Name: Shubham Sanay. Roll. No. .....

**Department of Electrical Engineering,**

**Indian Institute of Technology, Kanpur**

**ESC201** | **Mini-Quiz II** | **28/01/2025**

**Total Marks: 5** | **Time: 10 minutes**

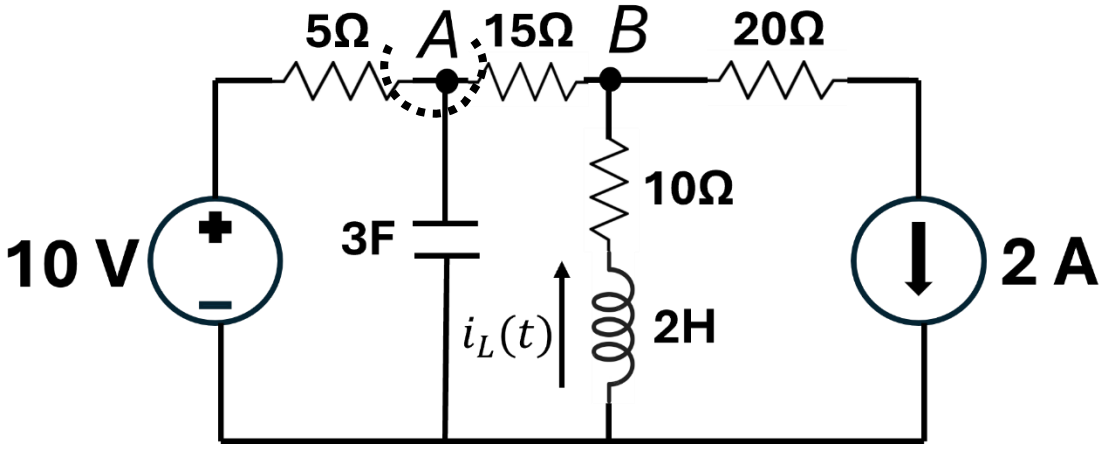
**Instructions**

- **Please write your name and roll number first.**
- **Read the question carefully and answer it in the question paper itself.**

**1)** Pradhan ji, with the help of Sachiv ji, designed the first RLC circuit from Phulera as shown below to deliver current to the inductor. However, in an attempt to spoil their efforts, Bhushan (the Banrakas) and Binod cut the wires randomly at node A (as shown below).

(a) Assuming that the wires were cut at $t = 0$, find out the voltage across the inductor $V_L(t)$ for $t > 0$. **(4.5 marks)**

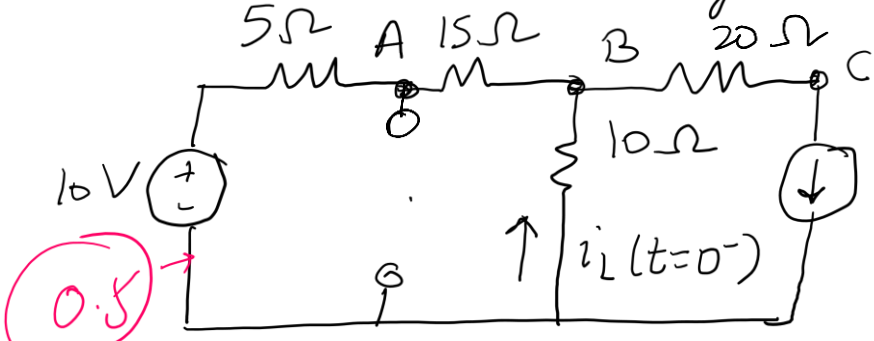
(b) Were Bhushan and Binod successful in their attempt? **(0.5 mark)**




Assumption 1: System is in steady state for $t < 0$. (0.5)

Equivalent circuit diagram for $t < 0$:

short inductor
open-circuit capacitor




(0.5)

Apply KCL at nodes C & B;

Node B: $\frac{V_B}{10} + \frac{V_B - 10}{20} + \frac{V_B - V_C}{20} = 0$ (0.8)

or $4V_B - V_C = 10$

$\Rightarrow 2V_B + V_B - 10 + V_B - V_C = 0$

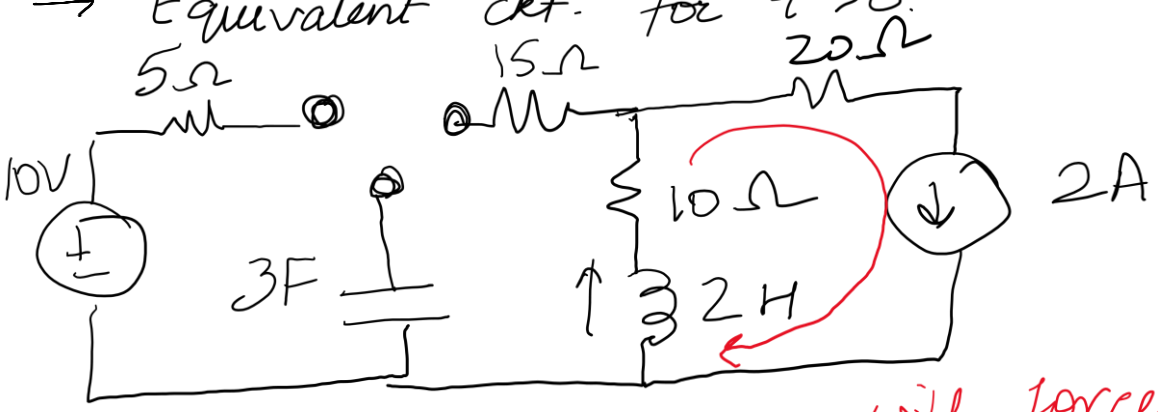
(1)

Node C: $2 + \frac{V_C - V_B}{20} = 0 \Rightarrow -40 = V_C - V_B$ — (2)

Adding (1) & (2), we get $3V_B = -30$ or $V_B = -10V$

$\therefore i_L(t=0^-) = -\left(\frac{V_B}{10}\right) = 1\,A$ → (0.5)

→ Equivalent ckt. for $t>0$:




→ The current source will force a current of 2A through this loop for $t>0$.

∴ even at $t=0^+$; $i_L(t=0^+)$ must be 2A.

→ However, this violates our assumption of $i_L(t=0^-) = i_L(t=0^+)$.

(2) → This is an exception where current through inductor changes instantaneously (from 1A to 2A) forcing voltage across it to spike to a large value (infinity) & then fall to 0 instantaneously.

→ Current (voltage) across inductor (capacitor) cannot change instantaneously only if the circuit element doesn't permit it. Here, current source can allow any voltage across it.

OR

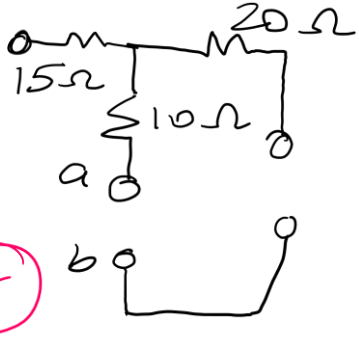
→ if someone solved for

← $i_L(t) = i_L(\infty) + \left[i_L(t=0^+) - i_L(t=\infty)\right] e^{-\frac{t}{\tau}}$

(0.8) and used $i_L(t=0^+) = i_L(t=0^-)$. ×

this is where you went wrong.

→ Also, if you calculate $\tau$ →




0.5 → $R_{th} = \infty$ → open circuit.

change

$\therefore i_L(t) = i_L(\infty) = 2A$ 0.8

& $V_L(t) = 0$ [this does not give a real picture of voltage spiking at $t = 0^+$] 0.8

→ Part (b) → They were unsuccesful because of the current source. → 0.5