Question 1 [10]

The current in a 20 mH inductor is

$$\begin{aligned} i &= 40 \text{ mA} , & t \leq 0 \\ i(t) &= (A_1 e^{-10000t} + A_2 e^{-40000t}) \text{ A} , & t \geq 0. \end{aligned}$$

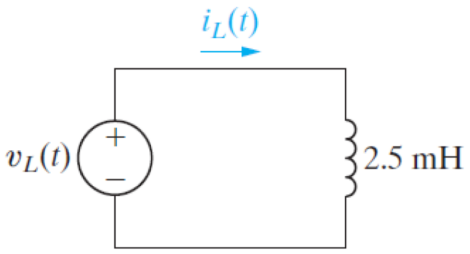
At $t = 0$, the voltage across the inductor is 28 V.

Find the expresion for the voltage across the inductor for $t > 0$.

Question 2 [10]

For $t < 0$, the current in the inductor is 1 A in the circuit below. The inductor voltage for $t > 0$ is given by,

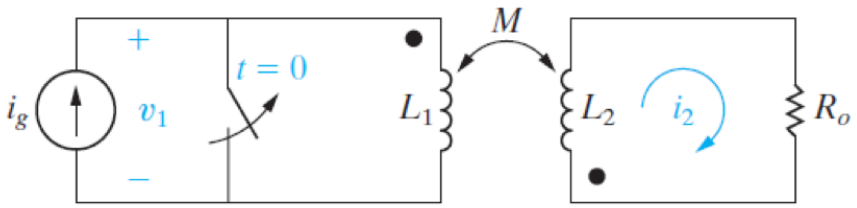
$$v_L(t) = 3e^{-4t} \text{ mV} , \qquad 0^+ \leq t \leq 2 \text{ s}$$
$$v_L(t) = -3e^{-4(t-2)} \text{ mV} , \qquad 2 \leq t < \infty \text{ s} .$$



Calculate the current $i_L(t)$ for the entire period $0 \leq t < \infty$ and sketch, **by hand**, both $v_L(t)$ and $i_L(t)$.

Question 3 [10]

At the moment the switch is opened in the circuit below, there is no energy stored in the inductor. $L_1 = 5\text{H}$, $L_2 = 0.2$ H, $M = 0.5$ H, and $R_o = 10\Omega$.

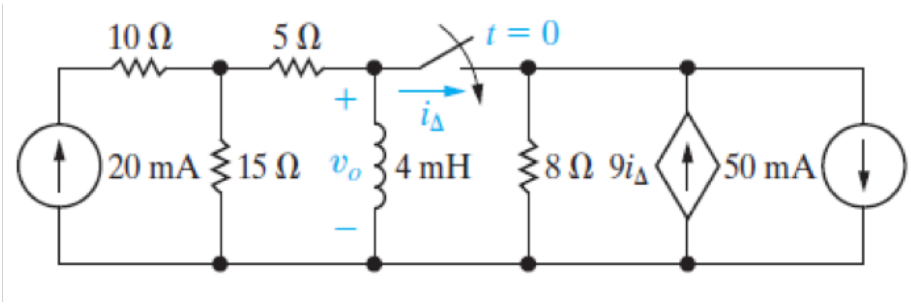


(i) Derive the differential equation that governs the behavior of i_2.

(ii) If, $i_g = (e^{-10t} - 10)$ A for $t \geq 0$ and $i_2(t) = (625e^{-10t} - 250e^{-50t})$ mA, what is the expression for the voltage, v_1, across the current source?

Question 4 [10]

For the following circuit:



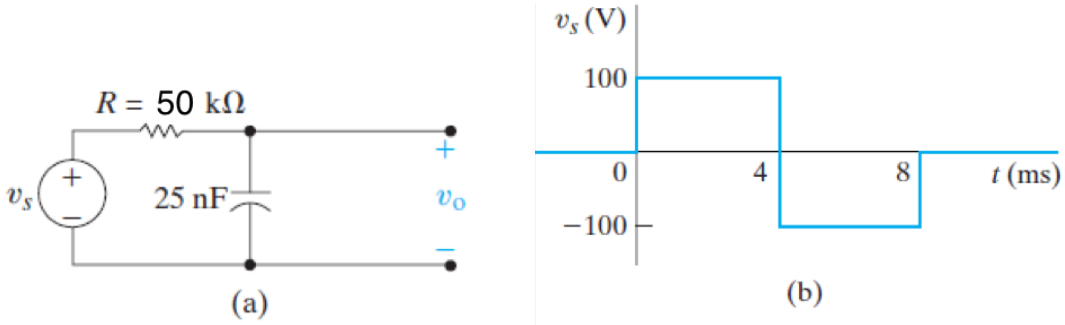
(i) Analyze the $t < 0$ circuit to find the initial current flowing through the inductor.

(ii) Analyze the $t = 0^+$ circuit. Perform a node analysis to arrive at an equation for the voltage across the 15Ω resistor in terms of v_o.

(iii) Similarly, perform a node analysis at the inductor node to arrive at an equation for i_Δ, and hence compute the initial voltage $v_o(0^+)$.

Question 5 [10]

The voltage source for the circuit in (a) is shown in (b). There is no energy stored in the capacitor for $t < 0$.



(i) Derive the three expressions for $v_o(t)$ for the three time intervals: $0 \leq t \leq 4$ ms, 4 ms $\leq t \leq 8$ ms, and $t \geq 8$ ms.

(ii) On the same figure, **draw by hand** v_o and v_s.