ECE241
HW #4
SOLUTION

1) P 5.2-2
2) P 5.2-7
3) P 5.3-7
4) P 5.4-3
5) P 5.5-3
6) P 5.6-3

SOLUTION:

P 5.2-2 Consider the circuit of Figure P 5.2-2. Find \( i_a \) by simplifying the circuit (using source transformations) to a single-loop circuit so that you need to write only one KVL equation to find \( i_a \).

Solution:

Finally, apply KVL: 
\[-10 + 3i_a + 4i_a - \frac{16}{3} = 0 \quad \therefore \quad i_a = 2.19 \, \text{A}\]
The equivalent circuit in Figure P5.2-7 is obtained from the original circuit using source transformations and equivalent resistances. (The lower case letters $a$ and $b$ identify the nodes of the capacitor in both the original and equivalent circuits.) Determine the values of $R_a$, $V_a$, $R_b$ and $I_b$ in the equivalent circuit.

Solution

Performing a source transformation at each end of the circuit yields

where

$V_a = 2.2(10) - 32 = -10 \, \text{V}$, $R_a = 18 + 10 = 28 \, \Omega$, $R_b = 18 || 9 = 6 \, \Omega$ and $I_b = 2.5 + \frac{36}{18} = 4.5 \, \text{A}$
P5.3-7 Determine $v(t)$, the voltage across the 40 $\Omega$ resistor in the circuit in Figure P5.3-7.

Solution:
We’ll use superposition. Let $v_1(t)$ be the part of $v(t)$ due to the voltage source acting alone. Similarly, let $v_2(t)$ be the part of $v(t)$ due to the voltage source acting alone. We can use these circuits to calculate $v_1(t)$ and $v_2(t)$.

Using voltage division we calculate
$$v_1(t) = \frac{40}{10+40}(12+15\cos(8t)) = -9.6-12\cos(8t)$$

Using equivalent resistance we first determine $10||40 = 8\,\Omega$ and then calculate
$$v_2(t) = 8(1+\sin(5t)) = 8+8\sin(5t)$$

Using superposition
$$v(t) = v_1(t) + v_2(t) = -1.6+8\sin(5t)-12\cos(8t)\,\text{ V}$$
P 5.4-3  The circuit shown in Figure P 5.4-3b is the Thévenin equivalent circuit of the circuit shown in Figure P 5.4-3a. Find the value of the open-circuit voltage, $v_{oc}$, and Thévenin resistance, $R_t$.

*Answer:* $v_{oc} = 2 \text{ V}$ and $R_t = 4 \text{ } \Omega$

![Figure P 5.4-3](image)

**Solution:**

The circuit from Figure P5.4-3a can be reduced to its Thévenin equivalent circuit in five steps:

1. ![Step 1](image)
2. ![Step 2](image)
3. ![Step 3](image)
4. ![Step 4](image)
5. ![Step 5](image)

Comparing (e) to Figure P5.4-3b shows that the Thévenin resistance is $R_t = 4 \text{ } \Omega$ and the open circuit voltage, $v_{oc} = 2 \text{ V}$.
P5.5-3 The circuit shown in Figure P5.5-3a can be reduced to the circuit shown in Figure P5.5-3b using source transformations and equivalent resistances. Determine the values of the source current \(i_s\) and the resistance \(R\).

Solution:

\[
48 = R_s = R || (80 + 160) = \frac{240R}{R + 240} \implies R = 60 \, \Omega
\]

\[
i_s = \frac{80}{80 + 160} \cdot (4.8) = 1.6 \, \text{A}
\]

P 5.6-3 For the circuit in Figure P 5.6-3, prove that for \(R_s\) variable and \(R_L\) fixed, the power dissipated in \(R_L\) is maximum when \(R_s = 0\).

Solution:
Reduce the circuit using source transformations:

Then (a) maximum power will be dissipated in resistor \(R\) when: \(R = R_s = 60 \, \Omega\) and (b) the value of that maximum power is

\[
P_{\text{max}} = i_s^2(R) = (0.03)^2(60) = 54 \, \text{mW}
\]