Homework 3

P3.1.13 Determine G_{eq} between terminals 'ab' in Figure P3.1.13, where G is a conductance.

Solution: G in series with $\frac{3}{2}G$ is $\frac{1\times1.5}{2.5}$ =0.6G. Two 0.6G resistors are in parallel between the top and bottom nodes, giving a conductance of 1.2G. This resistor is in series with the $\frac{3}{2}G$ $\frac{1.5\times1.2}{2.7}G=\frac{1.8G}{2.7}=\frac{2G}{3}$; $G_{\text{ab}}=\frac{G}{2}+\frac{2G}{3}=\frac{7}{6}G$.

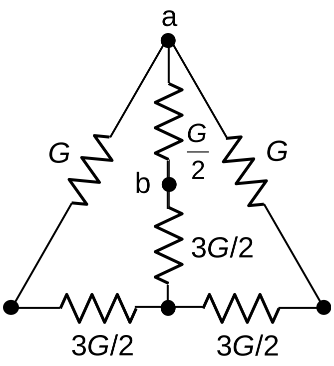


Figure P3.1.13

P3.1.15 Determine R_{eq} between terminals 'ab' in Figure P3.1.15, assuming all resistances are 1 Ω.

Solution: R_3 in parallel with R_4 is 0.5 Ω; this in series with R_2 is 1.5 Ω; this in parallel with R_1 is (1×1.5)/2.5 = 0.6 Ω. It follows that R_{eq} is 2×0.6 = 1.2 Ω.

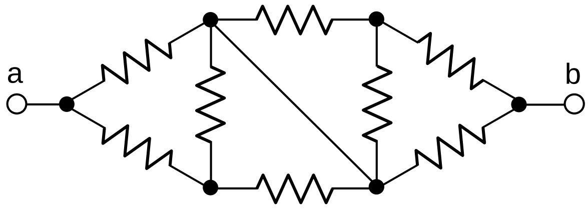


Figure P3.1.15

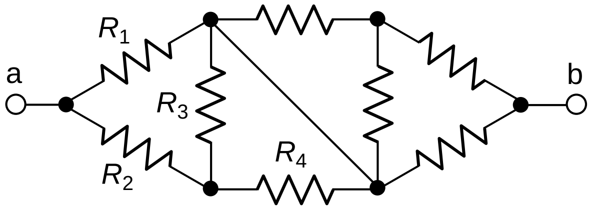


Figure P3.1.15-1

P3.1.20 Determine R_{in} in Figure P3.1.20.

Solution: The current in R/2 is 2V/R. From KVL around the mesh in the middle, starting at node 'c' and going CCW: -V_{ca} – V_T + 2V_T = 0, which gives V_{ca} = V_T. The current through R in the middle branch is V_T/R directed upwards. From KVL around the outer loop, starting at node 'b' and going CCW: -2V_X + V_X – V_T = 0, which gives V_X = -V_T. The current in R on the RHS is V_T/R directed upwards. From KCL at node 'a': $I_T + V_T/R + V_T/R - 2V_T/R = 0$. This makes I_T = 0, so that $R_{in} = V_T/I_T \rightarrow \infty$.

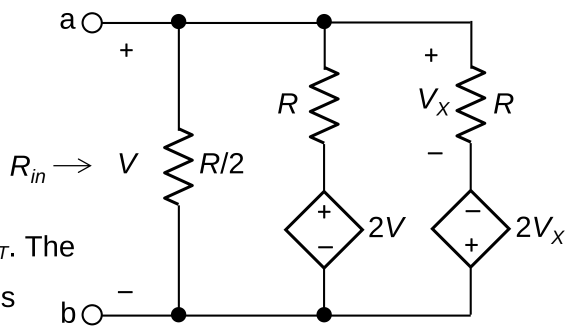


Figure P3.1.20

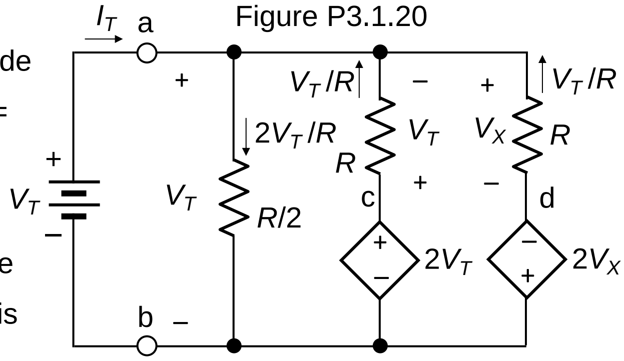


Figure P3.1.20-1

P3.2.7 Determine V_X and I_Y in Figure P3.2.7.

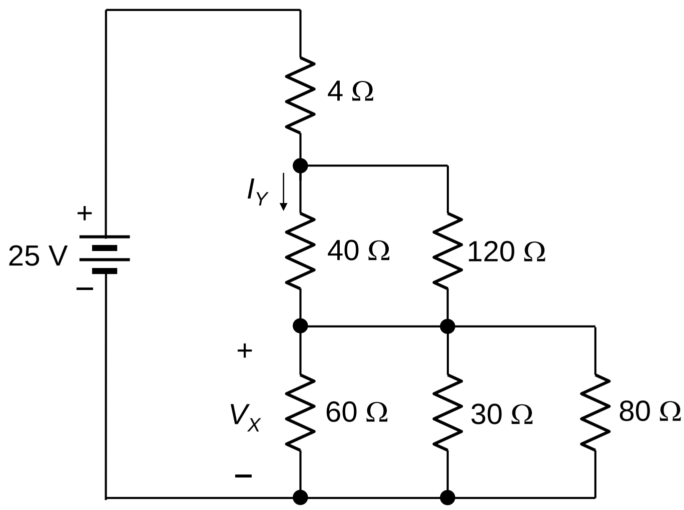


Figure P3.2.7

Solution:

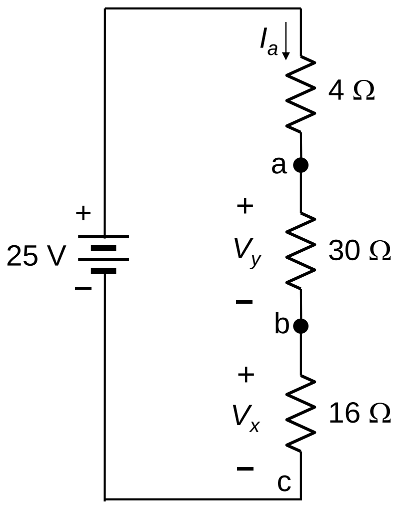


Figure P3.2.7-1

$$\frac{40\times 120}{40+120}=\frac{120}{4}=30\ \Omega,\ \frac{60\times 30}{60+30}=\frac{60}{3}=20\ \Omega,\ \frac{20\times 80}{20+80}=\frac{80}{5}=16\ \Omega.$$

$$V_x=\frac{16}{16+30+4}\times 25=\frac{16}{50}\times 25=8\ \text{V}.$$

$$I_a=\frac{25}{16+30+4}=\frac{25}{50}=0.5\ \text{A},\ I_y=\frac{120}{120+40}\times 0.5=\frac{3}{4}\times 0.5=0.375\ \text{A}.$$

P3.2.21 Determine V_O in Figure P3.2.21 using source transformation.

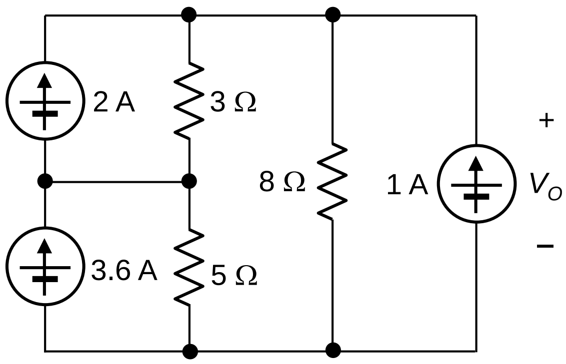


Figure P3.2.21

Solution: The 2 A and 3.6 A sources and their parallel source resistances are transformed to their equivalent voltage sources. The circuit reduces to a two-essential-node circuit can be analyzed by applying KCL. The circuit becomes as shown. The two voltage sources and the two resistances can be combined to simplify the circuit further. The 24 V source in series with the 8 Ω resistor can be transformed to its equivalent current source. The two 8 Ω resistors are combined in parallel into a 4 Ω resistor. The current in this resistor is (1 + 3) A, so that $V_O = 4(1 + 3) = 16$ V.

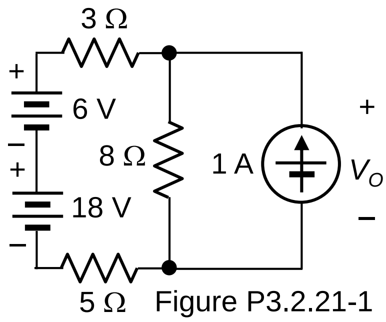
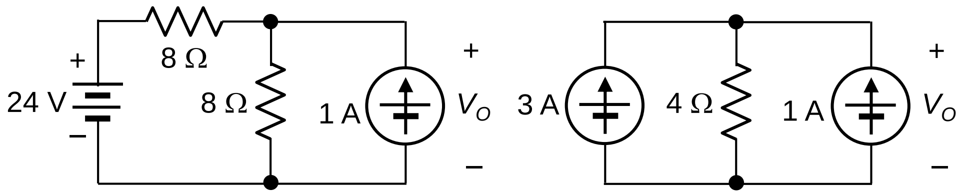


Figure P3.2.21-1



(a) Figure P3.2.21-2 (b)

P3.2.23 Determine V_O in Figure P3.2.23.

Solution: The current source in parallel with 10 Ω is transformed to avoltage source of 2.5 V in series with 10 Ω. In series with 5 Ω this is 15 Ω. The 2.5 V source in series with 15 Ω is transformed to a current source of 2.5/15 = 1/6 A in parallel with 15 Ω. The circuit becomes as shown. It follows from current division that: $I_X = (1/6 - 0.5I_X)/2$. Hence, $I_X = 1/15$ A, which gives $V_O = 2/3$ V.

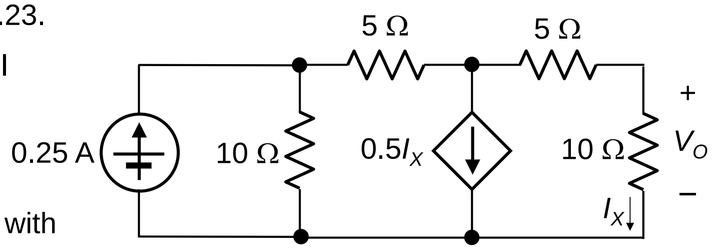


Figure P3.2.23

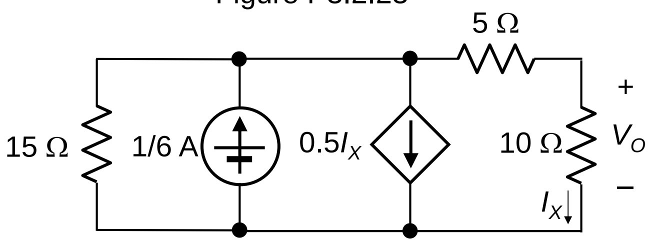


Figure P3.2.23-1

P3.3.8 Determine I_X in Figure P3.3.8.

Solution: **Initialize.** All given circuit parameters and variables are entered. The nodes are labelled.

Simplify. The circuit is in a simple enough form.

Deduce. From Ohm;s law, $V_{bd} = 2I_X$ V; From KVL around the mesh 'bcdb', $I_{cb} = 2(1 - I_X)/3$; if a closed surface is drawn as shown, $I_{ad} = 2(1 - I_X)/3$; from KVL around the loop 'abda', $2(1 - I_X)\times3/3 - 4 - 2I_X = 0$, or $I_X =$ - 0.5 A.

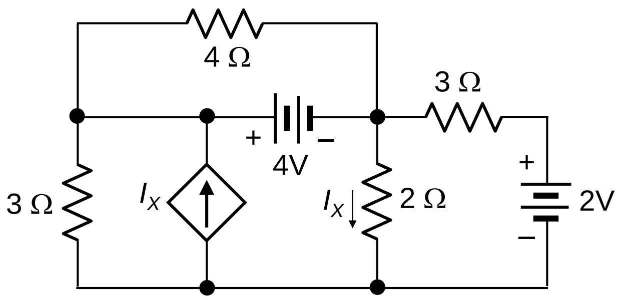


Figure P3.3.8

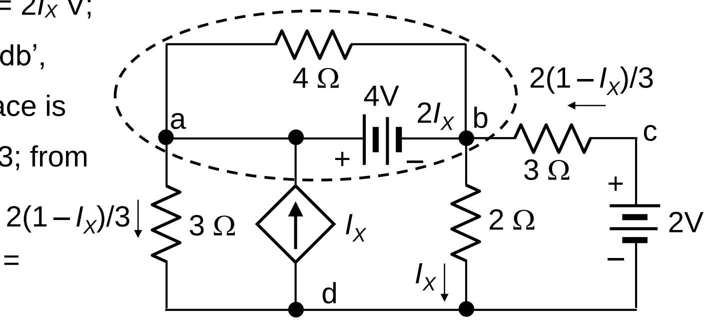


Figure P3.3.8-1

P3.3.12 Determine V_Y in Figure P3.3.12.

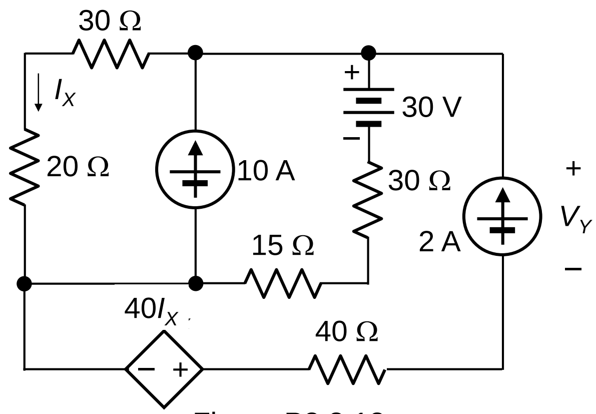


Figure P3.3.12

Solution: **Initialize.** All given parameters and variables are entered. The nodes are labelled.

Simplify. The 30 Ω and 20 Ω resistors are combined into a 50 Ω resistor. The 30 Ω and 15 Ω resistors are combined into a 45 Ω resistor. The circuit is redrawn to show it more clearly as a two-essential-node circuit.

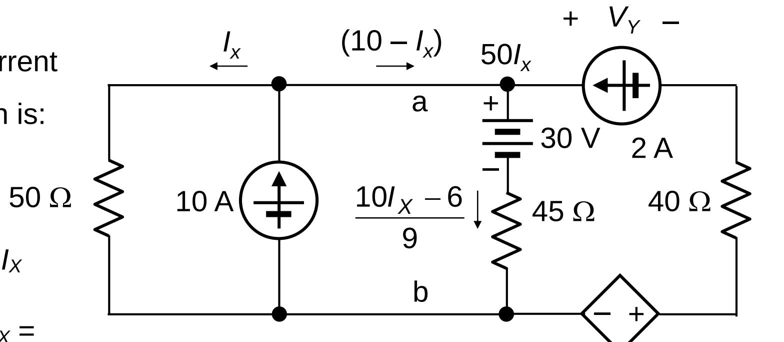


Figure P3.3.12-1

Deduce. $V_{ab} = 50I_X$; The current in the 30 V and 45 Ω branch is: $\frac{50I_X - 30}{45} = \frac{10I_X - 6}{9}$ A. From KCL at node ‘a’: $10 - I_X + 2 = \frac{10I_X - 6}{9}$, or $108 - 9I_X = 10I_X - 6$, or $19I_X = 114$, which gives: $I_X = 6$ A. It follows that $V_{ab} = 50\times6 = 300$ V $= V_Y - 40\times2 + 40\times6$, or $V_Y = 300 - 160 = 140$ V.