SOLUTIONS:

P 7.2-7 The voltage across a 40-$\mu$F capacitor is 25 V at $t_0 = 0$. If the current through the capacitor as a function of time is given by $i(t) = 6e^{-6t}$ mA for $t < 0$, find $v(t)$ for $t > 0$.

Answer: $v(t) = 50 - 25e^{-6t}$ V

Solution:

$$v(t) = v(0) + \frac{1}{C}\int_0^t i(\tau)d\tau = 25 + 2.5 \times 10^3 \int_0^t (6 \times 10^{-3})e^{-6\tau} d\tau$$

$$= 25 + 150\int_0^t e^{-6\tau} d\tau$$

$$= 25 + 150\left[ -\frac{1}{6}e^{-6\tau} \right]_0^t = \frac{50 - 25e^{-6t}}{V}$$
P7.4-5  Determine the value of the capacitance \( C \) in the circuit shown in Figure P 7.4-5, given that \( C_{eq} = 8 \) F.

*Answer:* \( C = 20 \) F

![Circuit Diagram](image)

**Figure P 7.4-5**

**Solution:** The 16 F capacitor is in series with a parallel combination of 4 F and 12 F capacitors. The capacitance of the equivalent capacitor is

\[
\frac{16(4+12)}{16+(4+12)} = 8 \text{ F}
\]

The 30 F capacitor is in parallel with a short circuit, which is equivalent to a short circuit. After making these simplifications, we have

\![Circuit Diagram](image)

Then

\[
8 = C_{eq} = \frac{10(12 + C + 8)}{10 + (12 + C + 8)} \Rightarrow C = 20 \text{ F}
\]
P7.5-19. The input to the circuit shown in Figure P7.5-19 is the current
\[ i(t) = 5 + 2e^{-7t} \text{ A for } t > 0 \]
The output is the voltage:
\[ v(t) = 75 - 82e^{-7t} \text{ V for } t > 0 \]
Determine the values of the resistance and inductance.

Solution:
\[ v(t) = 75 - 82e^{-7t} = R\left(5 + 2e^{-7t}\right) + L \frac{d}{dt}\left(5 + 2e^{-7t}\right) \]
\[ = R\left(5 + 2e^{-7t}\right) + L\left((-7)2e^{-7t}\right) = 5R + (2R - 14L)e^{-7t} \]
Equating coefficients gives
\[ 75 = 5R \quad \Rightarrow \quad R = 15 \text{ } \Omega \quad \text{and} \]
and
\[ -82 = 2R - 14L = 30 - 14L \quad \Rightarrow \quad L = \frac{82 + 30}{14} = 8 \text{ } H \]
P 7.7-5  Determine the value of the inductance $L$ in the circuit shown in Figure P 7.7-5, given that $L_{eq} = 18$ H.

*Answer:* $L = 20$ H

![Figure P 7.7-5](image)

**Solution:** The 25 H inductor is in series with a parallel combination of 20 H and 60 H inductors. The inductance of the equivalent inductor is

$$25 + \frac{60 \times 20}{60 + 20} = 40 \text{ H}$$

The 30 H inductor is in parallel with a short circuit, which is equivalent to a short circuit. After making these simplifications, we have

![Diagram](image)

Then

$$18 = L_{eq} = 10 + \frac{1}{\frac{1}{20} + \frac{1}{L} + \frac{1}{40}} \quad \Rightarrow \quad \frac{1}{20} + \frac{1}{L} + \frac{1}{40} = \frac{1}{8} \quad \Rightarrow \quad L = 20 \text{ H}$$
P7.8-6. The switch in the circuit shown in Figure P7.8-6 has been open for a long time before it closes at time $t = 0$. Determine the values of $v_{L}(0-)$, the voltage across the inductor immediately before the switch closes and $v_{L}(0+)$, the voltage across the inductor immediately after the switch closes.

**Solution:**
The circuit is at steady state immediately before the switch closes. We have

\[ i_{L}(0) \]

The inductor acts like a short circuit so $v_{L}(0-) = 0$.

The inductor current is the negative of the current source current:

\[ i_{L}(0) = -120 \text{ mA} \]

The inductor current does not change instantaneously so $i_{L}(0+) = i_{L}(0-) \approx i_{L}(0)$. Immediately after the switch closes we have:

\[ i_{L}(0) \]

Applying KVL to the left mesh gives:

\[ v_{L}(0+) + 20i_{L}(0) = 0 \]

\[ v_{L}(0+) + 20(-0.12) = 0 \]

\[ v_{L}(0+) = 2.4 \]
P7.8-7. The switch in the circuit shown in Figure P7.8-7 has been closed for a long time before it opens at time $t = 0$. Determine the values of $i_C(0-)$, the current in the capacitor immediately before the switch opens and $i_C(0+)$, the current in the capacitor immediately after the switch opens.

**Solution:**
The circuit is at steady state immediately before the switch opens. We have

The capacitor acts like an open circuit so $i_C(0-) = 0$.

The capacitor voltage is equal to the voltage source voltage:

$$v_C(0) = 20 \text{ V}$$

The capacitor does not change instantaneously so $v_C(0+) = v_C(0-) \triangleq v_C(0)$. Immediately after the switch opens we have:

Applying KCL at the top node of the capacitor, we see that:

$$i_C(0+) + \frac{v_C(0)}{20} = 0$$

$$i_C(0+) = -\frac{v_C(0)}{20} = -1 \text{ A}$$