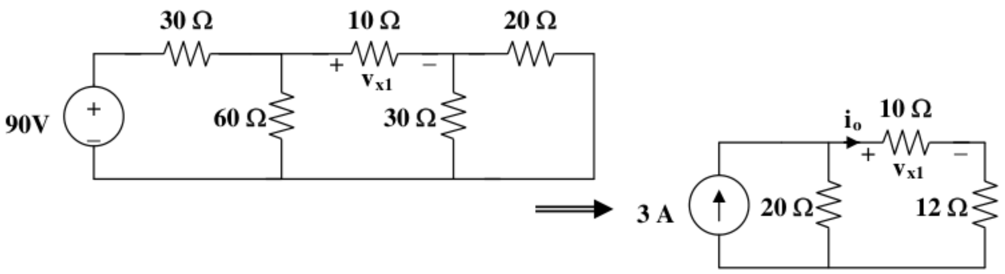
Problem 1:

Let $v_x = v_{x1} + v_{x2} + v_{x3}$, where v_{x1}, v_{x2}, and v_{x3} are due to the 90-V, 6-A, and 40-V sources. For v_{x1}, consider the circuit below.

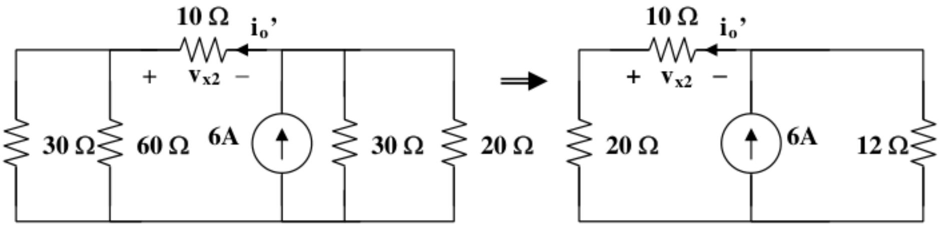


$$20\|30 = 12 \text{ ohms}, \quad 60\|30 = 20 \text{ ohms}$$

By using current division,

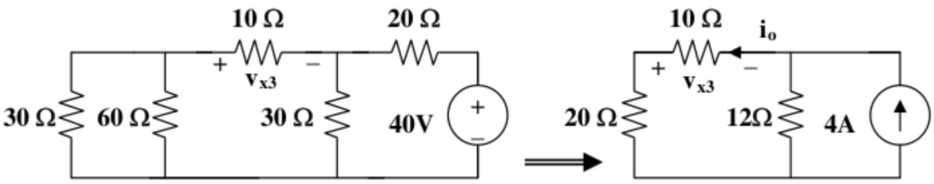
$$i_o = [20/(22 + 20)]3 = 60/42, \quad v_{x1} = 10i_o = 600/42 = 14.286 \text{ V}$$

For v_{x2}, consider the circuit below.



$$i_o' = [12/(12 + 30)]6 = 72/42, \quad v_{x2} = -10i_o' = -17.143 \text{ V}$$

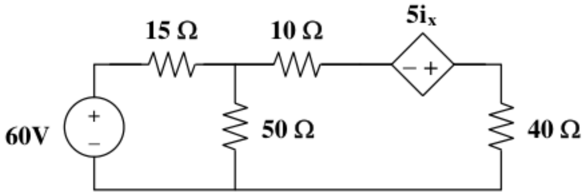
For v_{x3}, consider the circuit below.



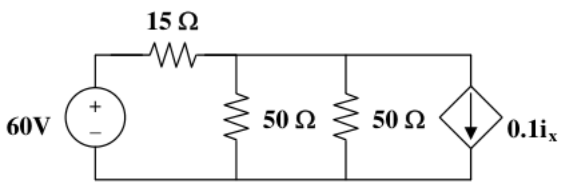
$$i_o'' = [12/(12 + 30)]2 = 24/42, \quad v_{x3} = -10i_o'' = -5.714 = [12/(12 + 30)]2 = 24/42,$$
$$v_{x3} = -10i_o'' = -5.714$$
$$= [12/(12 + 30)]2 = 24/42, \quad v_{x3} = -10i_o'' = -5.714$$
$$v_x = 14.286 - 17.143 - 5.714 = \mathbf{-8.571 \text{ V}}$$

Problem 2:

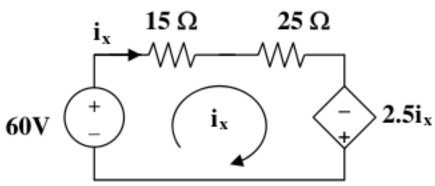
As shown in Fig. (a), we transform the dependent current source to a voltage source,



(a)



(b)



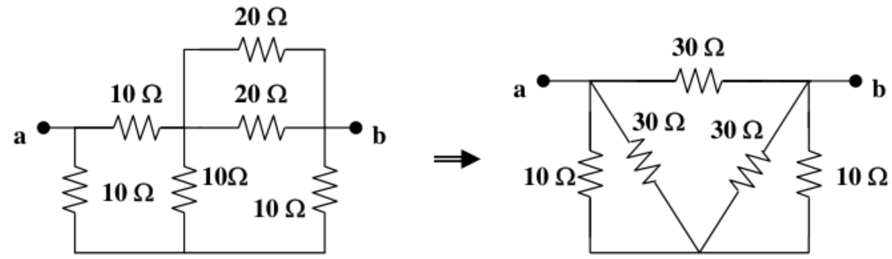
(c)

In Fig. (b), $50||50 = 25$ ohms. Applying KVL in Fig. (c),

$-60 + 40i_x - 2.5i_x = 0$, or $i_x =$ **1.6 A**

Problem3:

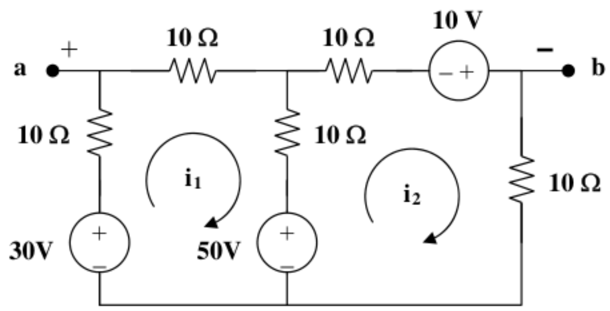
To find R_{Th}, consider the circuit in Fig. (a).



(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)

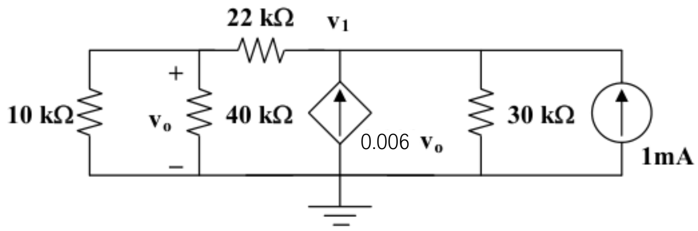
Solving (1) and (2), $i_1 = 0$, $i_2 = 2$ A

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

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

Problem4:

We need the Thevenin equivalent across the resistor R. To find R_{Th}, consider the circuit below.



Assume that all resistances are in k ohms and all currents are in mA.

$$10\|40 = 8, \text{ and } 8 + 22 = 30$$

$$1 + 6\,v_o = (v_1/30) + (v_1/30) = (v_1/15)$$

$$15 + 90\,v_o = v_1$$

But $v_o = (8/30)v_1$, hence,

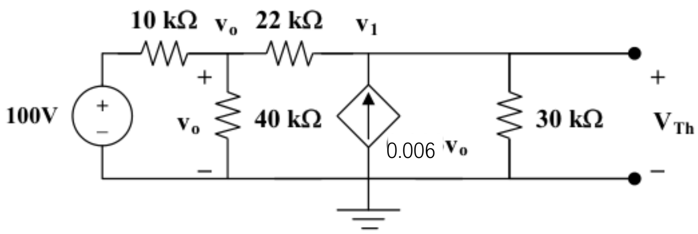
$$15 + 90\,x(8v_1/30)\;\; v_1, \text{ which leads to } v_1 = -0.65217$$

$$R_{Th} = v_1/1 = -\;652.17 \quad \text{ohms}$$

R_{Th} being negative indicates an active circuit and if you now make R equal to ~~1.3636 k~~ 652.17 ohms, then the active circuit will actually try to supply infinite power to the resistor. The correct answer is therefore:

$$p_R = \left(\frac{V_{Th}}{-\;652.17 + 652.17}\right)^2 652.17 = \left(\frac{V_{Th}}{0}\right)^2 652.17 = \infty$$

It may still be instructive to find V_{Th}. Consider the circuit below.



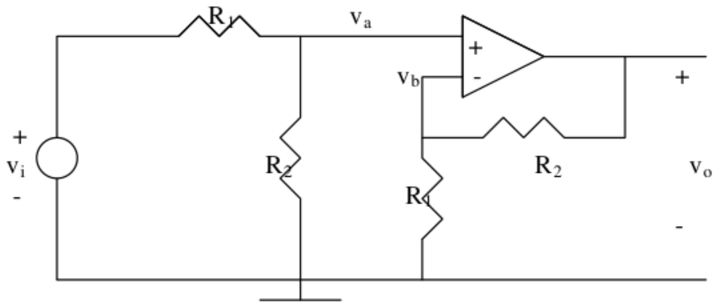
$$(100 - v_o)/10 = (v_o/40) + (v_o - v_1)/22 \qquad (1)$$

$$[(v_o - v_1)/22] + 6\,v_o = (v_1/30) \qquad (2)$$

Solving (1) and (2),

$$v_1 = V_{Th} = -\;231.30\text{volts}$$

Problem5:



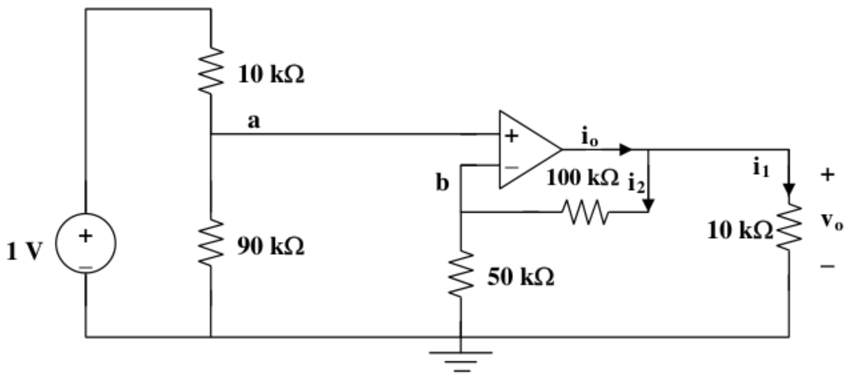
$$v_a = \frac{R_2}{R_1 + R_2} v_i, \qquad v_b = \frac{R_1}{R_1 + R_2} v_o$$

But $v_a = v_b$ $\longrightarrow$ $\frac{R_2}{R_1 + R_2} v_i = \frac{R_1}{R_1 + R_2} v_o$

Or

$$\underline{\boldsymbol{\frac{v_o}{v_i} = \frac{R_2}{R_1}}}$$

Problem6:



By voltage division,

$$v_a = \frac{90}{100}(1) = 0.9\text{V}$$

$$v_b = \frac{50}{150} v_o = \frac{v_o}{3}$$

But $v_a = v_b$ $\longrightarrow$ $\frac{v_0}{3} = 0.9$ $\longrightarrow$ $v_o = \mathbf{2.7V}$

$$i_o = i_1 + i_2 = \frac{v_o}{10\text{k}} + \frac{v_o}{150\text{k}} = 0.27\text{mA} + 0.018\text{mA} = \mathbf{288\ \mu A}$$