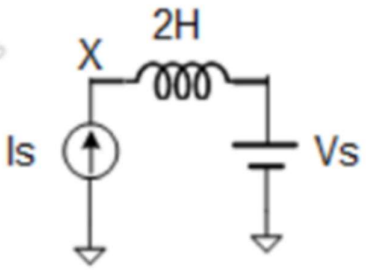
TI BYTE Simulation Exercise

Week 3 : RL Circuits

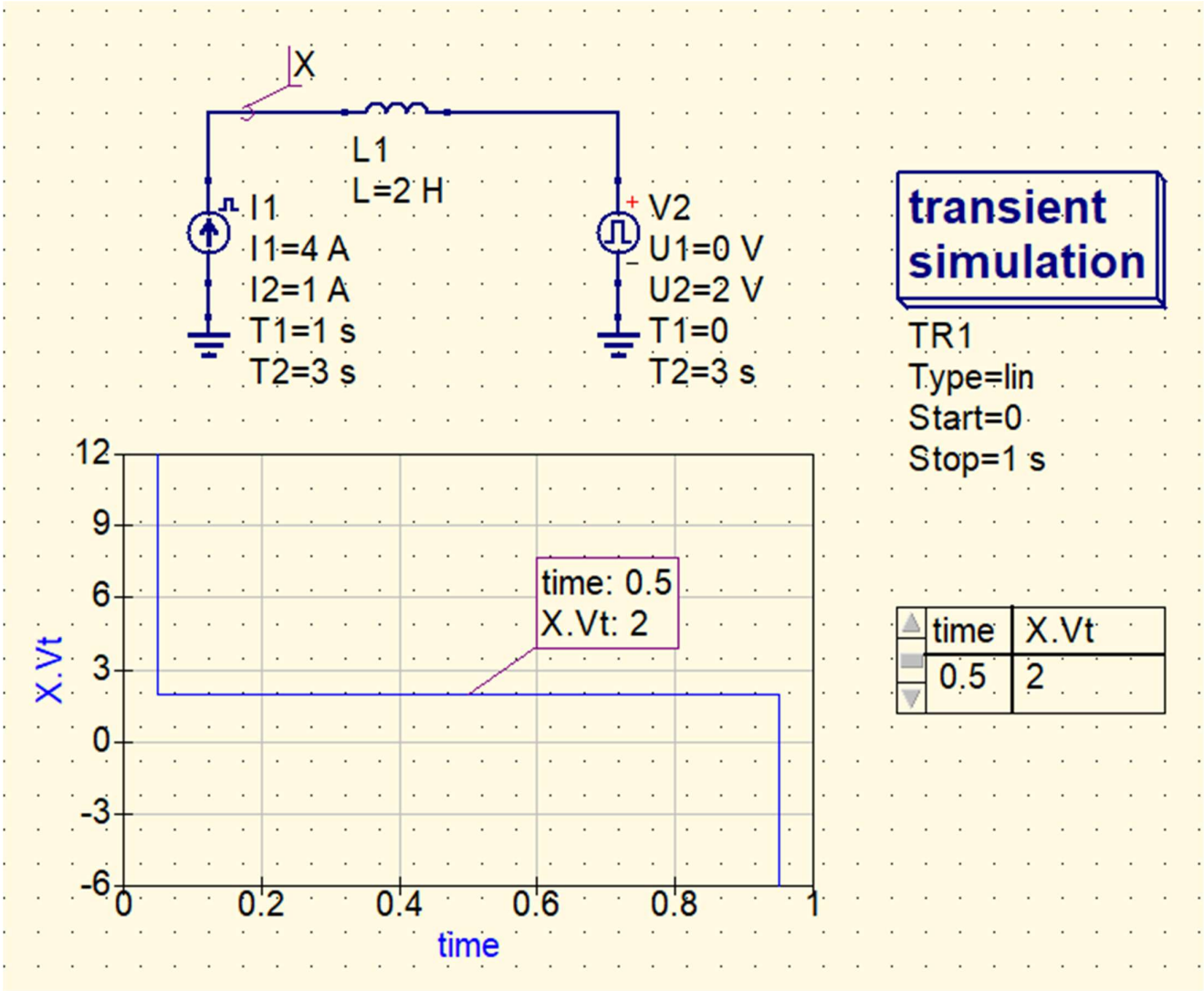
- **Question 1:**

603. Vs=2.u(t). Is=4.u(t)-3u(t-1). Voltage at node X at t=0.5sec is:

(a) 2V
(b) ∞ V
(c) 6V
(d) 3V
(e) 0V
(f) 4V
(g) 1V
(h) 10V



- **QUCS Circuit:**



- **X is used to label the node and find the voltage at that node.**
- **Both the inductors have zero initial current through them.**

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

V_x = 2V

Answer: (a)

➢ Conclusion:

- **The final voltage at X can be found out using the Superposition Theorem.**
- **Upon considering the current source I1 only,**

$$I_1 = 4.u(t) - 3.u(t-1)$$

$$I_1 = \begin{cases} 4, & 0 \le t \le 1 \\ 1, & t > 1 \end{cases}$$

- **Thus, voltage across the inductor due to the current source only,**

$$V_L = L\frac{dI}{dt}$$

$$I_1 = \begin{cases} \delta(t), & t = 0 \\ -\delta(t), & t = 1 \\ 0, & elsewhere \end{cases}$$

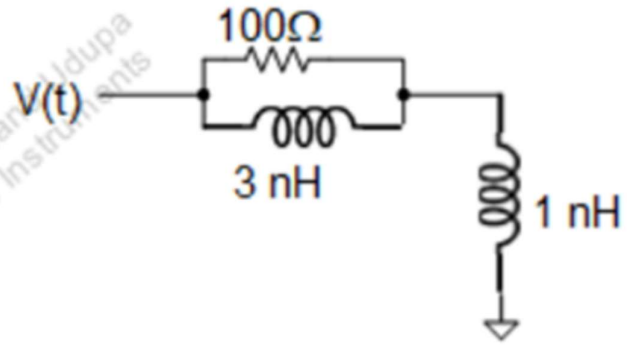
- **Due to the voltage source V2, the voltage at X is 2V.**
- **Therefore, it can be said that, at t = 0.5s, the voltage at X is**

$V_x = V_L + V_2 = (0 + 2)$ V = 2V.

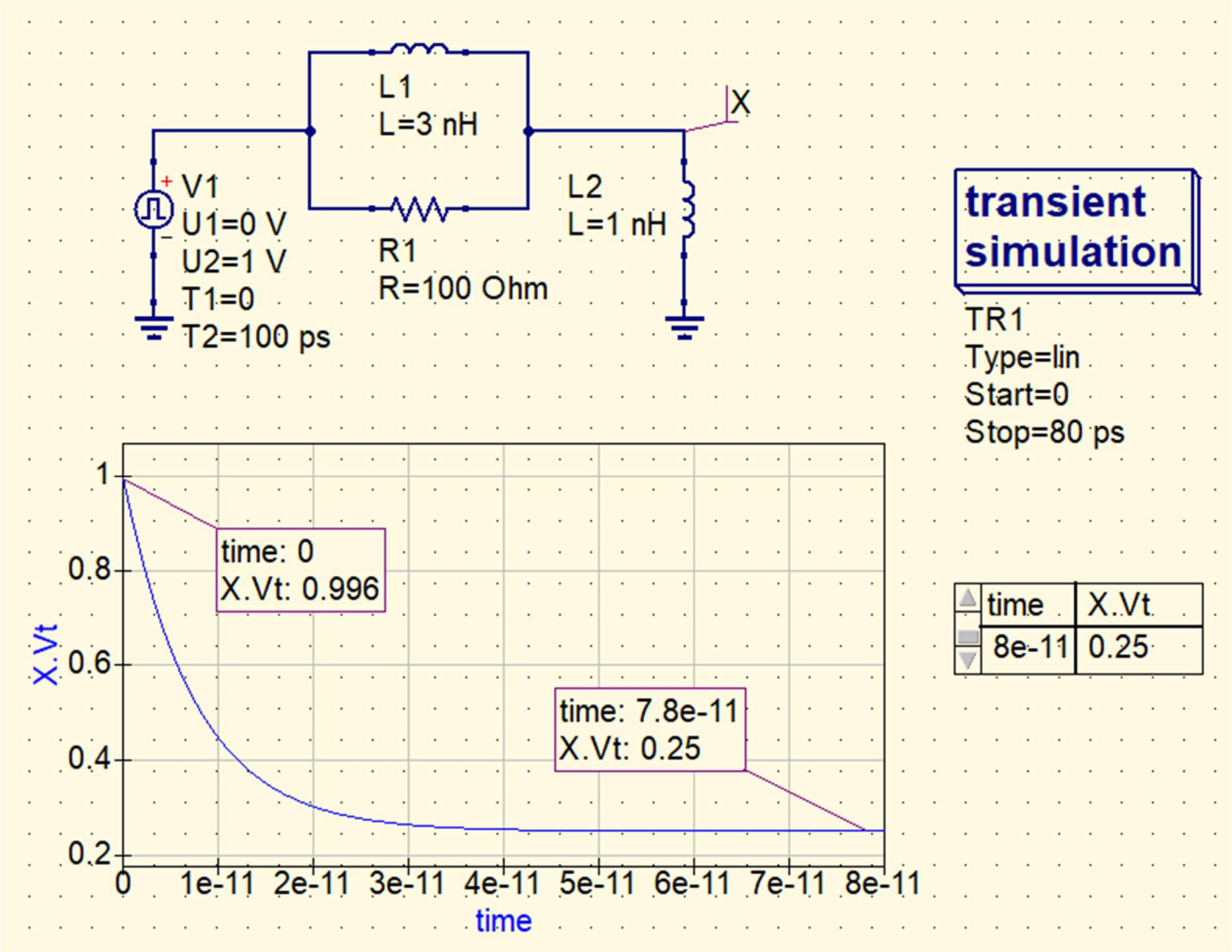
- **Question 2:**

610. V(t) = u(t). What is the steady state value of the voltage across the 1 nH inductor?

(a) 0V
(b) 0.5V
(c) 1V
(d) 2V
(e) 1.5V
(f) 0.25V
(g) 1.25V
(h) 0.75V



- **QUCS Circuit:**



- **X is used to label the node at which the unknown voltage is to be determined.**

- **Both the inductors L1 and L2 are initially uncharged, i.e., having zero initial current in them.**

➢ QUCS Result:

Therefore, from the simulation, we get our answer as:

V_x = 0.25V

Answer: (f)

➢ Conclusion:

- **At t = 0, since both the inductors are uncharged, they have high impedances and behave as open circuits (o.c.).**
- **Thus, no current flows through them, or even through the R1.**
- **Therefore, the voltage at node X is**

$$V_x \approx V_1 = 1V$$

- **Now, at t = ∞, both the inductors have reached steady state and have low impedance and behave as almost short circuits (s.c.).**
- **Since the current gets low impedance path through L_1, the equivalent impedance becomes,**

$$L_1 || R_1 \approx L_1$$

- **Thus, the voltage at X at t = ∞ (), is just a voltage divider between L_1 and L_2,**
- **The final voltage at X =** $\frac{L_2}{L_1 + L_2} = \frac{1}{(1+3)} = \frac{1}{4}$ **= 0.25 V**