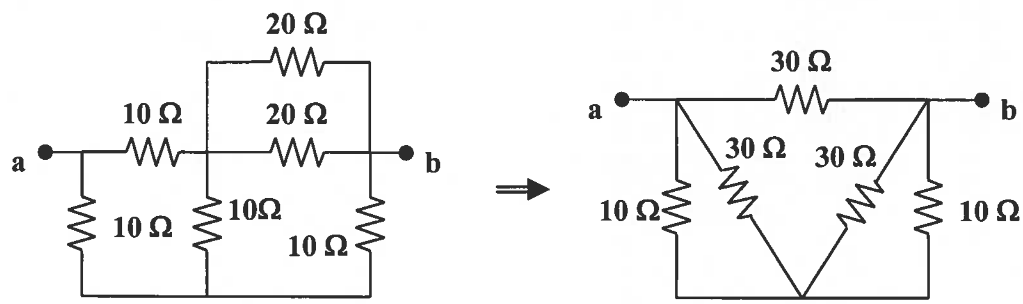
**Chapter 4, Solution 42.**

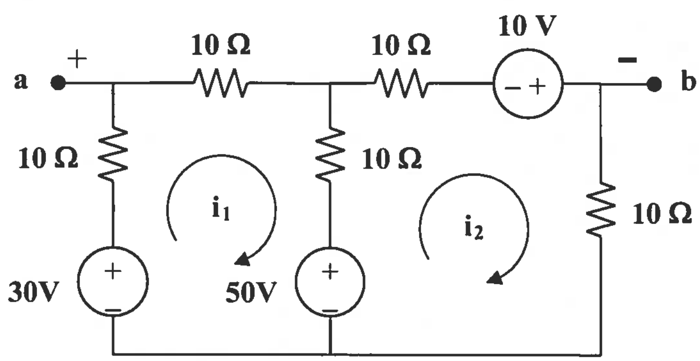
To find $R_{Th}$, consider the circuit in Fig. (a).




(a) (b)

$20||20 = 10$ ohms. Transform the wye sub-network to a delta as shown in Fig. (b).
$10||30 = 7.5$ ohms. $R_{Th} = R_{ab} = 30||(7.5 + 7.5) =$ **10 ohms.**

To find $V_{Th}$, we transform the 20-V (to a current source in parallel with the 20 Ω resistor and then back into a voltage source in series with the parallel combination of the two 20 Ω resistors) and the 5-A sources. We obtain the circuit shown in Fig. (c).




(c)

For loop 1, $-30 + 50 + 30i_1 - 10i_2 = 0$, or $-2 = 3i_1 - i_2$ (1)

For loop 2, $-50 - 10 + 30i_2 - 10i_1 = 0$, or $6 = -i_1 + 3i_2$ (2)

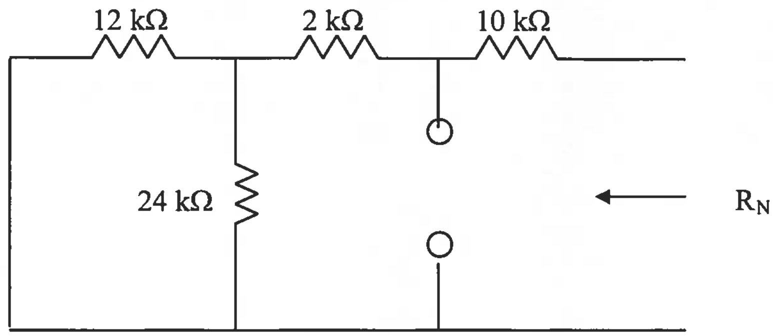
Solving (1) and (2), $i_1 = 0$, $i_2 = 2$ A

Applying KVL to the output loop, $-v_{ab} - 10i_1 + 30 - 10i_2 = 0$, $v_{ab} = 10$ V

$V_{Th} = v_{ab} =$ **10 volts**

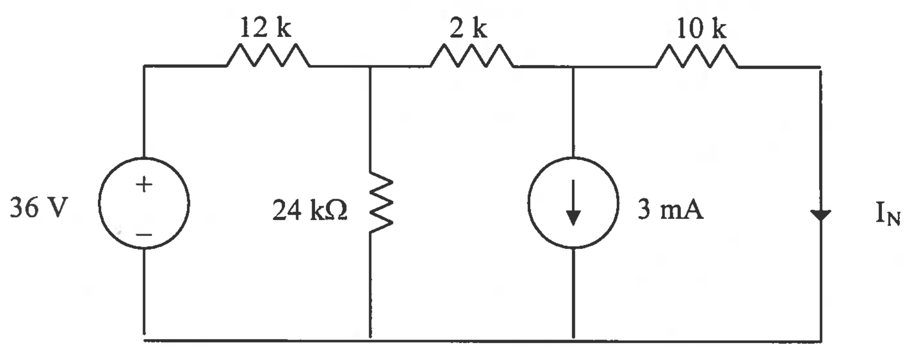
**Chapter 4, Solution 56.**

We remove the 1-kΩ resistor temporarily and find Norton equivalent across its terminals. $R_{eq}$ is obtained from the circuit below.

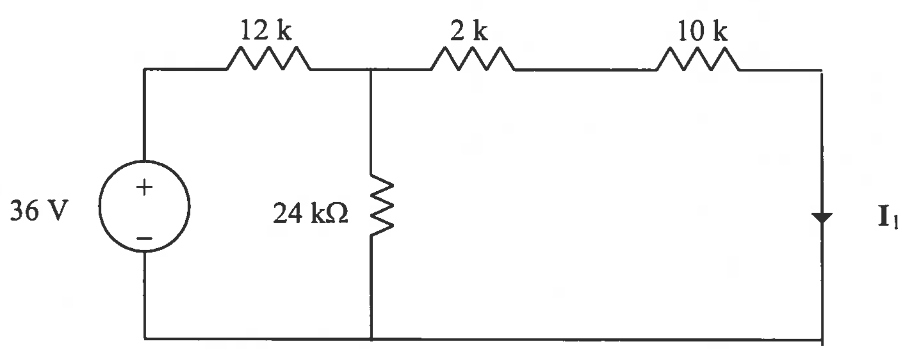



$R_{eq} = 10 + 2 + (12//24) = 12+8 = 20$ kΩ

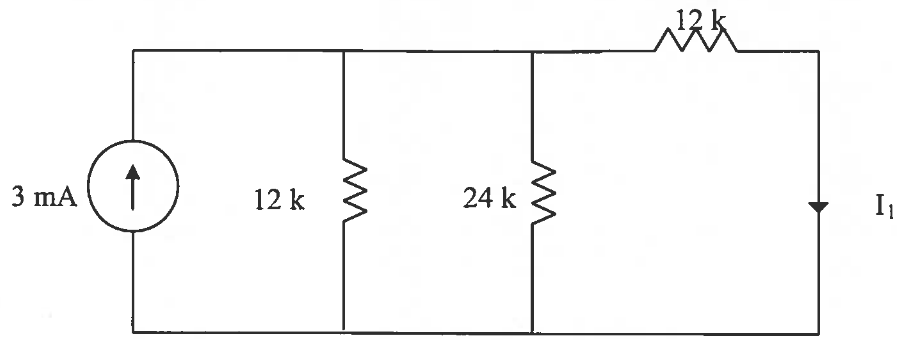
$I_N$ is obtained from the circuit below.




We can use superposition theorem to find $I_N$. Let $I_N = I_1 + I_2$, where $I_1$ and $I_2$ are due to 16-V and 3-mA sources respectively. We find $I_1$ using the circuit below.



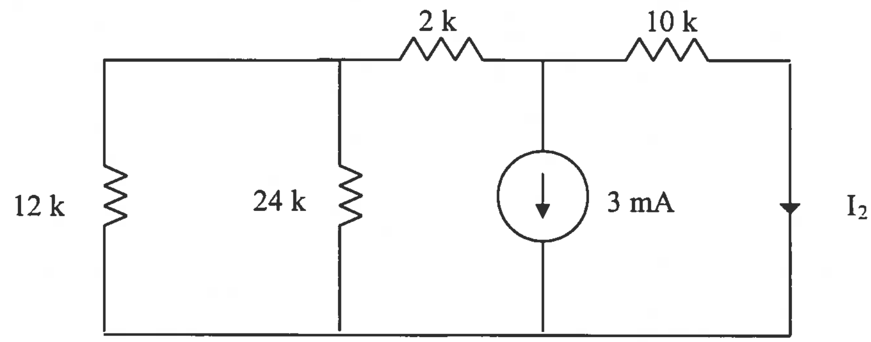
Using source transformation, we obtain the circuit below.




12//24 = 8 kΩ

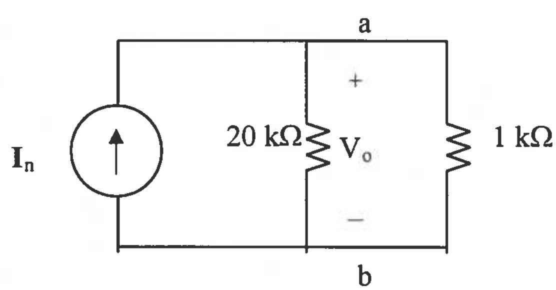
$$I_1 = \frac{8}{8+12}(3mA) = 1.2\ mA$$

To find $I_2$, consider the circuit below.




2k + 12k//24 k = 10 kΩ
$I_2$=0.5(-3mA) = -1.5 mA
$I_N$ = 1.2 –1.5 = -0.3 mA

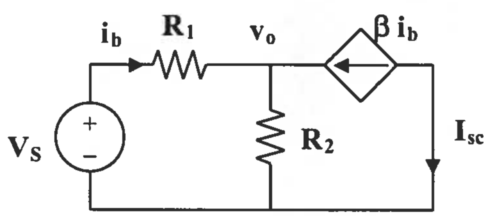
The Norton equivalent with the 1-kΩ resistor is shown below




$V_o$ = 1k(20/(20+1))(-0.3 mA) = **-285.7 mV**.

**Chapter 4, Solution 58.**

This problem does not have a solution as it was originally stated. The reason for this is that the load resistor is in series with a current source which means that the only equivalent circuit that will work will be a Norton circuit where the value of $R_N$ = **infinity**. $I_N$ can be found by solving for $I_{sc}$.




Writing the node equation at node vo,

$$i_b + \beta i_b = v_o/R_2 = (1 + \beta)i_b$$

But

$$i_b = (V_s - v_o)/R_1$$

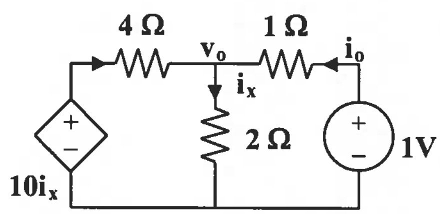
$$v_o = V_s - i_b R_1$$

$$V_s - i_b R_1 = (1 + \beta)R_2 i_b, \text{ or } i_b = V_s/(R_1 + (1 + \beta)R_2)$$

$$I_{sc} = I_N = -\beta i_b = \mathbf{-\beta V_s/(R_1 + (1 + \beta)R_2)}$$

**Chapter 4, Solution 64.**

With no independent sources, $V_{Th} = \mathbf{0\ V}$. To obtain $R_{Th}$, consider the circuit shown below.




$$i_x = [(1 - v_o)/1] + [(10i_x - v_o)/4], \text{ or } 5v_o = 4 + 6i_x \qquad (1)$$

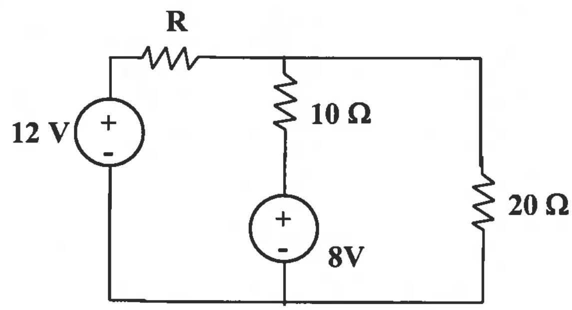
But $i_x = v_o/2$. Hence,

$$5v_o = 4 + 3v_o, \text{ or } v_o = 2, \; i_o = (1 - v_o)/1 = -1$$

$$\text{Thus, } R_{Th} = 1/i_o = \mathbf{-1\ ohm}$$

**Chapter 4, Solution 68.**

This is a challenging problem in that the load is already specified. This now becomes a "minimize losses" style problem. When a load is specified and internal losses can be adjusted, then the objective becomes, reduce $R_{Thev}$ as much as possible, which will result in maximum power transfer to the load.




Removing the 10 ohm resistor and solving for the Thevenin Circuit results in:

$$R_{Th} = (Rx20/(R+20)) \text{ and a } V_{oc} = V_{Th} = 12x(20/(R+20)) + (-8)$$

As R goes to zero, $R_{Th}$ goes to zero and $V_{Th}$ goes to 4 volts, which produces the maximum power delivered to the 10-ohm resistor.

$$P = vi = v^2/R = 4x4/10 = 1.6 \text{ watts}$$

Notice that if R = 20 ohms which gives an $R_{Th}$ = 10 ohms, then $V_{Th}$ becomes -2 volts and the power delivered to the load becomes 0.1 watts, much less that the 1.6 watts.

It is also interesting to note that the internal losses for the first case are $12^2/20 = 7.2$ watts and for the second case are = to 12 watts. This is a significant difference.