LUMS
A Not-for-Profit University

Department of Electrical Engineering
School of Science and Engineering

EE240 Circuits I - Fall 2022

ASSIGNMENT 3

Due Date: 4:30pm, Monday. November 28, 2022
Format: 6 problems, for a total of 120 marks

(Assignment is to be submitted in class)

Instructions:

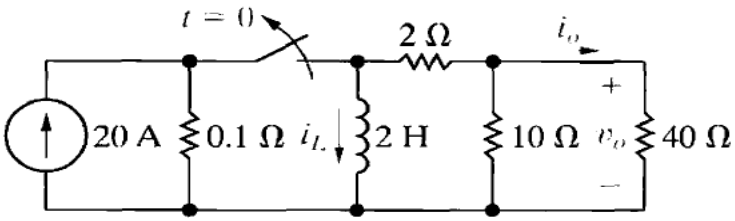
- You are allowed to collaborate with your peers but copying your colleague's solution is strictly prohibited. This is not a group assignment. Each student must submit his/her own assignment.
- Solve the assignment on blank A4 sheets and staple them before submitting.
- Submit in-class or in the drop box labelled EE-240 outside the instructor's office.
- Write your name and roll no. on the first page.
- Feel free to contact the instructor or the teaching assistants if you have any concerns.

Course Learning Outcomes Covered:

Formulate network equations based on the understanding of Kirchhoff's voltage and current laws.

Problem 1 [18 marks]: First Order Circuits (RL)

The switch in the circuit shown in the figure has been closed for a long time before its opened at time t = 0.



Find:

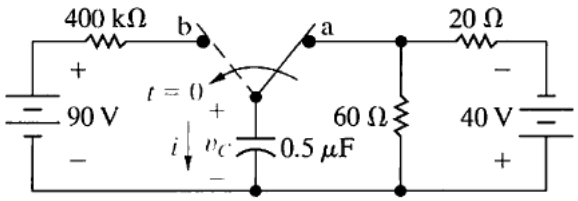
a) **[4 marks]** Current through the inductor i_L for t >= 0.

b) **[4 marks]** Current i_o for t >= 0^+.

c) **[4 marks]** Voltage v_o for t >= 0^+.

d) **[6 marks]** The percentage of total energy stored in the 2H inductor that is dissipated in the 10 Ω resistor.

Problem 2 [30 marks]: First Order RC Circuit Response



The switch in the circuit shown in Figure above has been in position a for a long time.
At *t* = 0 the switch is moved to position b.

a) **[5 marks]** What is the initial value of V_c?

b) **[3 marks]** What is the final value of V_c?

c) **[3 marks]** What is the time constant of the circuit when the switch is in position b?

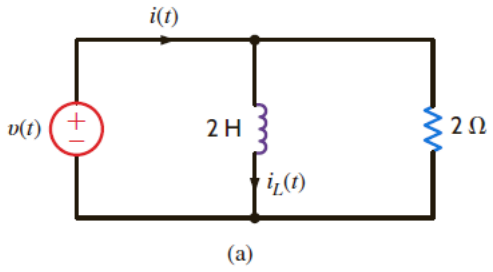
d) **[3 marks]** What is the expression for V_c (t) when t >= 0?

e) **[6 marks]** What is the expression for i(t) when t >= 0+?

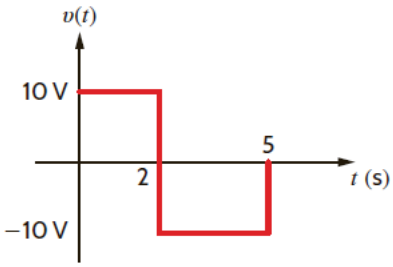
f) **[5 marks]** How long after the switch is in position b does the capacitor voltage equal zero?

g) **[5 marks]** Plot V_c (t) and i(t) versus t.

Problem 3 [17 marks]: Initial Conditions



(a)



(b)

The voltage V(t) shown in Fig. a is given by the graph shown in Fig. b. If $I_L(0) = 0$, answer the following questions:

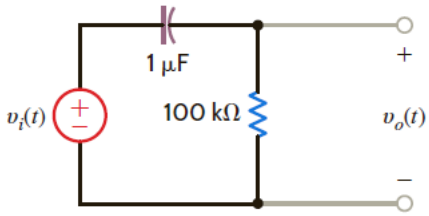
(a) [4 marks] How much energy is stored in the inductor at t = 3 s?

(b) [4 marks] How much power is supplied by the source at t = 4 s?

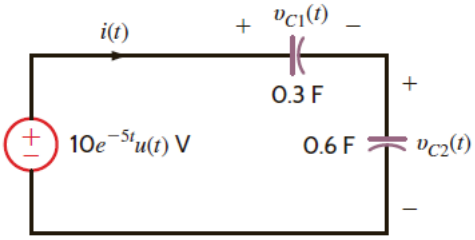
(c) [5 marks] What is i(t = 6 s)?

(d) [4 marks] How much power is absorbed by the inductor at t = 3 s?

Problem 4 [15 marks]: Initial conditions



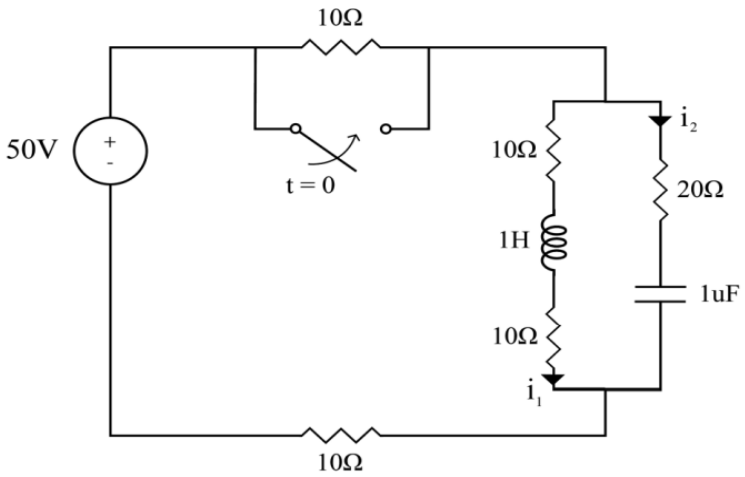
(a) **[7 marks]** Find the output voltage $\upsilon_o(t)$ in the network in Fig. above if the input voltage is $\upsilon_i(t) = 5(u(t) - u(t - 0.05))$ V.



(b) **[8 marks]** In the network in Fig. above, find $i(t)$ for $t > 0$. If $\upsilon_{C1}(0-) = -10$ V, calculate $\upsilon_{C2}(0-)$.

Problem 5 [20 marks]: Initial Conditions

In the fig. shown below, the switch is initially open and steady state is achieved. At time t=0, the switch is closed.



(a) **[5 marks]** Produce the first order differential equations that govern the circuit.

(b) **[3 marks]** Determine Vc (0-), the voltage across the capacitor before the switch is closed. Indicate its polarity.

(c) **[10 marks]** Calculate $i_1(0+)$, $i_2(0+)$, $di_1(0+)/dt$, and $di_2(0+)/dt$.

(d) **[2 mark]** Determine $di1(\infty)/dt$.

Problem 6 [20 marks]: First Order Circuits

For the circuit given below, find out $v(t)$ for all times $t > 0$ and also sketch its waveform.