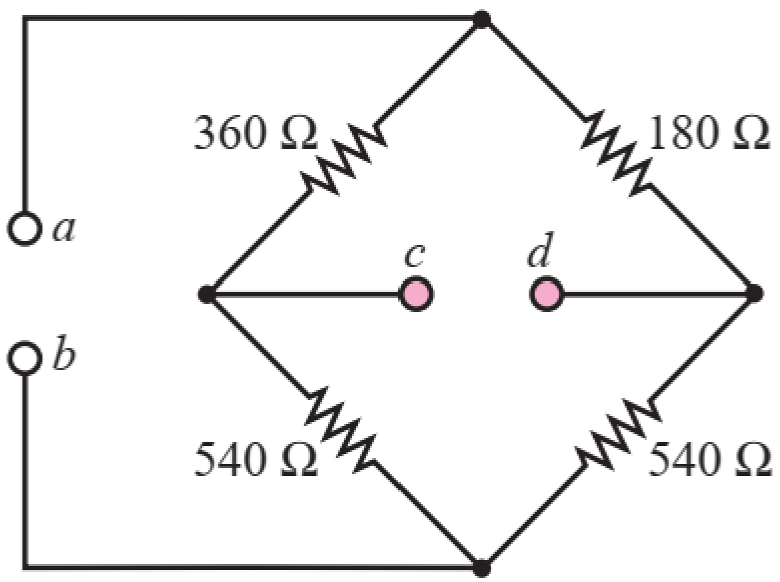
1.

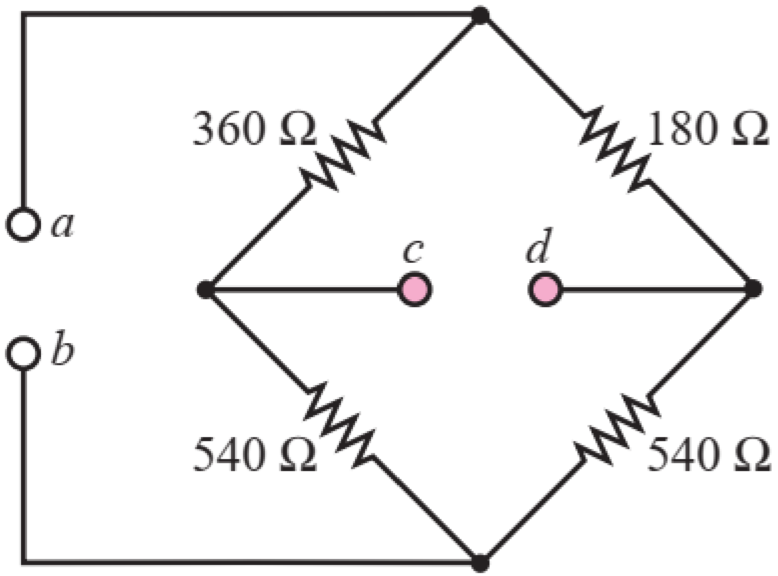
Find the equivalent resistance looking in at terminals *a* and *b* if terminals *c* and *d* are open and again if terminals *c* and *d* are shorted together. Also, find the equivalent resistance looking in at terminals *c* and *d* if terminals *a* and *b* are open and if terminals *a* and *b* are shorted together.



1.

Terminals (c – d) open

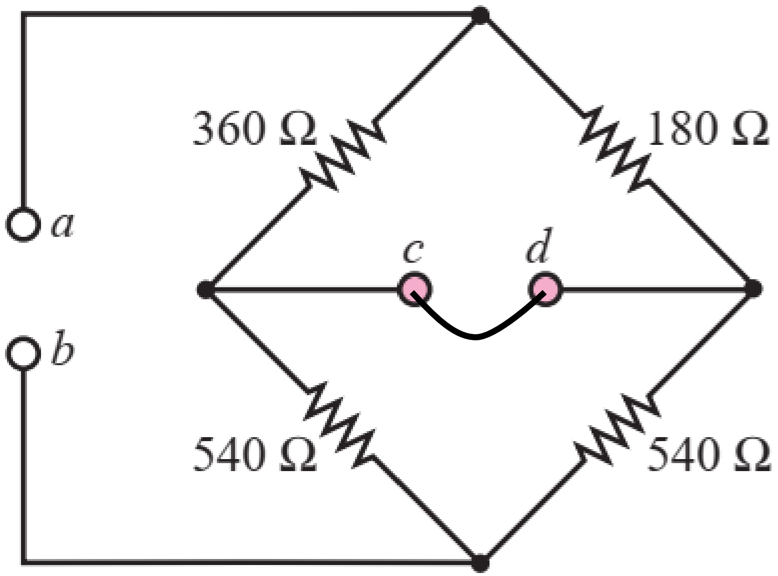
$$R_{eq} = \left(\frac{1}{360 + 540} + \frac{1}{180 + 540} \right)^{-1} = 400\ \Omega$$



1.

Terminals (c – d) shorted

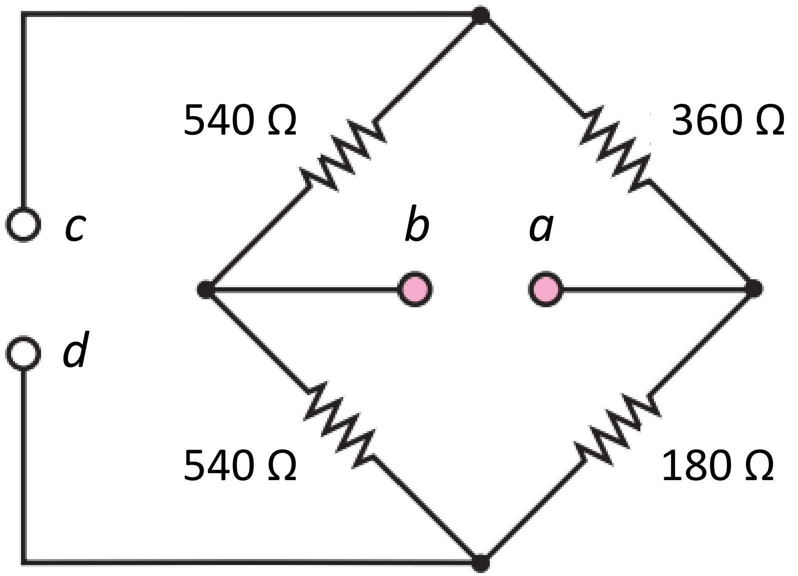
$$R_{eq} = \left(\frac{1}{360} + \frac{1}{180}\right)^{-1} + \left(\frac{1}{540} + \frac{1}{540}\right)^{-1} = 390 \ \Omega$$



1.

$$R_{eq} = \left(\frac{1}{540 + 540} + \frac{1}{360 + 180} \right)^{-1} = 360\ \Omega$$

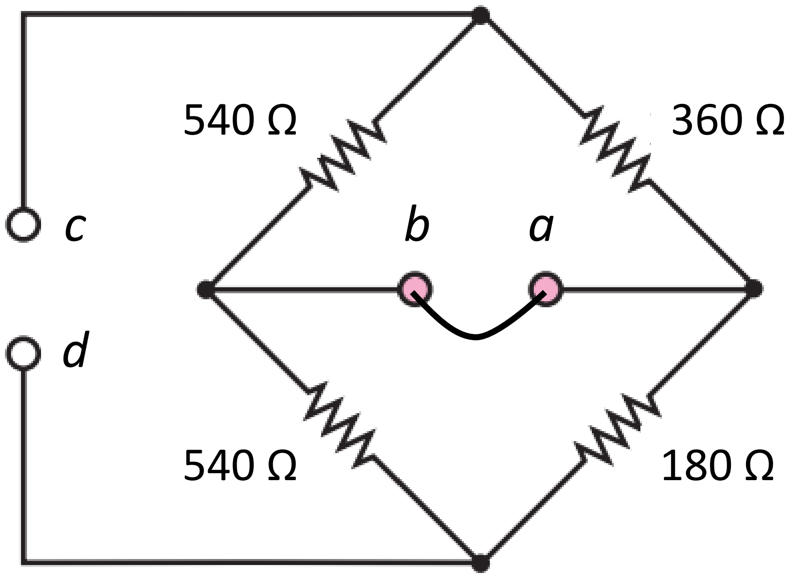
terminals (a – b) open



1.

$$R_{eq} = \left(\frac{1}{540} + \frac{1}{360}\right)^{-1} + \left(\frac{1}{540} + \frac{1}{180}\right)^{-1} = 351\ \Omega$$

Terminals (a – b) shorted



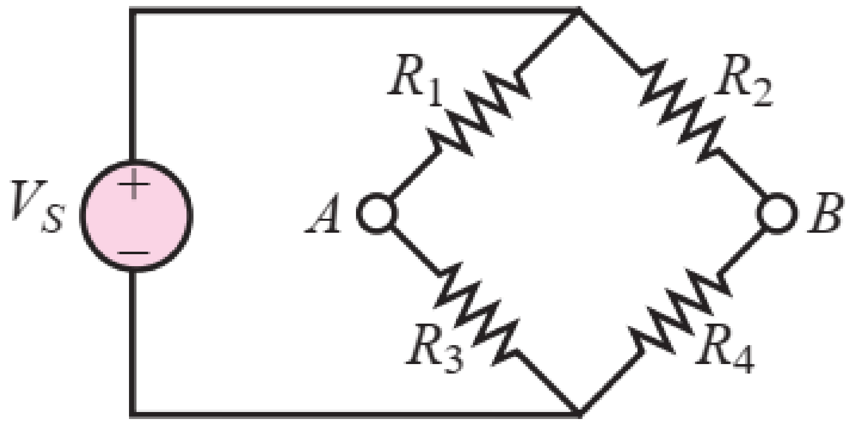
2.

Determine the voltage between nodes *A* and *B* in the circuit

$V_S = 12$ V

$R_1 = 11$ kΩ $\quad$ $R_3 = 6.8$ kΩ

$R_2 = 220$ kΩ $\quad$ $R_4 = 0.22$ MΩ



2.

Determine the voltage between nodes *A* and *B* in the circuit

$$V_3 := V_S \cdot \frac{R_3}{R_1 + R_3} = 4.584 \text{ V}$$

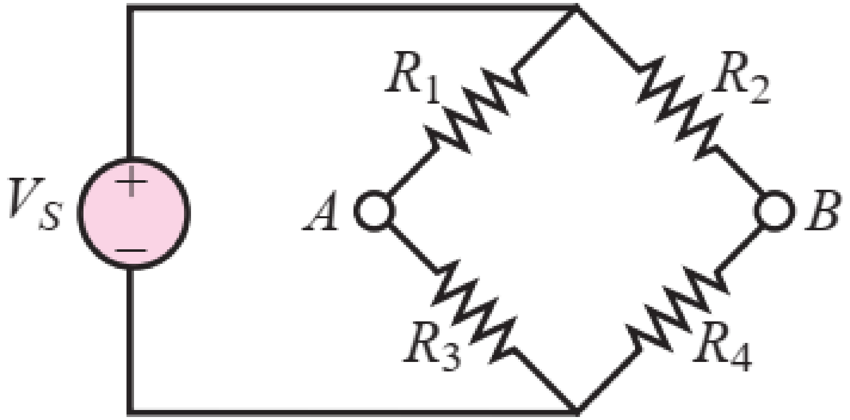
$$V_4 := V_S \cdot \frac{R_4}{R_2 + R_4} = 6 \text{ V}$$

Answer: $V_3 - V_4 = -1.41 \text{ V}$

$V_S = 12\ \text{V}$

$R_1 = 11\ \text{k}\Omega$ $R_3 = 6.8\ \text{k}\Omega$

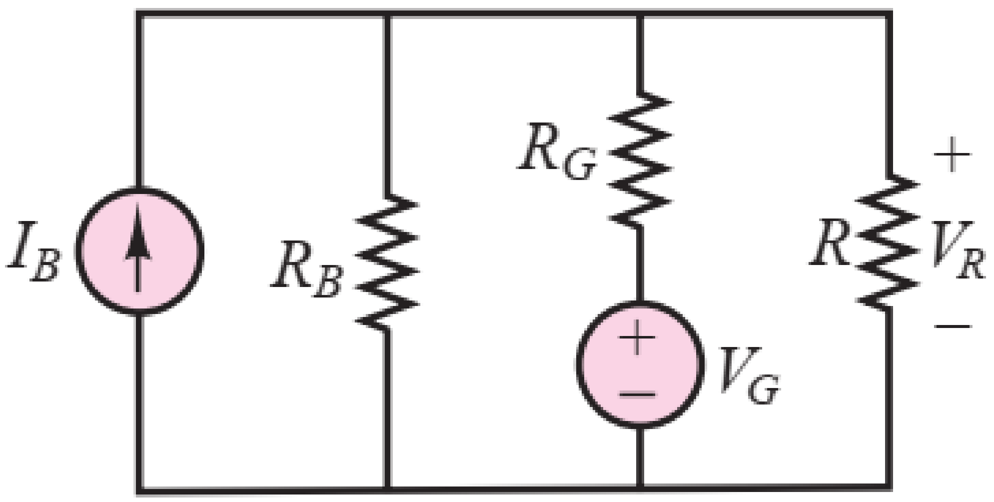
$R_2 = 220\ \text{k}\Omega$ $R_4 = 0.22\ \text{M}\Omega$



3.

Determine the voltage across resistor *R* in the circuit

$I_B = 12\text{ A};\ V_G = 12\text{ V};\ R_B = 1\ \Omega;\ R_G = 0.3\ \Omega;\ R = 0.23\ \Omega$

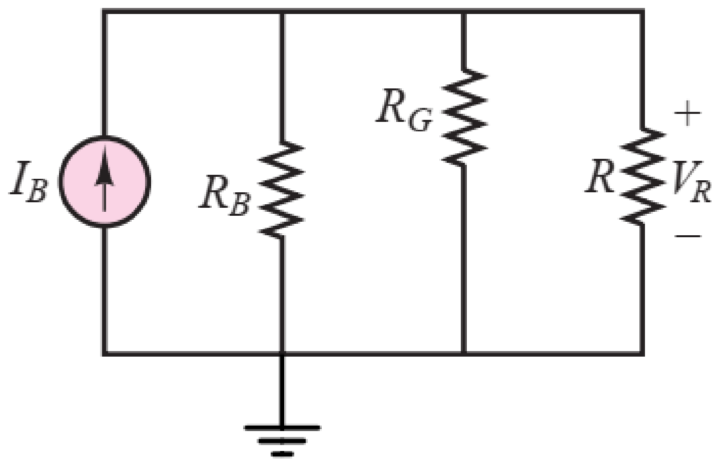


3.

$I_B = 12$ A; $V_G = 12$ V; $R_B = 1\ \Omega$; $R_G = 0.3\ \Omega$; $R = 0.23\ \Omega$

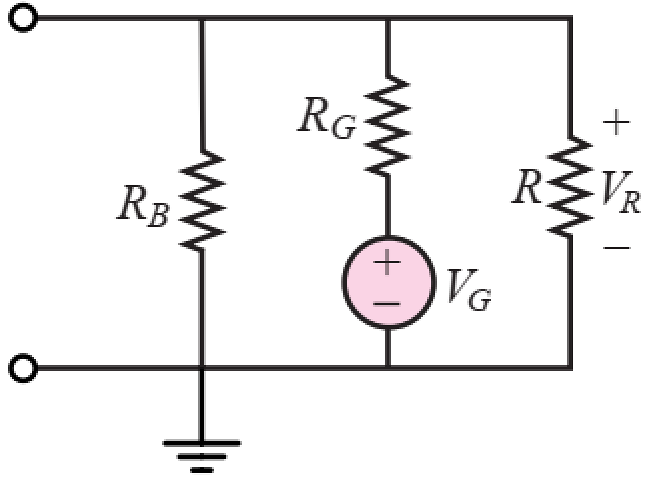
$$-I_B + \frac{V_{R-I}}{R_B} + \frac{V_{R-I}}{R_G} + \frac{V_{R-I}}{R} = 0$$

$$V_{R-I} = \frac{I_B}{1/R_B + 1/R_G + 1/R} = \frac{12}{1/1 + 1/0.3 + 1/0.23} = 1.38\ \text{V}$$



$$\frac{V_{R-V}}{R_B} + \frac{V_{R-V} - V_G}{R_G} + \frac{V_{R-V}}{R} = 0$$

$$V_{R-V} = \frac{V_G/R_G}{1/R_B + 1/R_G + 1/R} = \frac{12/0.3}{1/1 + 1/0.3 + 1/0.23} = 4.61\ \text{V}$$



Answer: $V_R = V_{R-I} + V_{R-V} = 5.99\ \text{V}$

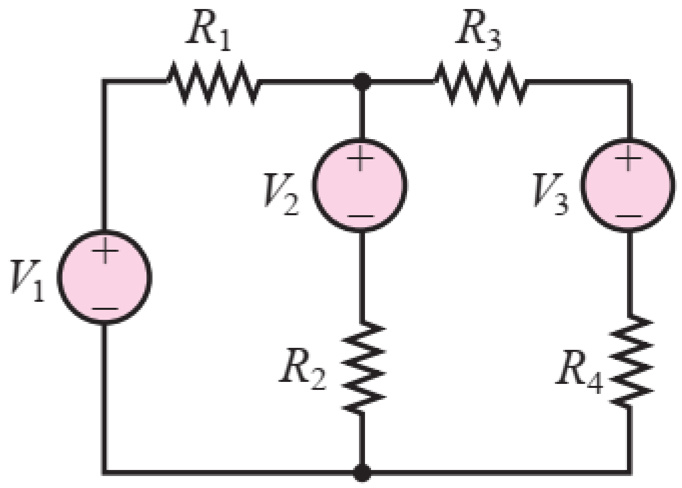
4.

Find the mesh currents in the circuit using superposition

$V_1 = 10\text{ V};\ V_2 = 9\text{ V};\ V_3 = 1\text{ V};$

$R_1 = 5\ \Omega;\ R_2 = 10\ \Omega;\ R_3 = 5\ \Omega;$

$R_4 = 5\ \Omega.$



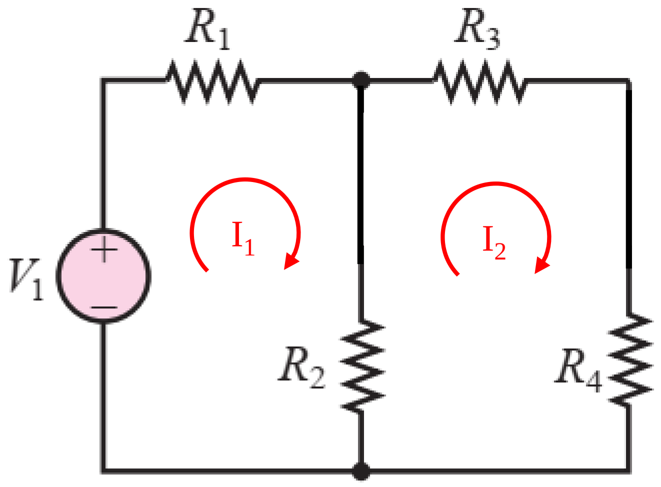
4.

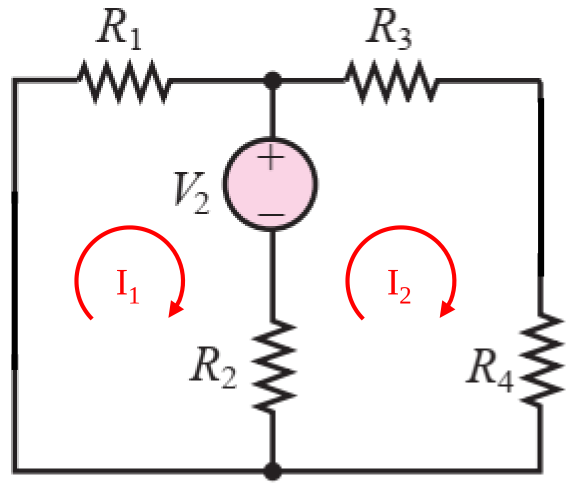
Find the mesh currents in the circuit using superposition

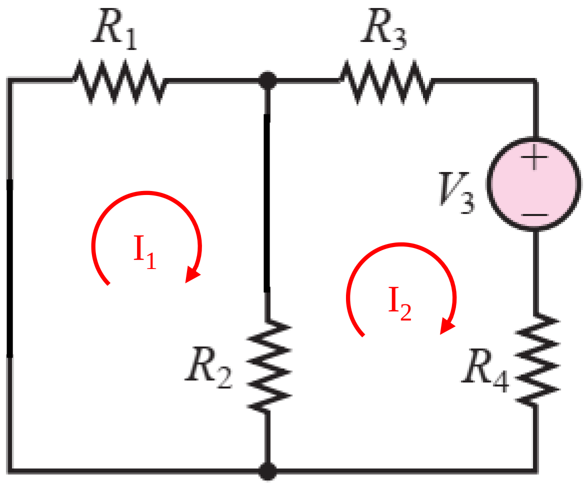
$V_1 = 10\text{ V};\ V_2 = 9\text{ V};\ V_3 = 1\text{ V};$

$R_1 = 5\ \Omega;\ R_2 = 10\ \Omega;\ R_3 = 5\ \Omega;$

$R_4 = 5\ \Omega.$







$$\begin{cases} V_1 - R_1 \cdot I1 - R_2(I1 - I2) = 0 \\ R_2 \cdot (I2 - I1) + R_3 \cdot I2 + R_4 \cdot I2 = 0 \end{cases}$$

I1 = 1 A

I2 = 0.5 A

$$\begin{cases} -R_1 \cdot I1 - V_2 - R_2 \cdot (I1 - I2) = 0 \\ -R_2 \cdot (I2 - I1) + V_2 - R_3 \cdot I2 - R_4 \cdot I2 = 0 \end{cases}$$

I1 = -0.45 A

I2 = 0.225 A

$$\begin{cases} R_1 \cdot I1 + R_2 \cdot (I1 - I2) = 0 \\ -R_2 \cdot (I2 - I1) - R_3 \cdot I2 - V_3 - R_4 \cdot I2 = 0 \end{cases}$$

I1 = -0.05 A

I2 = -0.075 A

Answer: $I1_{tot} = 1 - 0.45 - 0.05 = 0.5\text{ A}$

$I2_{tot} = 0.5 + 0.225 - 0.075 = 0.65\text{ A}$

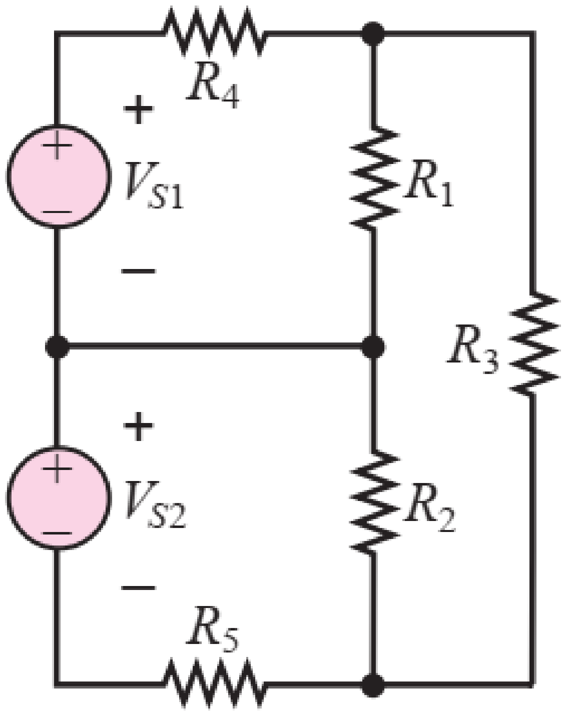
5.

Using superposition, determine the component of the current through R_3 that is due to V_{S2}.

$V_{S1} = V_{S2} = 450\ \text{V}$

$R_1 = 7\ \Omega$ $R_2 = 5\ \Omega$

$R_3 = 10\ \Omega$ $R_4 = R_5 = 1\ \Omega$



5.

Using superposition, determine the component of the current through R_3 that is due to V_{S2}.

$$R_{41} := \left(\frac{1}{R_4} + \frac{1}{R_1}\right)^{-1} = 0.875\ \Omega$$

$$\begin{cases} V_{S2} - (I1 - I2)\cdot R_2 - I1\cdot R_5 = 0 \\ R_{41}\cdot I2 + R_3\cdot I2 + (I2 - I1)\cdot R_2 = 0 \end{cases}$$

Answer: $I1 = 101.7\ A$

$I2 = 32.0\ A$

$V_{S1} = V_{S2} = 450\ \mathrm{V}$

$R_1 = 7\ \Omega \qquad R_2 = 5\ \Omega$

$R_3 = 10\ \Omega \qquad R_4 = R_5 = 1\ \Omega$