Data Mining
Assignment Solution 2

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1. Question 1 Solution

Download data set Iris and answer the following questions:

1.1 Section 1

Calculate the average value and standard deviation for each of the four features.

Average for Petal Width: 1.2
Variance for Petal Width: 0.58
Standard Deviation for Petal Width: 0.762

Average for Petal Length: 3.76
Variance for Petal Length: 3.09
Standard Deviation for Petal Length: 1.758

Average for Sepal Length: 5.84
Variance for Sepal Length: 0.68

Applying nodal method at the v_L node of circuit on Figure 1

$$I_0 = \frac{v_L}{R} + i_L \tag{1.1}$$

$$\dot{i_L}(t) + \frac{R}{L} i_L(t) = \frac{R}{L} I_0 \quad , t > 0 \tag{1.2}$$

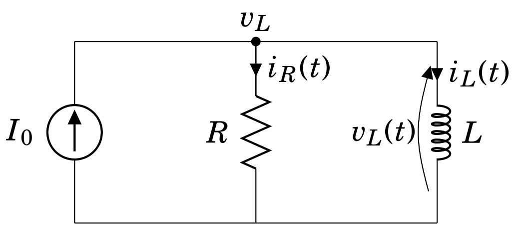


Figure 1: Electric Circuit

1.2 Section 2

Assuming circuit's steady state, yields constant[1] current, therefore

$$\textit{ZSR:} \quad \boxed{i_L = I_0} \tag{1.3}$$

Proof. Solving ZIR of the equation (1.2) :

$$i_{L,ZIR}(t) = A\exp(\frac{-t}{\tau}) \tag{1.4}$$

$$\lim_{t\to\infty} i_L(t) = \lim_{t\to\infty} \left(i_{L,ZIR} + i_{L,ZSR}\right) = i_{L,ZSR} = I_0$$

□

1.3 Section 3

Summarizing equation (1.3) with (1.4) and activating given initial condition $i_L(t = 0) = 2$ A results in final solution $i_L(t)$, where $\tau = \frac{L}{R}$:

$$\boxed{i_L(t) = I_0 + (2 - I_0)exp\left(\frac{-t}{\tau}\right) \quad ,t > 0}$$

Figure 2: Inductor Current with $I_0 = 1A$

2. Question 2 Solution

2.1 Section 1

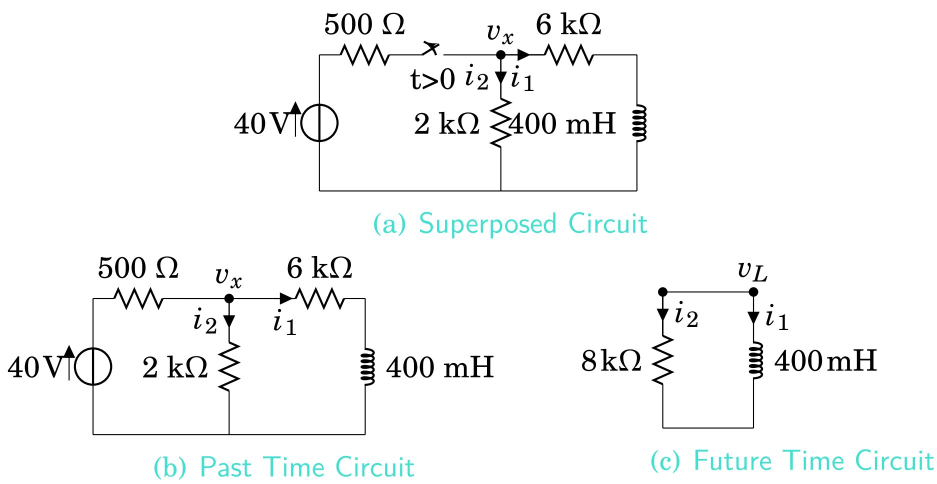
Consider the circuit on Figure 3b. Now[2] applying current divider technique one could easily calculate the following currents:

$$i_1 = \frac{40}{500 + 2k||6k} \cdot \frac{2k}{500 + 2k||6k}$$

$$i_2 = \frac{40}{500 + 2k||6k} \cdot \frac{6k}{500 + 2k||6k}$$

$$\boxed{i_1(0^-) = 20\,\text{mA} \qquad i_2(0^-) = 60\,\text{mA}}$$

[1] Resistor Shortened by Inductor
[2] Inductor is Short



(a) Superposed Circuit

(b) Past Time Circuit

(c) Future Time Circuit

Figure 3: Question 2 Circuit

2.2 Section 2

Assuming continuity in the inductor current $i_1(0^-) = i_1(0^+) = 20\,\text{mA}$ on Figure 3c, where $i_1 = -i_2$, thus, setting $i_1(0^+) = -i_2(0^+) = 20\,\text{mA}$ we get the currents

$$\boxed{i_1(0^+) = 20\,\text{mA} \qquad i_2(0^+) = -20\,\text{mA}}$$

2.3 Section 3

It's obvious, that circuits 3b and 3c are equivalent to the one on Figure 1 (Page 1) with $\tau = 50$ ms and $I_0 = V_0/R_{eq} = 20$ mA:

$$\boxed{\dot{i_L}(t) + \frac{R}{L} i_L(t) = \frac{R}{L} I_0 \quad , t > 0} \tag{2.5}$$

2.4 Section 4

Adopting ZIR[3] solution (1.4)

$$\boxed{i_1(t) = i_1(0^+)\exp\left(\frac{-t}{\tau}\right) \quad ,t>0}$$
$$\boxed{i_2(t) = -i_1(t)}$$

3. Question 3 Solution

3.1 Section 1

The voltage drop on the capacitor[4] on Figure 4b as follows

$$\boxed{v_C(0^-) = 15\text{ mA}\cdot 2.4\text{ k}\Omega = 36\text{ V}} \tag{3.6}$$

3.2 Section 2

Replacing capacitor with a test voltage, as shown on Figure 4c, allows input resistance calculation $R_{in} = \dfrac{v_t}{i_t}$

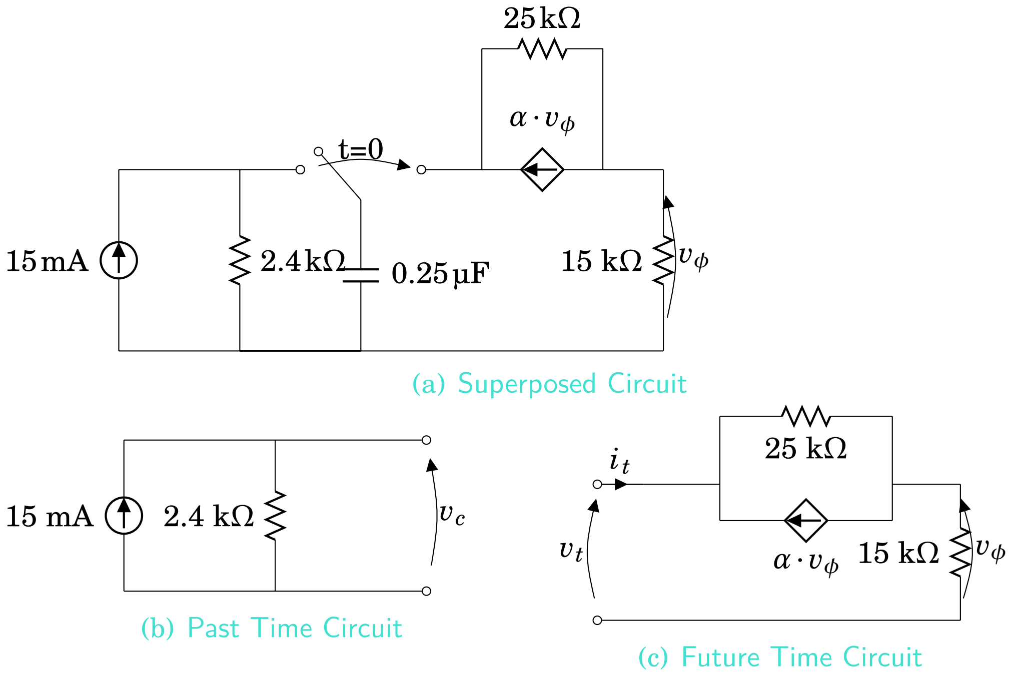
$$v_t - v_\phi = 25k\alpha\cdot v_\phi$$
$$v_t = (1+25k\alpha)\cdot v_\phi = 15k(1+25k\alpha)\cdot i_t$$
$$\boxed{R_{in}(C) = 15k(1+25k\alpha)} \tag{3.7}$$

3.3 Section 3

Given circuit's time constant $\tau = R\cdot C = 25$ ms requires resistor $R = 100$ kΩ. Setting into (3.7) leads to the value of α-parameter

$$\boxed{\alpha \approx 2.26\cdot 10^{-4}}$$

[3]Since, there is no source in the circuit
[4]Open-Circuited Capacitor



(a) Superposed Circuit

(b) Past Time Circuit

(c) Future Time Circuit

Figure 4: Question 3 Circuit

3.4 Section 4

As before[5] using ZIR solution (1.4) adapted for voltages, where τ = 25 ms and initial condition of the capacitor[6] $v_C(0^-) = v_C(0^+) = 36$ V

$$\begin{cases} v_C(t) = v_C(0^+)\exp\left(\frac{-t}{\tau}\right) & ,t \geqslant 0 \\ v_C(t) = v_C(0^-) & ,t < 0 \end{cases}$$

[5]Due to circuits analogy
[6]Continuity in voltage drop