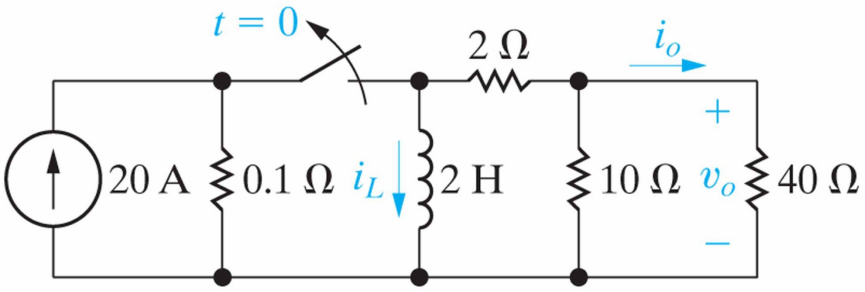
$$4\frac{di_1}{dt}+8\frac{d}{dt}(i_g-i_2)+20(i_1-i_2)+5(i_1-i_g)=0$$

$$20(i_2-i_1)+60i_2+16\frac{d}{dt}(i_2-i_g)-8\frac{di_1}{dt}=0$$



Activity 6

The switch has been closed for long time before it is opened at t=0. Find $i_L(t)$ for >=0.

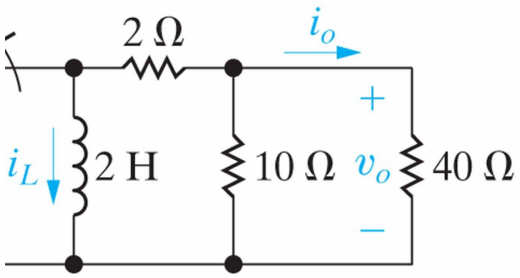


Solution

R_{eq}=2+10//40=10Ω, I_0=20A, L=2H

$$i(t) = I_0 e^{-(R/L)t}, \quad \tau = \frac{L}{R} \text{ time constant}$$

$$i(t) = 20e^{-5t}$$



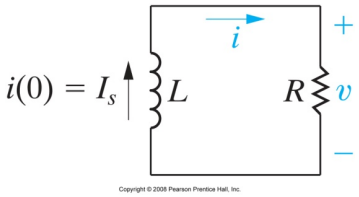
Activity 7

The circuit we analyzed for the RL natural response problem is shown below, along with the expression for *i(t)*, for *t* ≥ *0*. What is the value of *i(t)* as *t* → ∞?

A. 0

B. I_S

C. ∞



$$i(t) = I_s e^{-(R/L)t}, \qquad t \geq 0$$

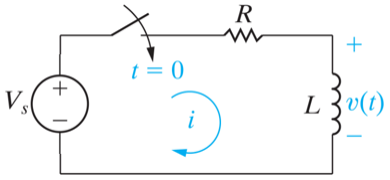
Activity 8

Now consider what happens to the current as $t \rightarrow \infty$ in the RL step response circuit. First, as $t \rightarrow \infty$, we can replace the inductor by

A. An open circuit

B. A short circuit

C. A resistor



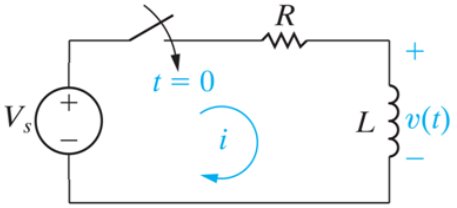
Activity 9

To evaluate the current in the inductor as $t \rightarrow \infty$, close the switch and replace the inductor with a short circuit. The current in the short circuit is

A. 0

B. infinite

C. V_S /R

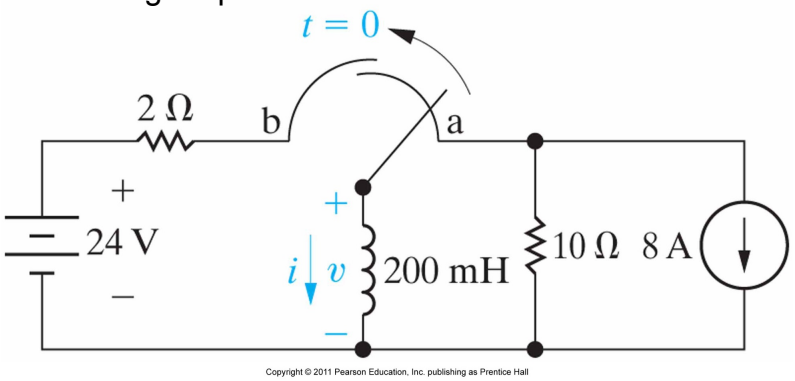


Activity 10

1.Find i(t) for t>=0

2. What is voltage across inductor just after switch has been moved to b.

3. How many ms after the switch has been moved does the inductor voltage equal 24V?



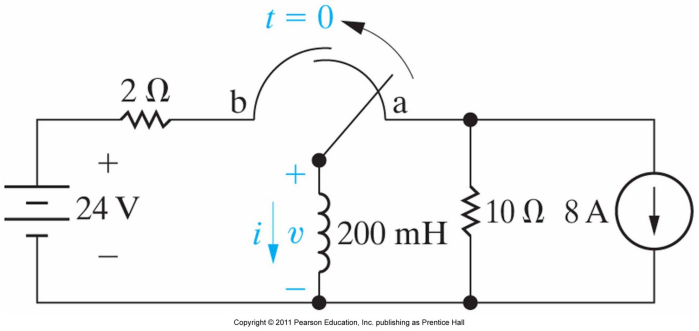
Solution

Switch at a: $I_0 = -8A$

Switch at b: $I_F = 24/2 = 12A$

$\tau = L/R = 200/2 = 100ms$

$\therefore i(t) = 12 + (-8-12)e^{-10t}A$ for $t \geq 0$

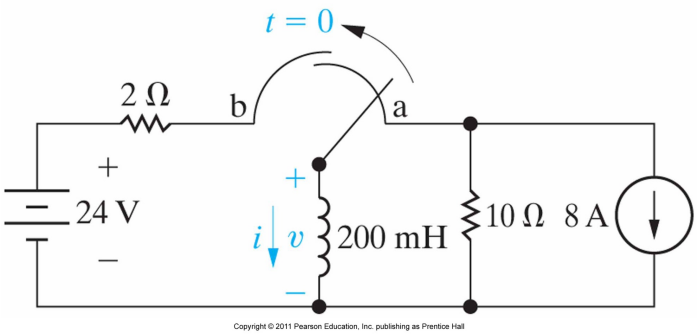


Solution

$$v(t) = L\frac{di(t)}{dt} = 0.2(-20)(-10)\frac{d}{d(-10t)}e^{-10t}$$

$$\therefore v(t) = 40e^{-10t}V \text{ for } t \geq 0$$

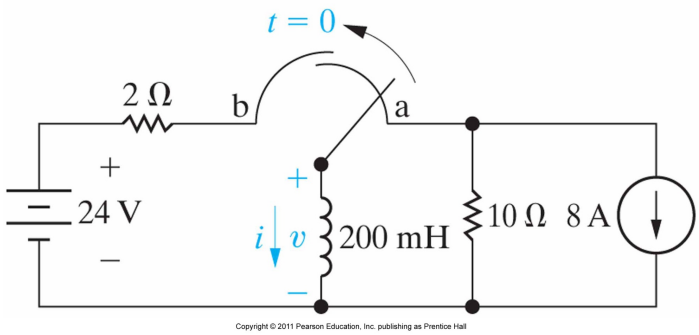
$$v(0^+) = 40V$$



Solution

$$24 = 40e^{-10t}$$

$$t = \frac{1}{10}\ln\frac{40}{24} = 51.08ms$$



Solution