**ECE241**
**HW #4**
**SOLUTION**

Problems from "Introduction to Electric Circuits", Svoboda and Dorf, 9th ed. Pages 204-213.

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 $i_a$.

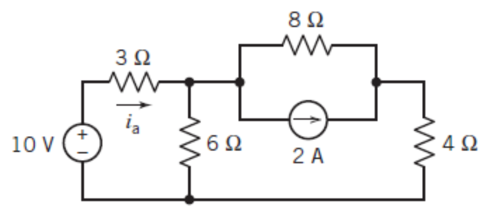
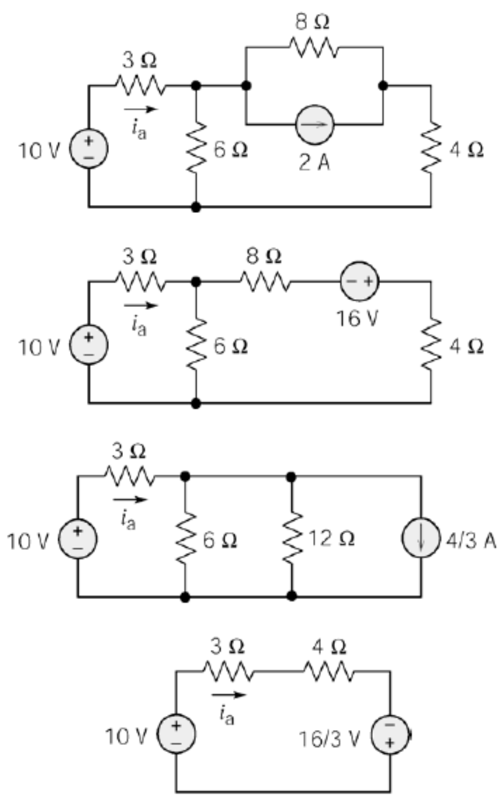



**Figure P 5.2-2**

**Solution:**




Finally, apply KVL: $-10+3\,i_a+4\,i_a-\dfrac{16}{3}=0 \quad \therefore\ \underline{i_a = 2.19\text{ A}}$

**P5.2-7**

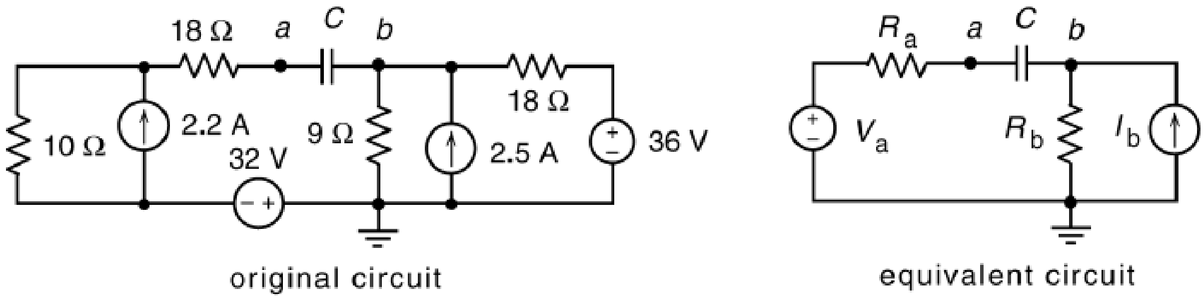
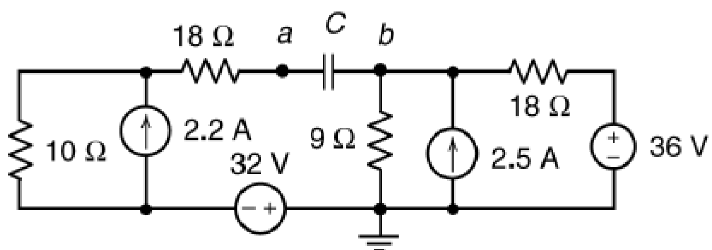


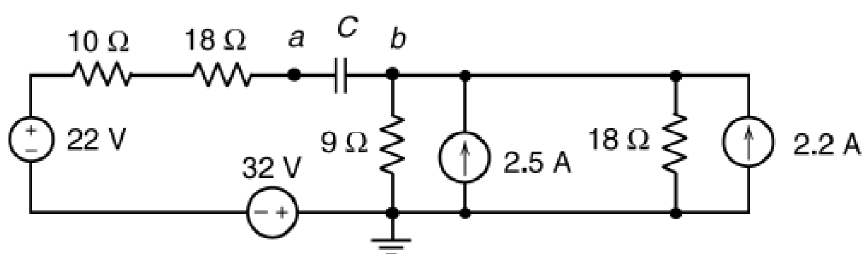

**Figure P5.2-7**

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.

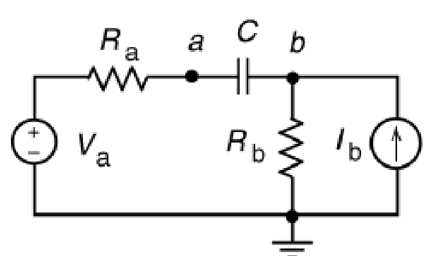
**Solution**




Performing a source transformation at each end of the circuit yields




Thenx




where

$V_a = 2.2(10) - 32 = -10$ V, $R_a = 18 + 10 = 28\ \Omega$, $R_b = 18 \,||\, 9 = 6\ \Omega$ and $I_b = 2.5 + \dfrac{36}{18} = 4.5$ A

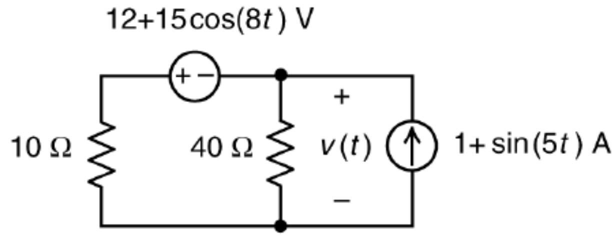
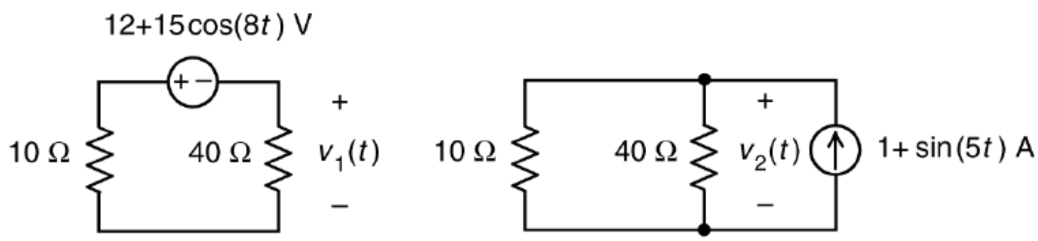



**Figure P5.3-7**

**P5.3-7** Determine $v(t)$, the voltage across the 40 Ω resistor in the circuit in Figure P5.3-7.

**Solution:**
We'll use superposition. Let $v_1(t)$ the be the part of $v(t)$ due to the voltage source acting alone. Similarly, let $v_2(t)$ the 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

$$v_1(t) = -\frac{40}{10+40}\left(12+15\cos(8t)\right) = -9.6 - 12\cos(8t)$$

Using equivalent resistance we first determine 10||40 = 8 Ω and then calculate

$$v_2(t) = 8\left(1+\sin(5t)\right) = 8 + 8\sin(5t)$$

Using superposition $\quad v(t) = v_1(t) + v_2(t) = -1.6 + 8\sin(5t) - 12\cos(8t)\ \text{V}$

**P 5.4-3** The circuit shown in Figure P 5.4-3*b* is the Thévenin equivalent circuit of the circuit shown in Figure P 5.4-3*a*. Find the value of the open-circuit voltage, $v_{oc}$, and Thévenin resistance, $R_t$.

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

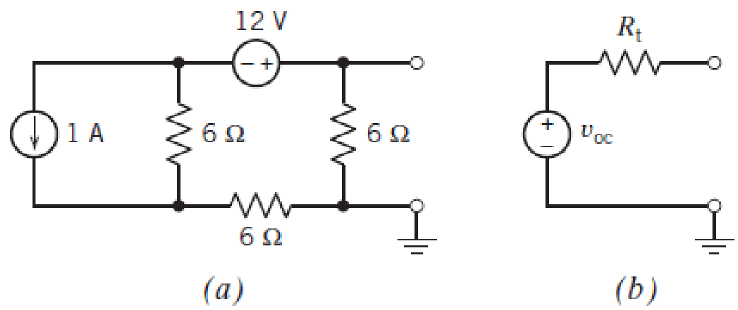
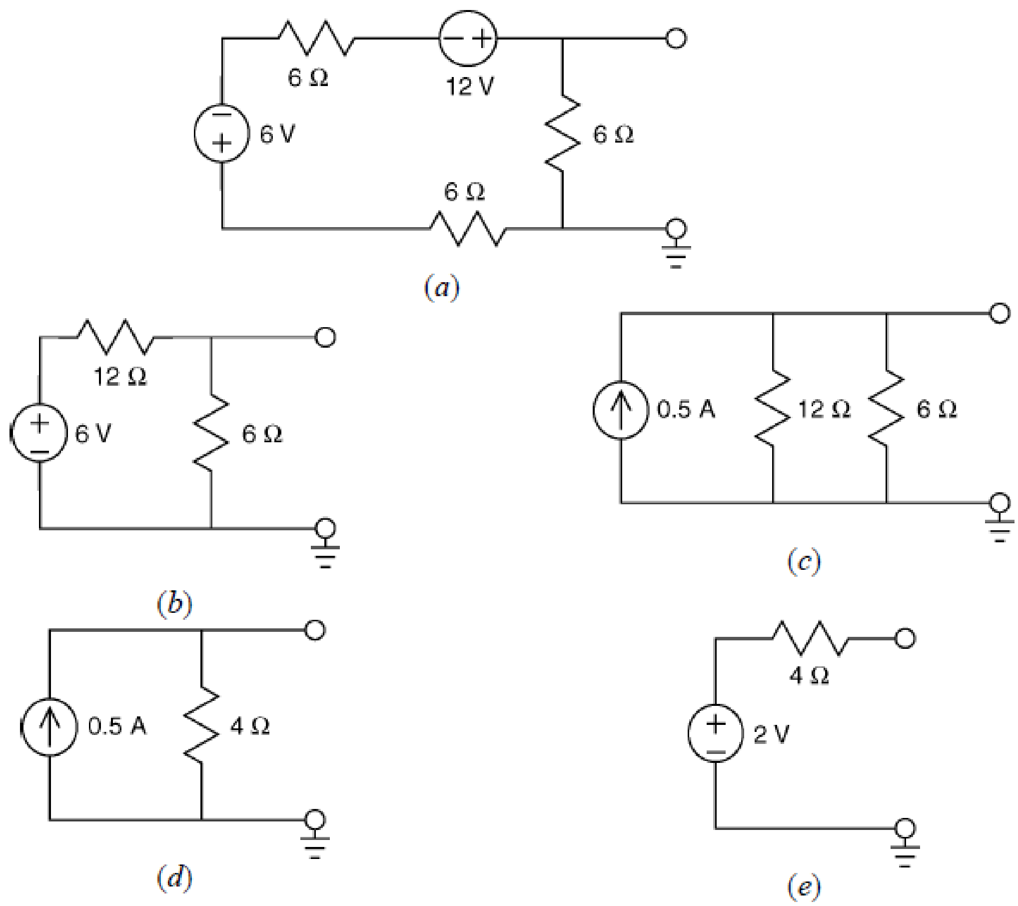



**Figure P 5.4-3**

**Solution:**

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




Comparing (*e*) to Figure P5.4-3*b* shows that the Thevenin resistance is $R_t = 4\ \Omega$ and the open circuit voltage, $v_{oc} = 2$ V.

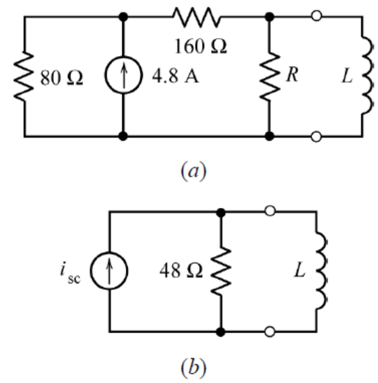



**Figure P5.5-3**

**P5.5-3** The circuit shown in Figure P5.5-3*a* can be reduced to the circuit shown in Figure P5.5-3*b* using source transformations and equivalent resistances. Determine the values of the source current $i_{sc}$ and the resistance $R$.

**Solution:**


$$48 = R_t = R \,||\, (80+160) = \frac{240\,R}{R+240} \quad \Rightarrow \quad R = 60\ \Omega$$

$$i_{sc} = \frac{80}{80+160}(4.8) = 1.6\ \text{A}$$

**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 $R_s = 0$.

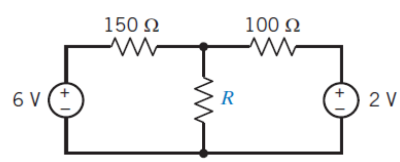
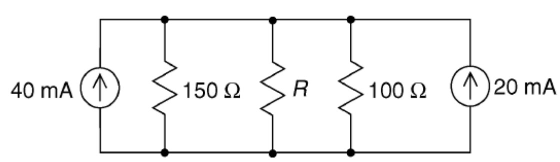
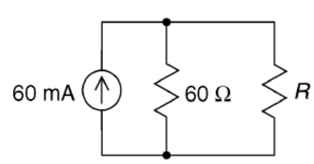



**Figure P 5.6-3**

**Solution:**
Reduce the circuit using source transformations:




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

$$P_{max} = i_R^2(R) = (0.03)^2(60) = \underline{54\ \text{mW}}$$