LAHORE UNIVERSITY OF MANAGEMENT SCIENCES
Department of Electrical Engineering

EE240 Circuits I
Quiz 04 Solutions

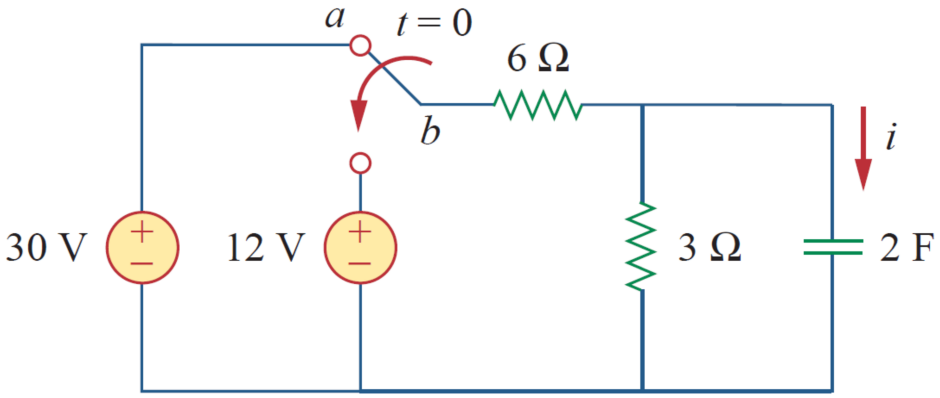
Name: _____

Campus ID: _____

Total Marks: 10
Time Duration: 20 minutes

Question 1 (10 marks)

In a first-order circuit given below, the switch is operated from position a to position b at $t = 0$.



(a) [1 mark] Determine the voltage across capacitor at $t = 0^-$.

Solution:

$$v_c(0^-) = 30\frac{3}{9} = 10\,V$$

(b) [2 marks] Determine $i(t)$ at $t = 0^+$.

Solution: For $t \geq 0$, $v_c(t)$ and $i(t)$ are related by $v_c(t) = \frac{1}{2}\int i dt$. Applying KCL yields

$$\frac{v_c}{3} + \frac{v_c - 12}{6} + i = 0 \quad \Rightarrow \quad \frac{v_c}{2} - 2 + i = 0.$$

We can evaluate this this at $t = 0$ to obtain $i(0^+) = 2 - 5 = -3\,A$.

(c) [2 marks] Write down the differential equation, in terms of $i(t)$, describing the circuit after the switch is operated, that is, for $t \geq 0$.

Solution: Using the equation formulated in part(b), we obtain

$$\frac{1}{4}\int i dt + i = 2. \quad \Rightarrow \quad \frac{di}{dt} + \frac{i}{4} = 0$$

(d) [1 mark] Determine $i(t)$ at $t = \infty$.

Solution:

$$i(0^+) = 0\,A$$

(e) [3 marks] Determine $i(t)$ for all values of t and plot (and label) it.

Solution: $i(t) = 0$ for $t < 0$. Using differential equation formulation, we determine

$$i(t) = Ke^{-t/4},$$

where $K = -3$ using the initial conditions.

Alternatively, we can start with the following solution:

$$i(t) = K_1 + K_2 e^{-t/\tau}.$$

We can find $K_1 = 0$ and $K_2 = -3$ using initial and final conditions and $\tau = R_{\text{eq}}C = 4\,s$, where $R_{\text{eq}} = 6||3 = 2\,\Omega$.

(f) [1 mark] On the plot that is obtained in part (e), superimpose plot of $i(t)$ for if 2 F capacitor is replaced with 1 F capacitor.

Solution: For $C = 1F$, time constant is halved and therefore the current decays to zero relatively faster.