5.72 Find $V_o$ in the network in Fig. P5.72 using Thévenin's theorem.

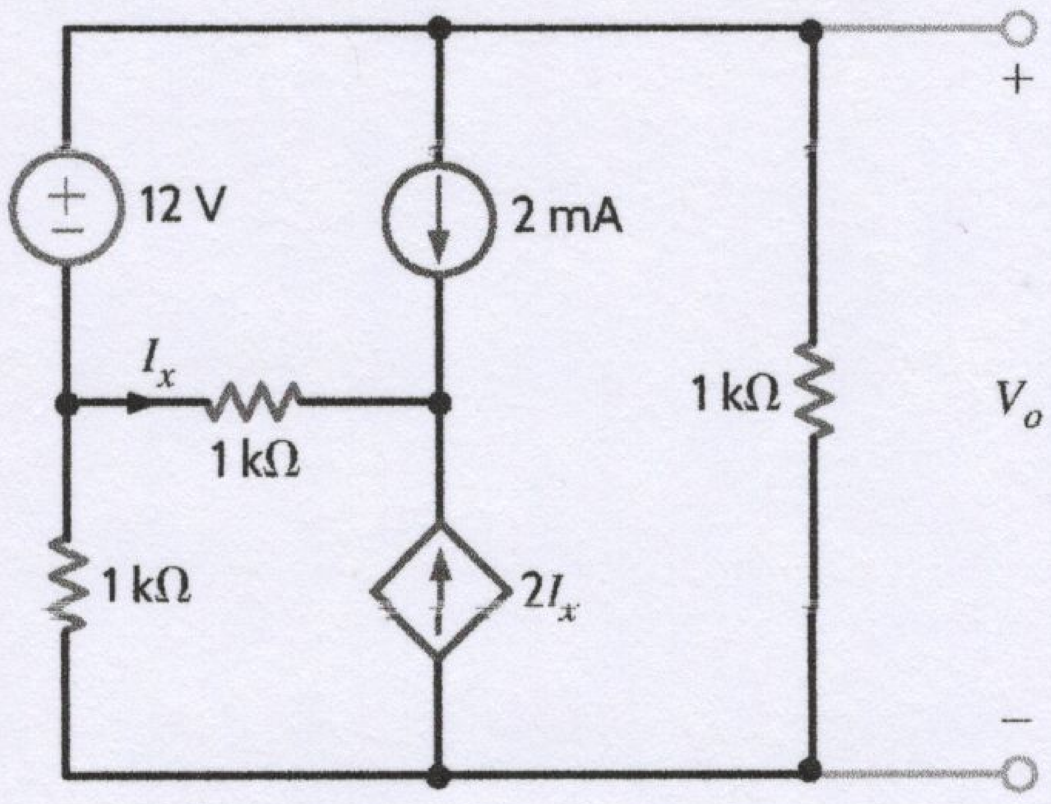



Figure P5.72

5.73 Find $V_o$ in the network in Fig. P5.73 using Norton's theorem.

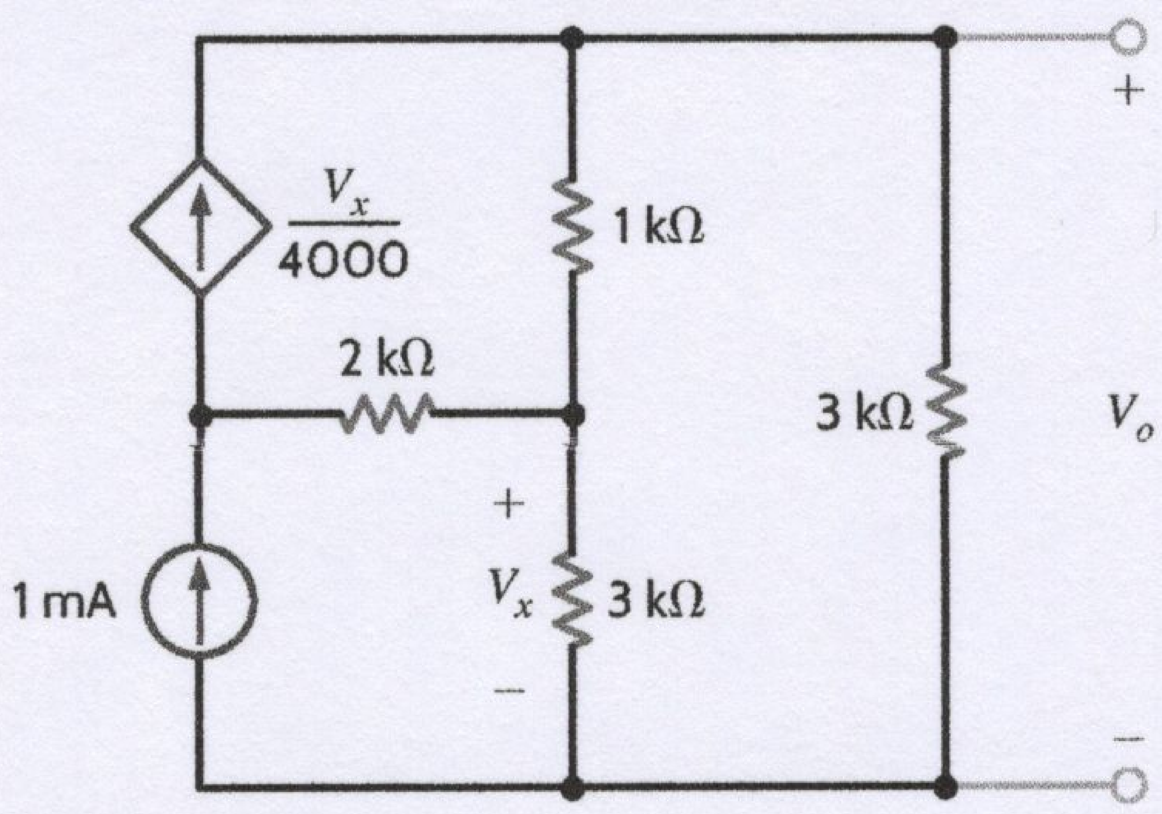



Figure P5.73

5.74 Use Thévenin's theorem to find the power supplied by the 2-V source in the circuit in Fig. P5.74.

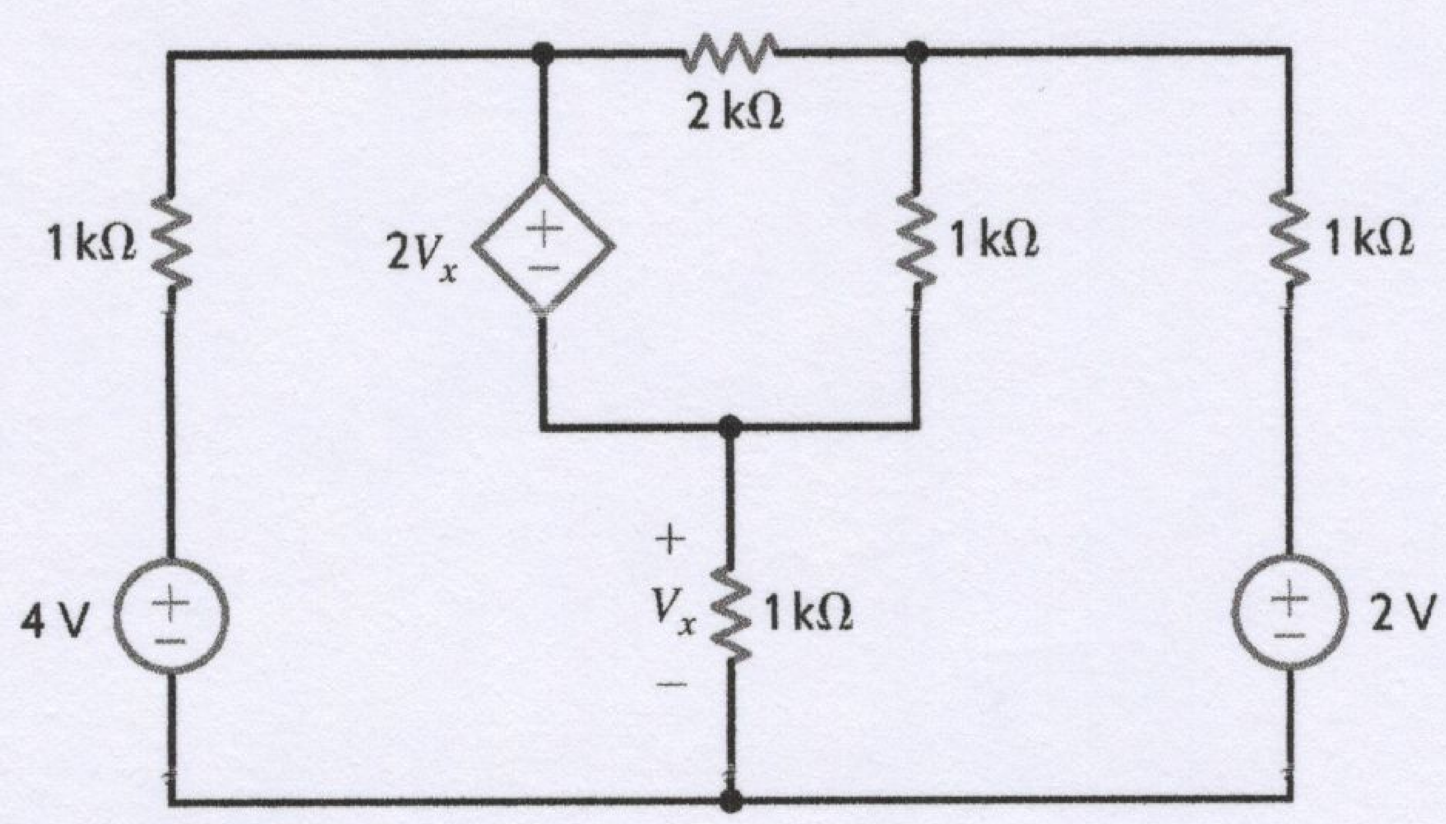



Figure P5.74

5.75 Find $V_o$ in the circuit in Fig. P5.75 using Thévenin's theorem.

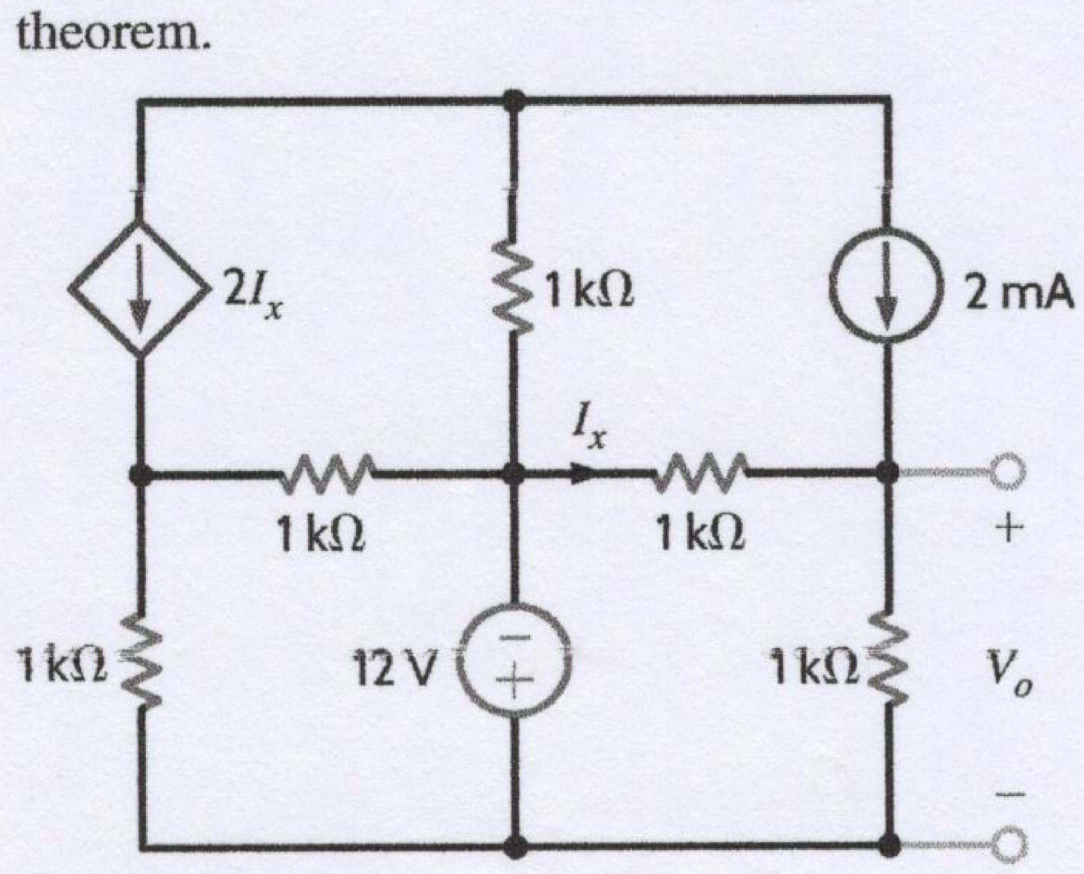



Figure P5.75

$\boxed{5.76}$ Find $V_o$ in the network in Fig. P5.76 using Thévenin's theorem.

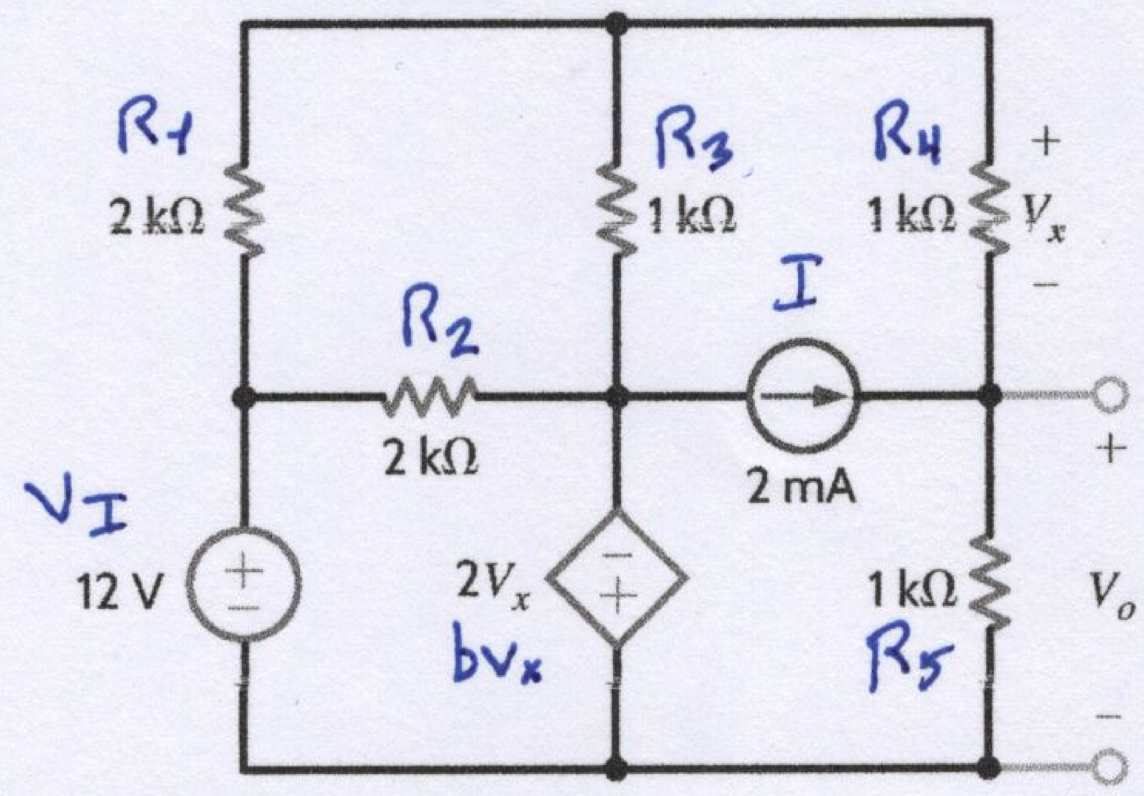



Figure P5.76

5.77 Find $V_o$ in the network in Fig. P5.77 using Thévenin's theorem.

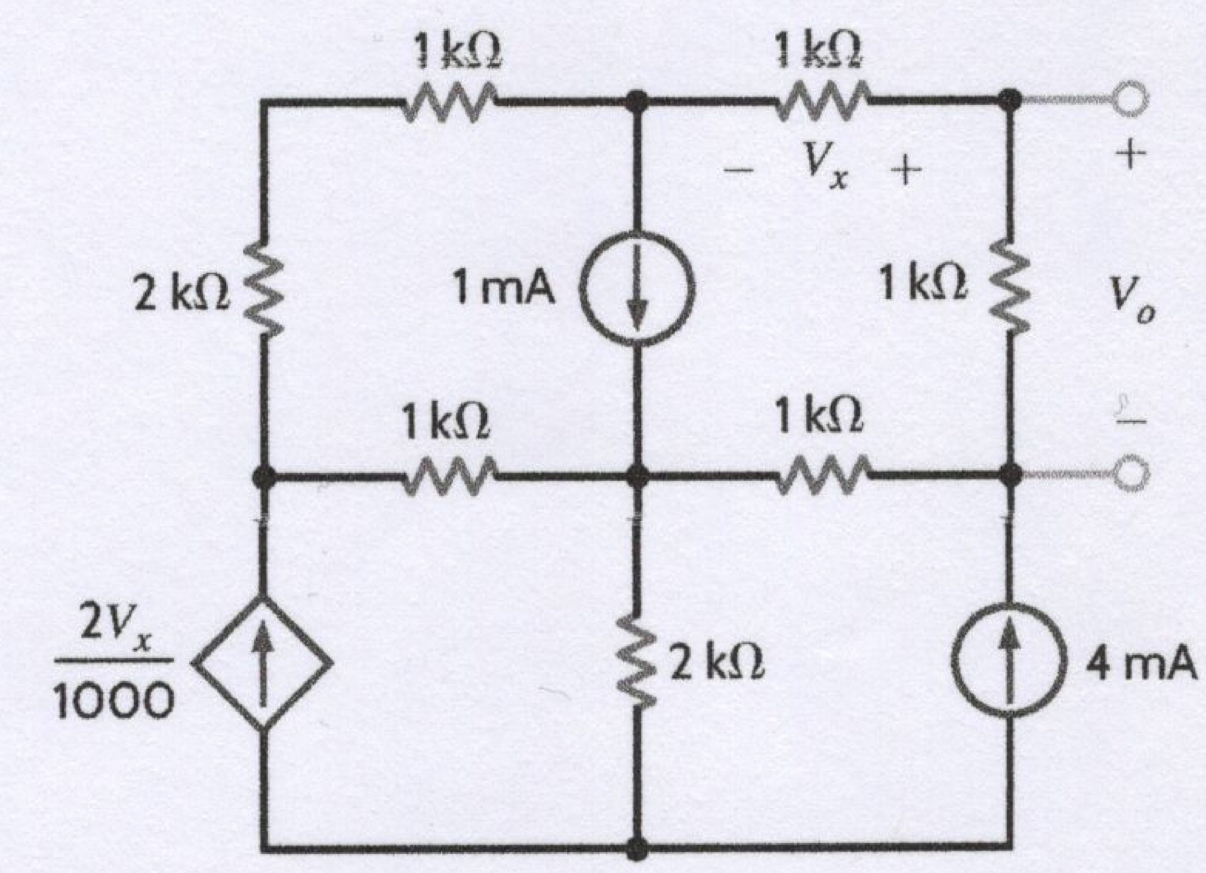



Figure P5.77

5.78 Use Thévenin's theorem to find $I_2$ in the circuit in Fig. P5.78.

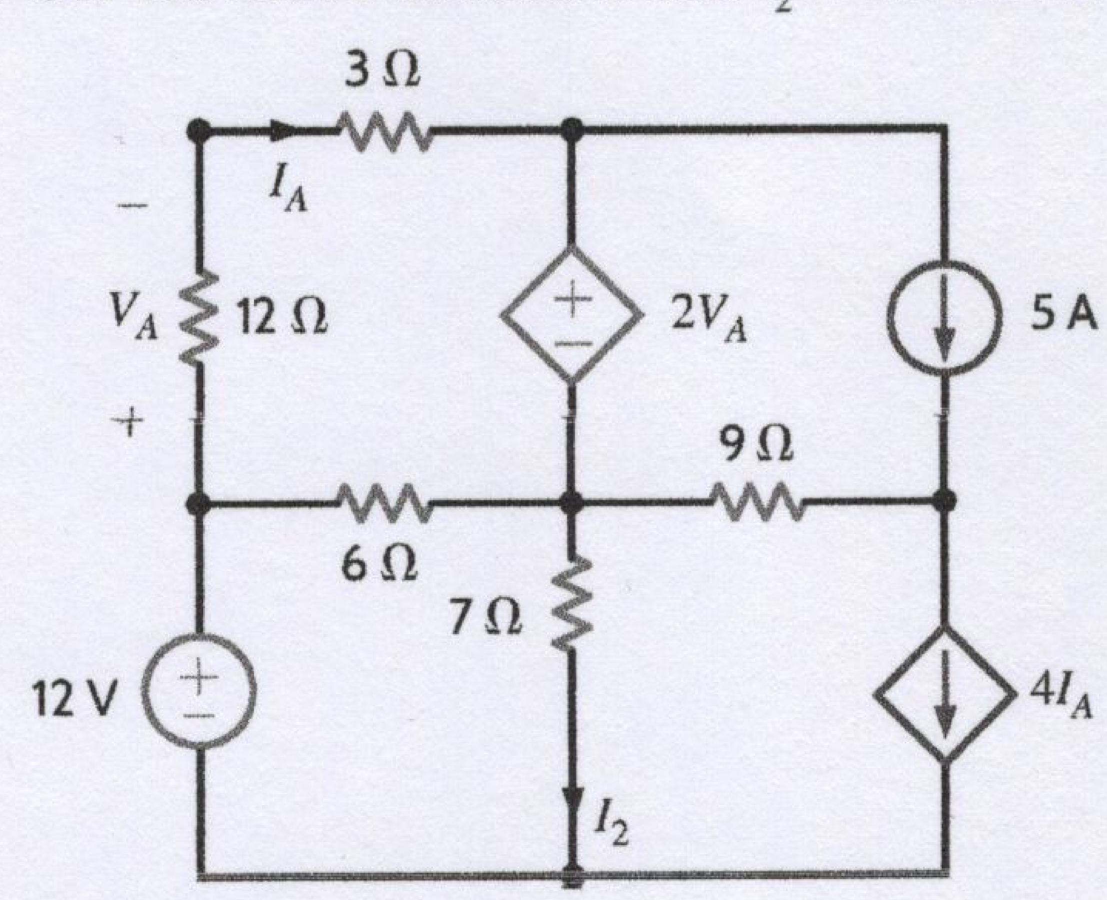



Figure P5.78

5.79 Use Thévenin's theorem to find $V_o$ in the circuit in Fig. P5.79.

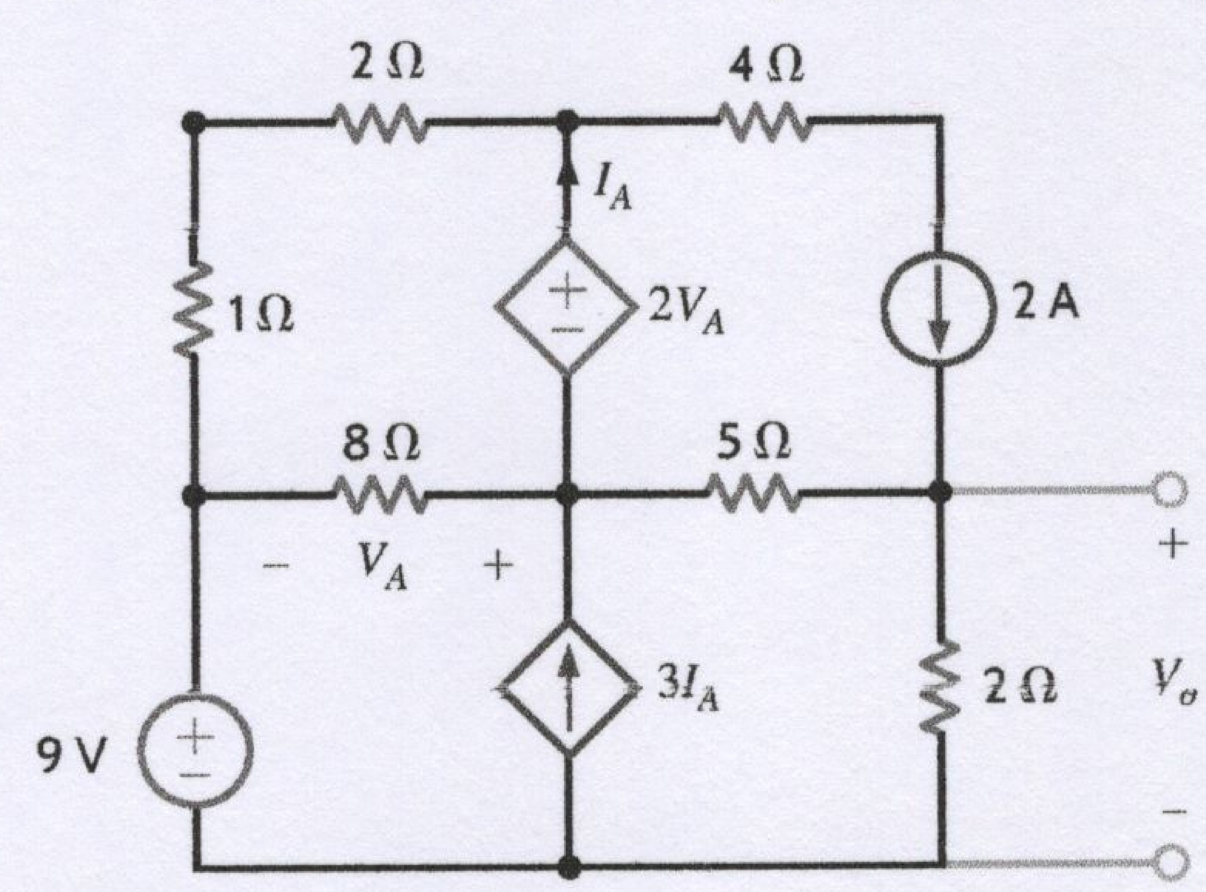
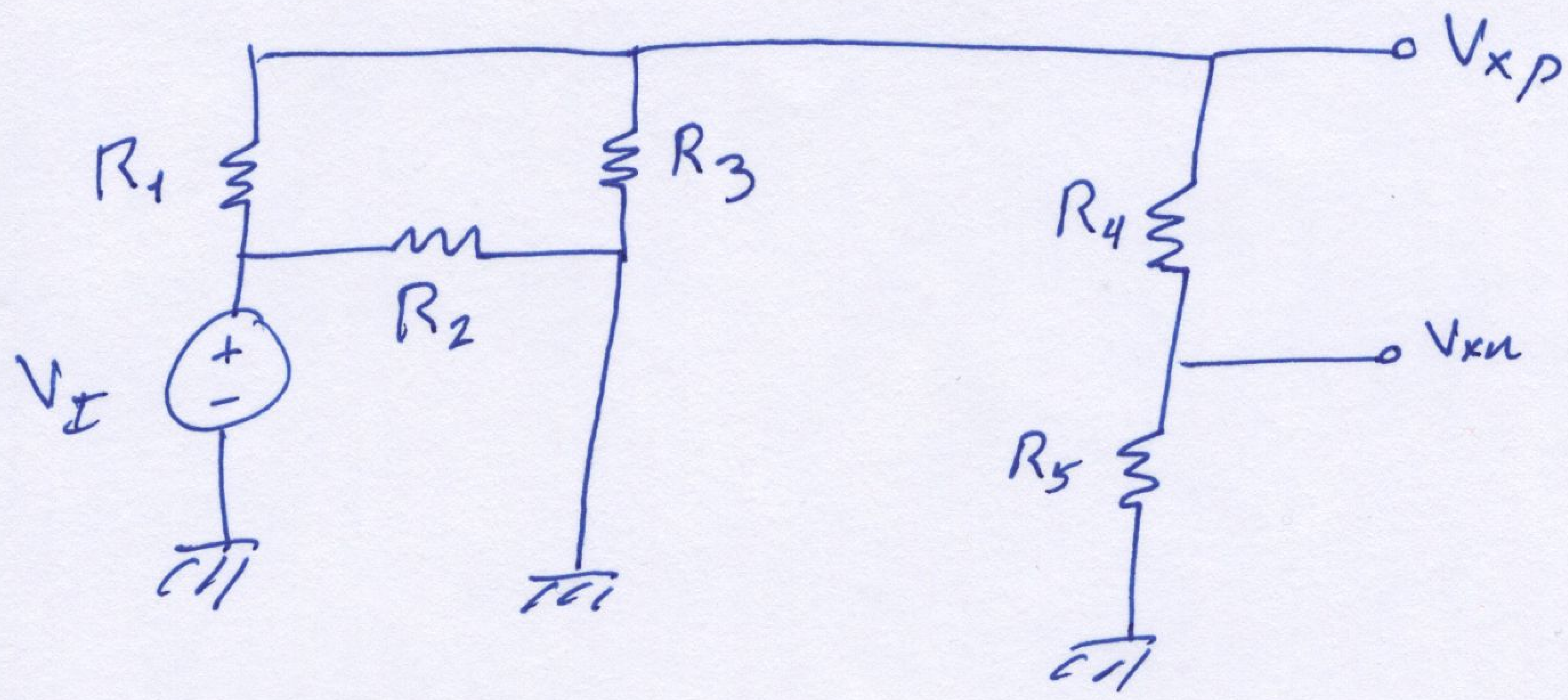



Figure P5.79

$V_I$ alone.

Irwin & Nelms 11th ed, problem 5.76 | Garek Dyszel



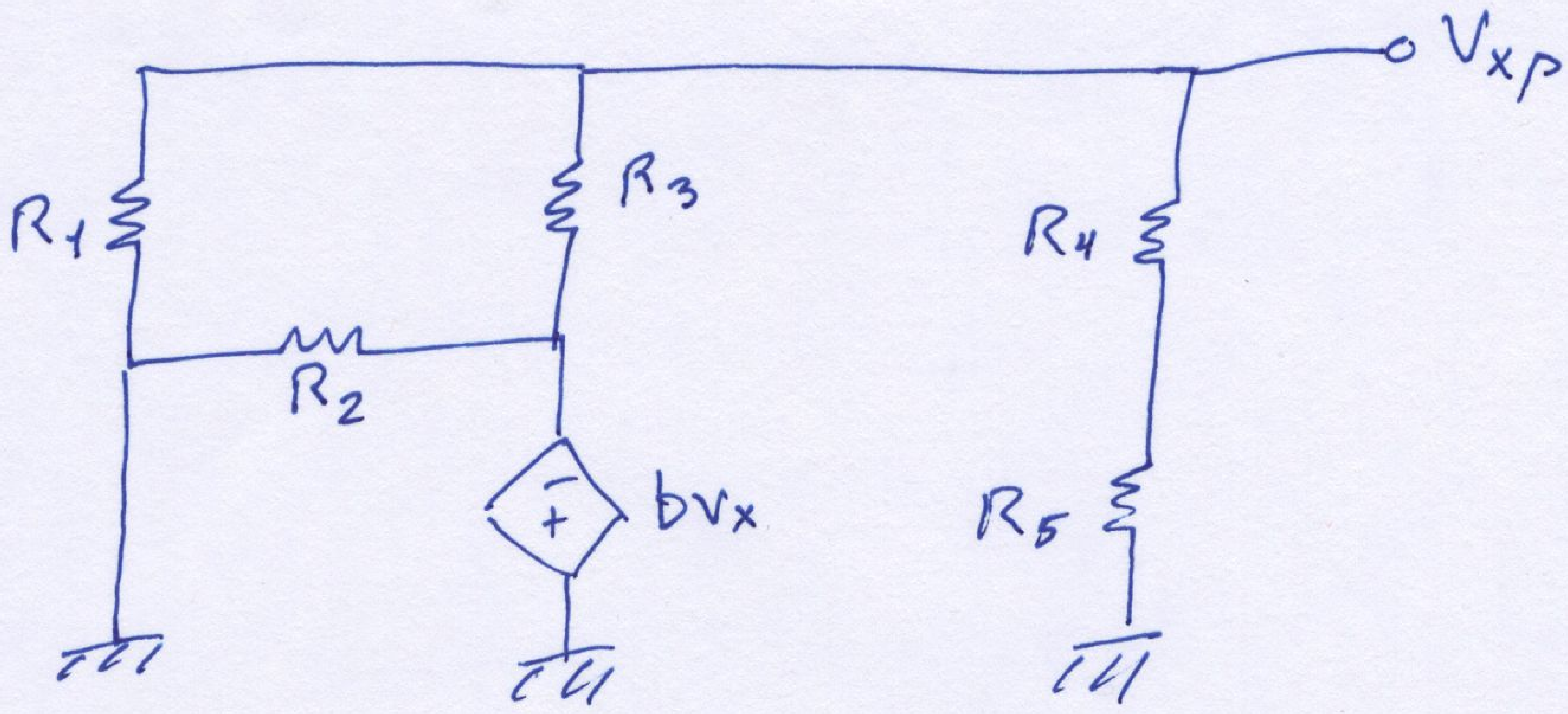

Inspection at node $V_{xp}$.

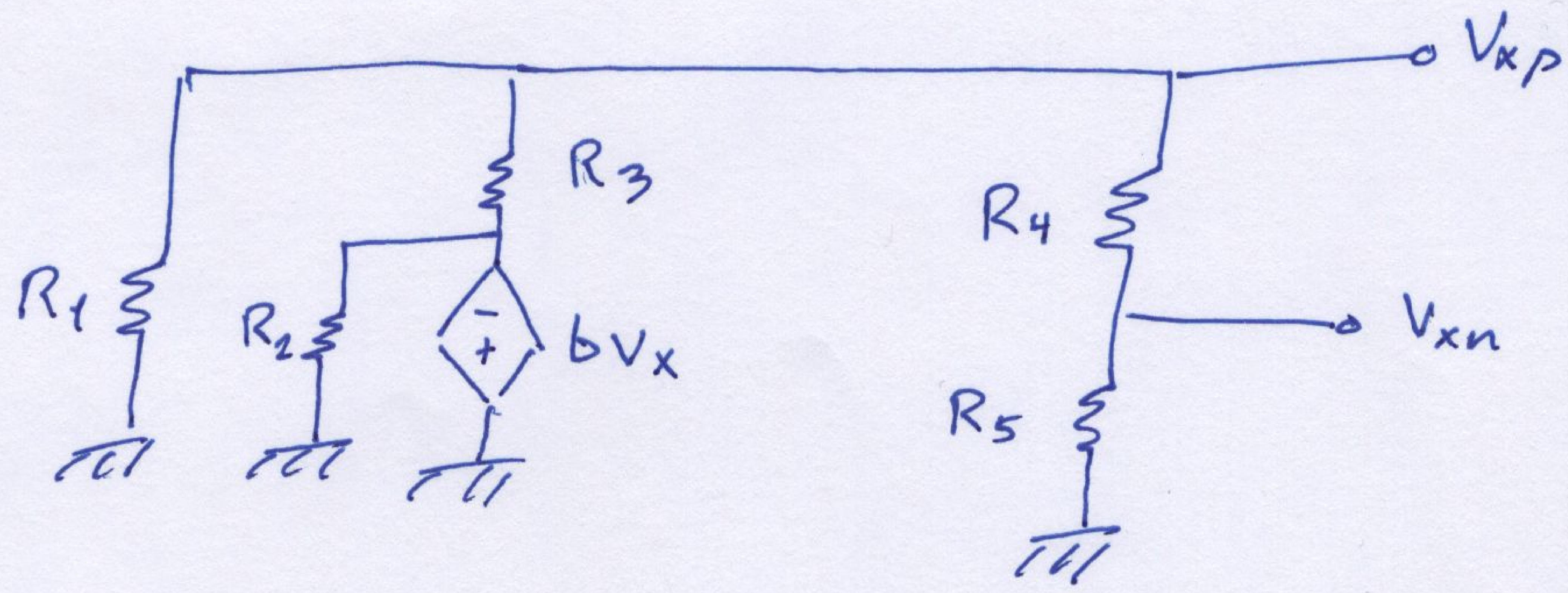
$$\frac{V_{xp}}{R_1 \| R_3 \| (R_4+R_5)} = \frac{V_I}{R_1}$$

$$\boxed{V_{xp} = \frac{V_I}{R_1}\left[R_1 \| R_3 \| (R_4+R_5)\right]}$$

$$\boxed{V_{xn} = V_{xp}\,\frac{R_5}{R_4+R_5}}$$

$bV_x$ alone



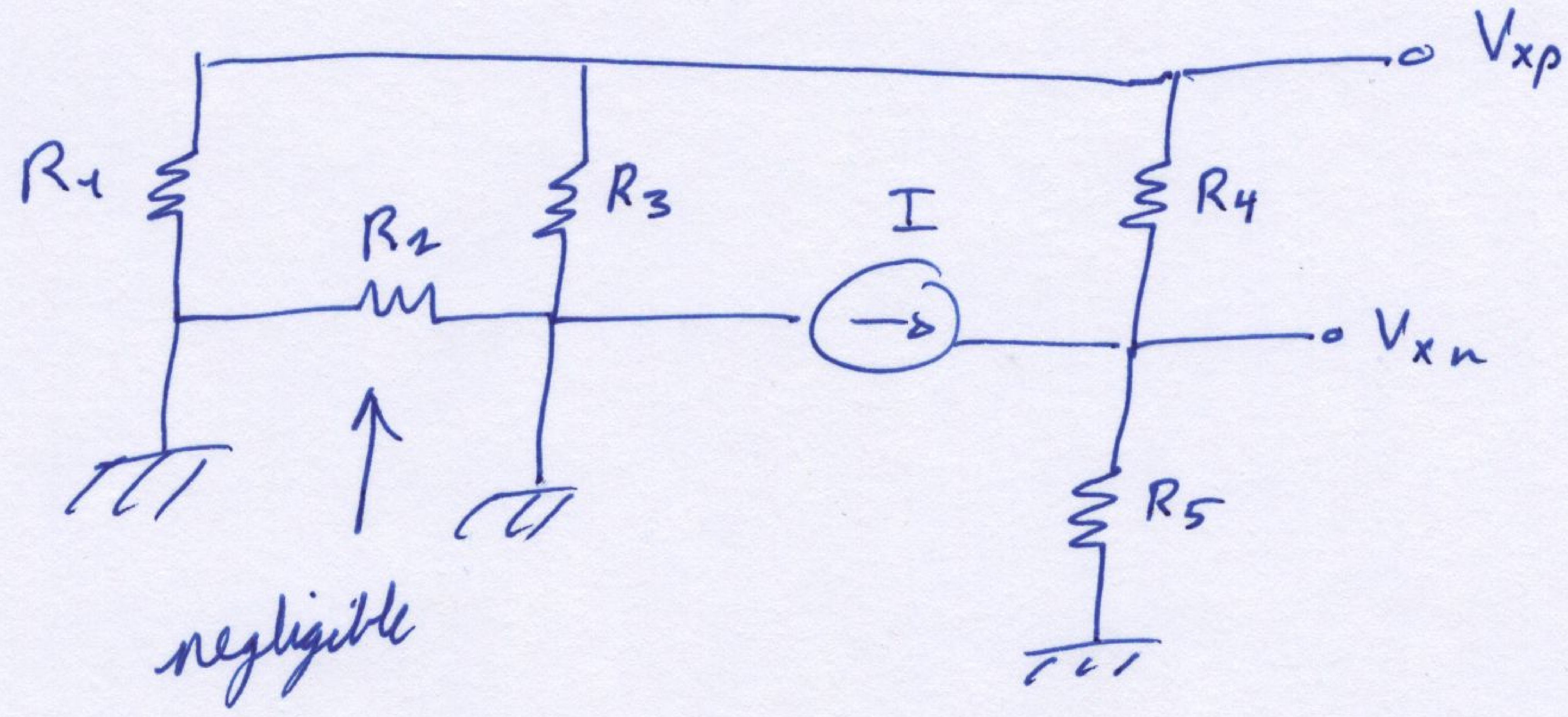

By inspection at node $V_{xp}$.

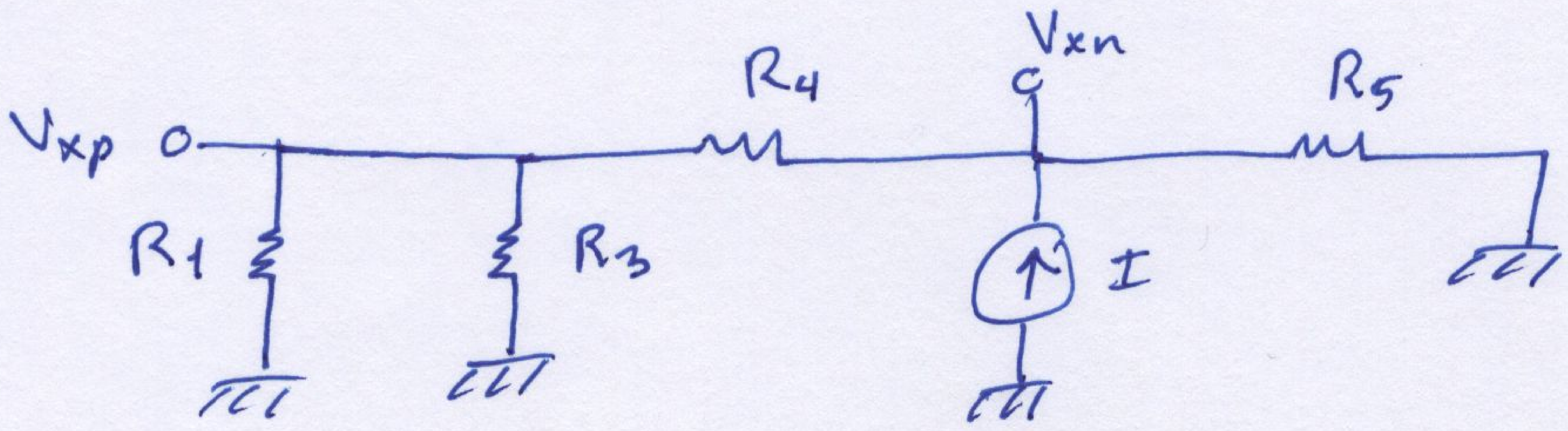
$$\frac{V_{xp}}{R_1 \| R_3 \| (R_4+R_5)} = -\frac{bV_x}{R_3}$$

$$\boxed{V_{xp} = -\frac{bV_x}{R_3}\left[R_1 \| R_3 \| (R_4+R_5)\right]}$$

$$\boxed{V_{xn} = V_{xp}\frac{R_5}{R_4+R_5}}$$

I alone.




KCL @ node $V_{xn}$.

$$I = \frac{V_{xn}}{(R_1 \| R_3) + R_4} + \frac{V_{xn}}{R_5}$$

$$I = \frac{V_{xn}}{[(R_1 \| R_3) + R_4] \| R_5}$$

$$\boxed{V_{xn} = I\,[(R_1 \| R_3) + R_4] \| R_5}$$

$$\boxed{V_{xp} = V_{xn} \frac{(R_1 \| R_3)}{(R_1 \| R_3) + R_4}}$$

## $V_{xp}$ for $V_I$ alone

$$V_{xp1} = \frac{V_I}{R_1}\left[R_1 \| R_3 \| (R_4 + R_5)\right]\left(1 - \frac{R_5}{R_4 + R_5}\right)$$

## $V_{xp}$ for $bV_x$ alone

$$V_{xp2} = -\frac{bV_x}{R_3}\left[R_1 \| R_3 \| (R_4 + R_5)\right]\left(1 - \frac{R_5}{R_4 + R_5}\right)$$

## $V_{xp}$ for $I$ alone

$$V_{xp3} = I\left[(R_1 \| R_3) + R_4\right] \| R_5 \left(\frac{(R_1 \| R_3)}{(R_1 \| R_3) + R_4} - 1\right)$$

Apply superposition now. Solve for $V_{xp}$.

$$V_{xp} = V_{xp1} + V_{xp2} + V_{xp3}$$

$$V_{xp} - V_{xp2} = V_{xp1} + V_{xp3}$$

$$V_{xp}\left(1 + \frac{b}{R_3}\left[R_1 \| R_3 \| (R_4 + R_5)\right]\left(1 - \frac{R_5}{R_4 + R_5}\right)\right) = V_{x1} + V_{x3}$$

$\cancel{\frac{V_I}{R_1}[R}$

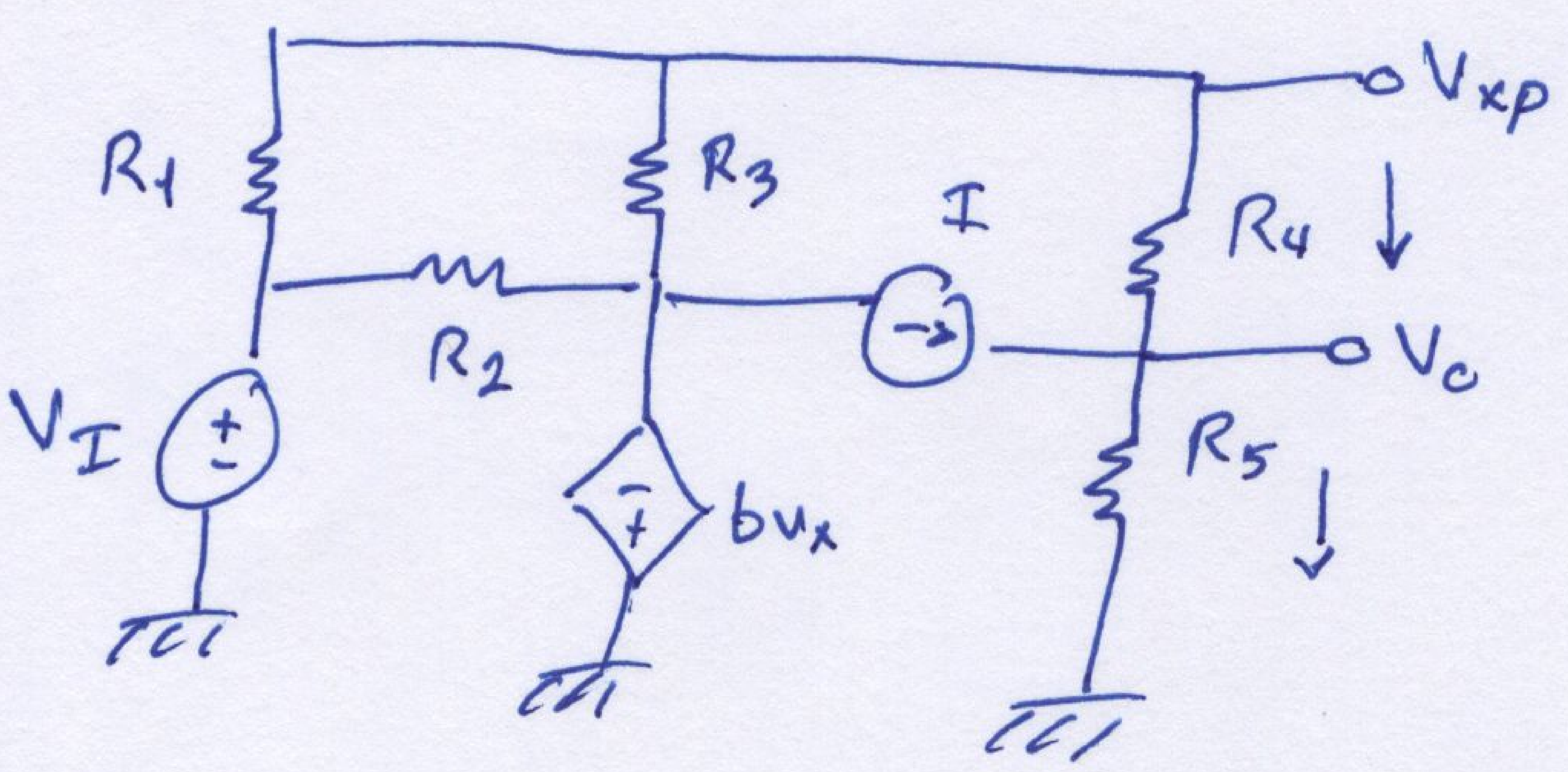
$\cancel{V_{xp} =}$

$$R_a = R_1 \| R_3 \| (R_4 + R_5)$$

$$R_b = \left[(R_1 \| R_3) + R_4\right] \| R_5$$

$$\boxed{V_{xp} = \frac{\frac{V_I}{R_1} R_a \left(1 - \frac{R_5}{R_4 + R_5}\right) + I R_b \left[\frac{(R_1 \| R_3)}{(R_1 \| R_3) + R_4} - 1\right]}{1 + \frac{b}{R_3} R_a \left(1 - \frac{R_5}{R_4 + R_5}\right)}}$$

Now back to the full circuit to find $V_o$.




$$\frac{V_{xp} - V_o}{R_4} + I = \frac{V_o}{R_5}$$

$$\boxed{V_o = \left(\frac{V_{xp}}{R_4} + I\right)(R_4 \| R_5)}$$

Calculate numerical values.

$$R_a = 2k \| 1k \| (1k + 1k) = 500\,\Omega$$

$$R_b = [(2k \| 1k) + 1k] \| 1k = 625\,\Omega$$

$$V_{xp} = \frac{\frac{12V}{2k}(500)\left(1 - \frac{1}{2}(1k)\right) + (2mA)(625)\left(\frac{666.67}{666.67 + 1k} - 1\right)}{1 + \frac{2}{1k}(500)\left(1 - \frac{1}{2}(1k)\right)}$$

$$\boxed{V_{xp} = 3.00753V}$$

$$V_o = \left(\frac{3.00753\ V}{1k} + 2mA\right)\left(\frac{1}{2}(1k)\right)$$

$$\boxed{V_o = 2.5038\ V}$$