

LAHORE UNIVERSITY OF MANAGEMENT SCIENCES
 Department of Electrical Engineering

EE240 Circuits I
Quiz 05 - Section 2 (Solutions)

Name: _____

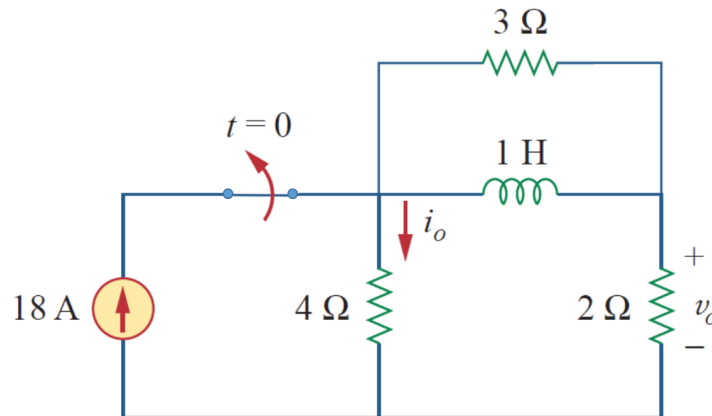
Campus ID: _____

Total Marks: 10

Time Duration: 20 minutes

Question 1 (10 marks)

In the following circuit, the switch is opened at $t = 0$. Determine the current $i_o(t)$ and voltage $v_o(t)$ for all times. Also plot the voltage and current for $-\tau \leq t \leq 6\tau$ (where τ denotes the time constant of the circuit)



Solution:

At $t = 0^-$:

- Inductor is short-circuit
- $i_o(0^-) = \frac{2}{6} \times 18 = 6 \text{ A}$
- $i_L(0^-) = 18 - 6 = 12 \text{ A}$
- $v_o(0^-) = 4 \parallel 2 \times 18 = 24 \text{ V}$

At $t = 0^+$:

- Switch is opened, implies that the source is removed
- $i_L(0^+) = i_L(0^-) = 12 \text{ A}$; inductor acts as a current source of 12 A
- 4 Ω and 2 Ω are in series, sum is in parallel with 3 Ω
- $i_o(0^+) = -\frac{3}{9} \times 12 = -4 \text{ A}$
- $v_o(0^+) = -2 \times i_o(0^+) = 8 \text{ V}$

At $t = \infty$:

- No source
- $i_o(\infty) = 0 \text{ A}$
- $v_o(\infty) = 0 \text{ V}$

Time constant τ :

- Resistance across inductor, $R_{eq} = 6 \parallel 3 = 2 \Omega$
- $\tau = L/R_{eq} = 1/2 \text{ s}$

Solution Formulation:

$$v_o(t) = \begin{cases} 24 & t < 0 \\ 8e^{-2t} & t > 0 \end{cases}$$

$$i_o(t) = \begin{cases} 6 & t < 0 \\ -4e^{-2t} & t > 0 \end{cases}$$