UNIVERSIDAD DE LAS FUERZAS ARMADAS-ESPE

DEPARTAMENTO DE ELÉCTRICA Y ELECTRÓNICA

CARRERA DE INGENIERÍA MECATRÓNICA

PERIODO	:	Noviembre 2020 – Abril 2021
ASIGNATURA	:	Fundamentos de Circuitos Eléctricos
TEMA	:	Resolución de los ejercicios pares del capítulo 7
NOMBRES	:	Bryan Santiago Torres Reyes.
NIVEL-PARALELO	:	Segundo
DOCENTE	:	Ing. Darwin Alulema MSc.
FECHA DE ENTREGA	:	21/01/2021
NRC	:	4867

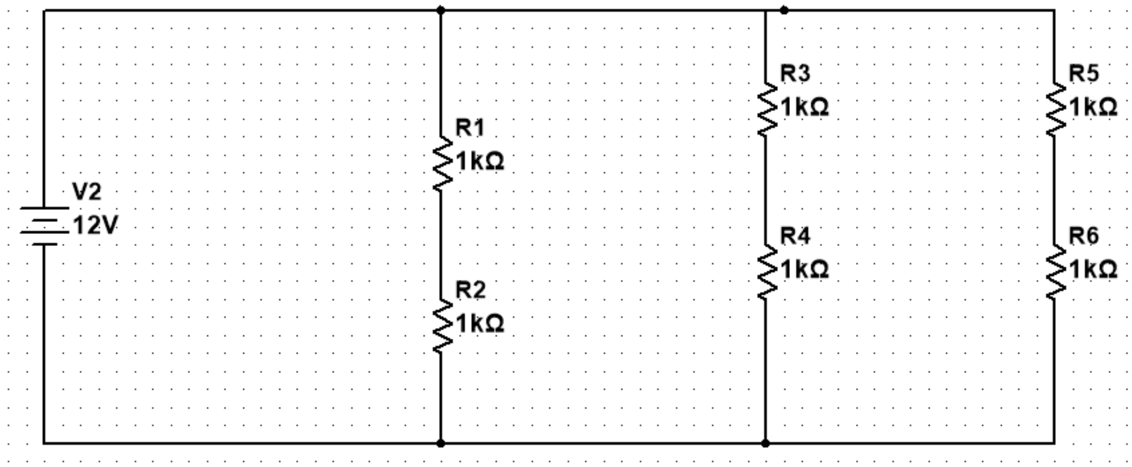
SANGOLQUI - ECUADOR

2020

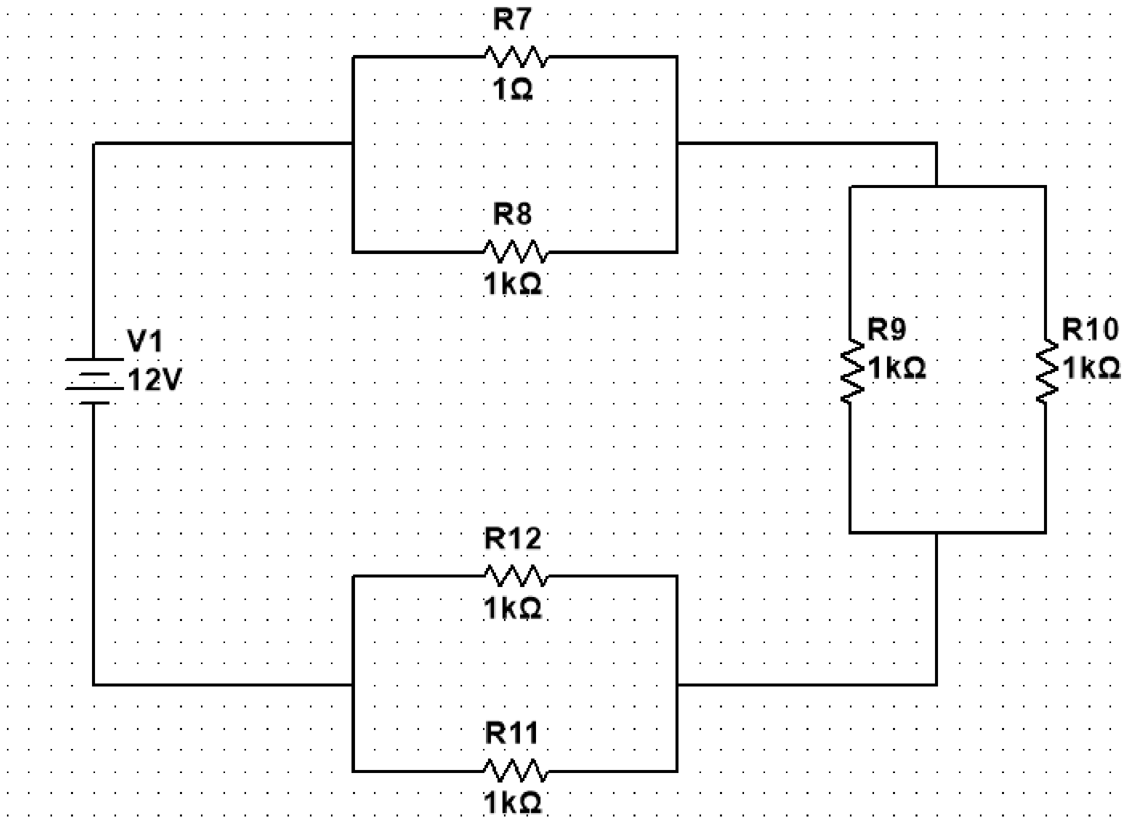
PROBLEMAS

SECCIÓN 7-1 Identificación de relaciones en serie-paralelo.

2. **Visualice y trace los siguientes circuitos en serie-paralelo.**
   - **a.** Una combinación en paralelo de tres ramas, cada rama con dos resistores en serie.

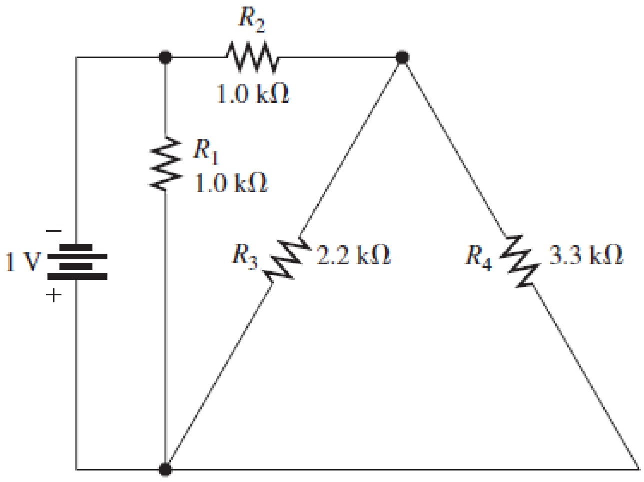


   - **b.** Una combinación serie de tres circuitos en paralelo, cada circuito con dos resistores.

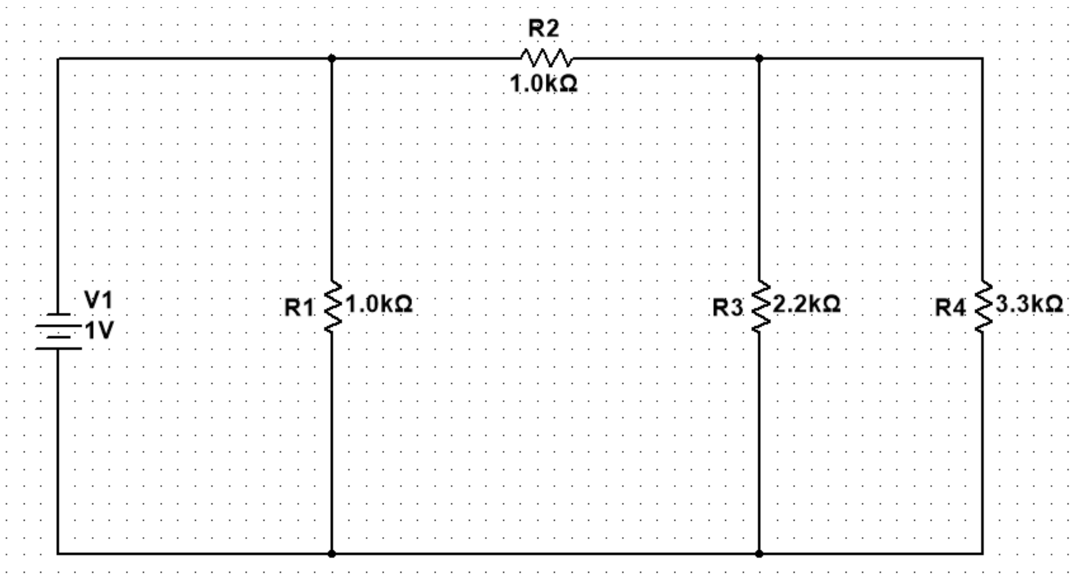


4. **En cada uno de los circuitos de la figura 7-63, identifique las relaciones en serie-paralelo de los resistores vistas desde la fuente.**

a.

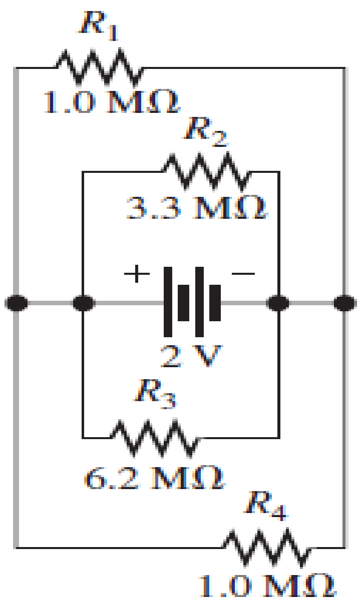


Solución:

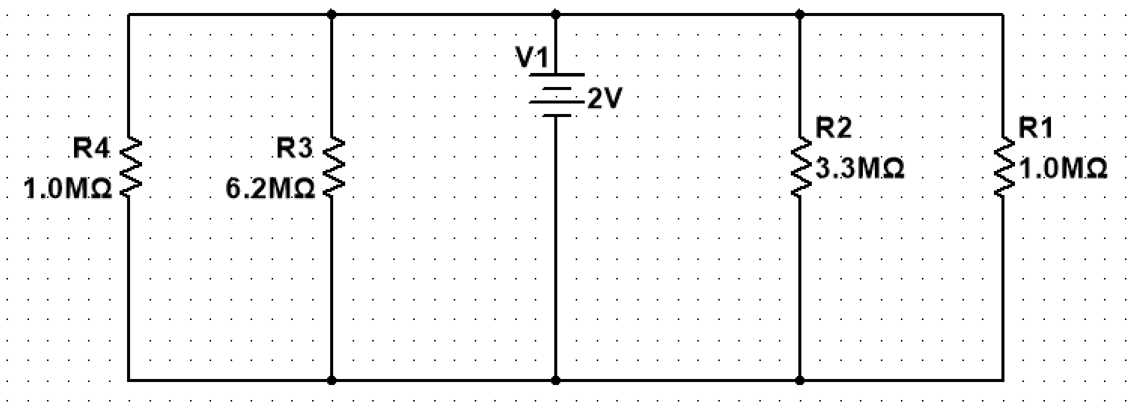


Relación $R_1 \parallel (R_2 + R_3 \parallel R_4)$

b.

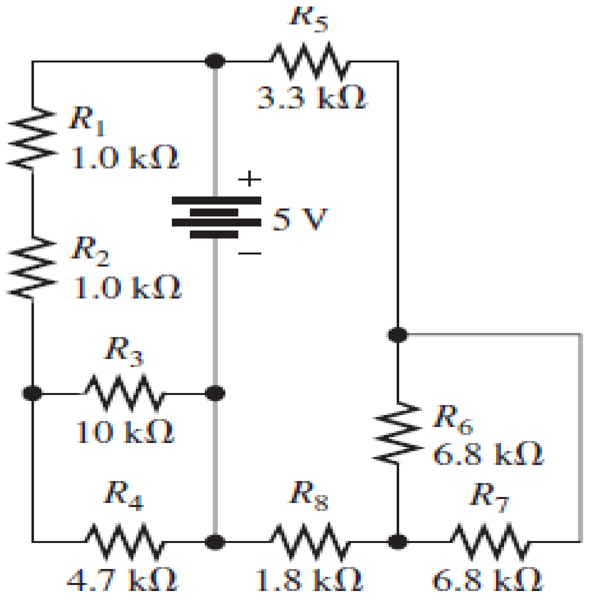


Solución

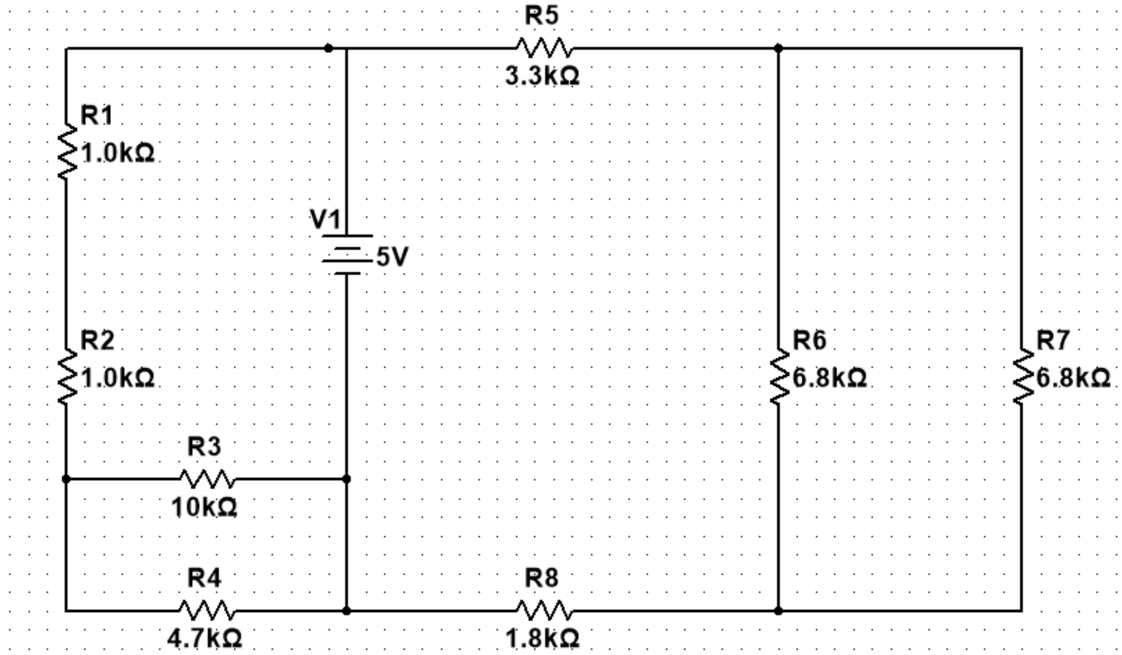


Relación: $R_1 \parallel R_2 \parallel R_3 \parallel R_4$

c.

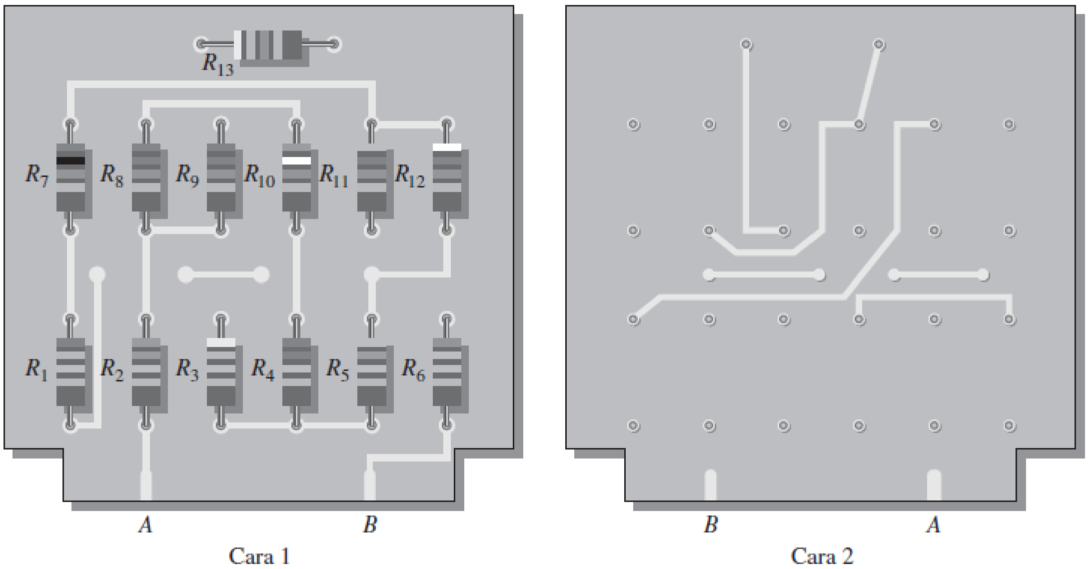


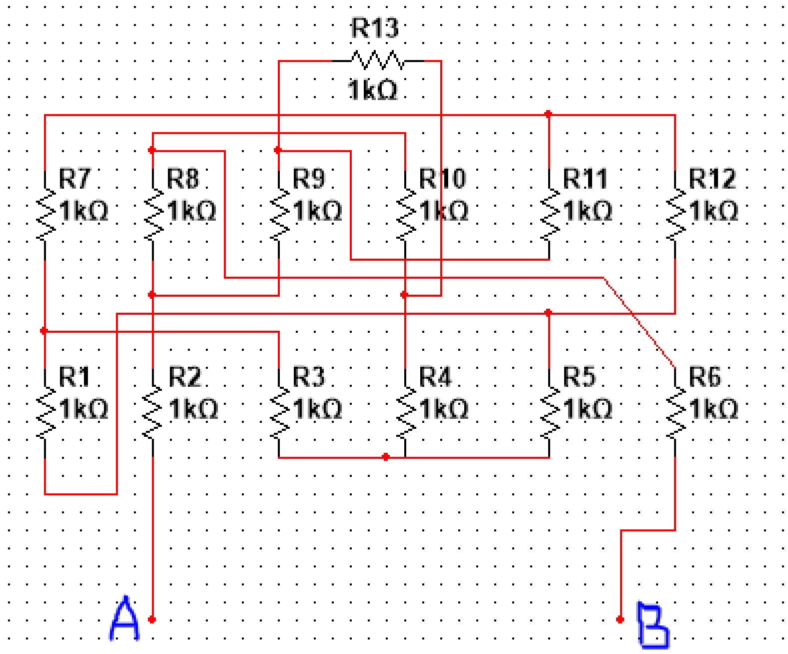
Solución



Relación: $(R_3 \parallel R_4 + R_1 + R_2) \parallel (R_6 \parallel R_7 + R_5 + R_8)$

6. **Desarrolle un diagrama esquemático de la tarjeta de circuito impreso de doble cara mostrada en la figura 7-65, y marque los valores del resistor.**





SECCIÓN 7-2 Análisis de circuitos resistivos en serie-paralelo

8. **Un cierto circuito se compone de dos resistores en paralelo. La resistencia total es de $667\ \Omega$. Uno de los resistores es de $1.0\ k\Omega$. ¿Cuál es el otro resistor?**

$$\boldsymbol{R_T} = \frac{R_1 R_2}{R_1 + R_2}$$

$$667 = \frac{1000R_2}{1000 + R_2}$$

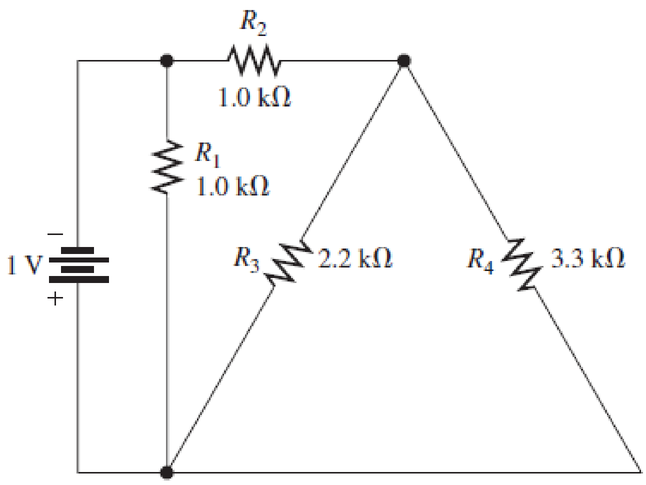
$$667000 + 667R_2 = 1000R_2$$

$$R_2 = \frac{667000}{333}$$

$$R_2 \approx 2\ \text{k}\Omega$$

10. **Repita el problema 9 para cada uno de los circuitos mostrados en la figura 7-63.**

a.



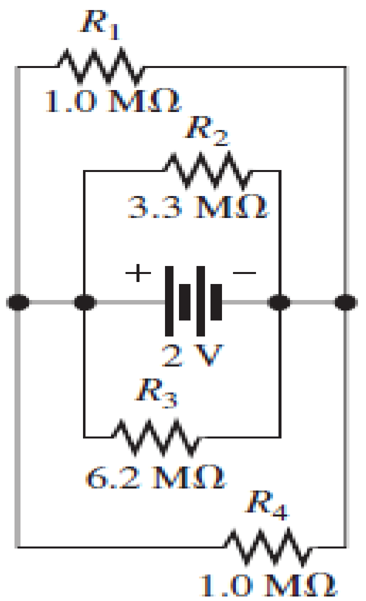
$$\boldsymbol{R_T = \frac{\left(\frac{R_3R_4}{R_3+R_4} + R_2\right)R_1}{\frac{R_3R_4}{R_3+R_4} + R_2 + R_1}};$$

$$R_T = \frac{(R_3R_4 + R_2R_3 + R_2R_4)R_1}{R_3R_4 + R_2R_3 + R_2R_4 + R_1R_3 + R_1R_4};$$

$$R_T = \left[\frac{\big(2.2(3.3) + 1(2.2) + 1(3.3)\big)1}{2.2(3.3) + 1(2.2) + 1(3.3) + 1(2.2) + 1(3.3)}\right]$$

$$\boldsymbol{R_T \approx 698.8\ \Omega}$$

b.



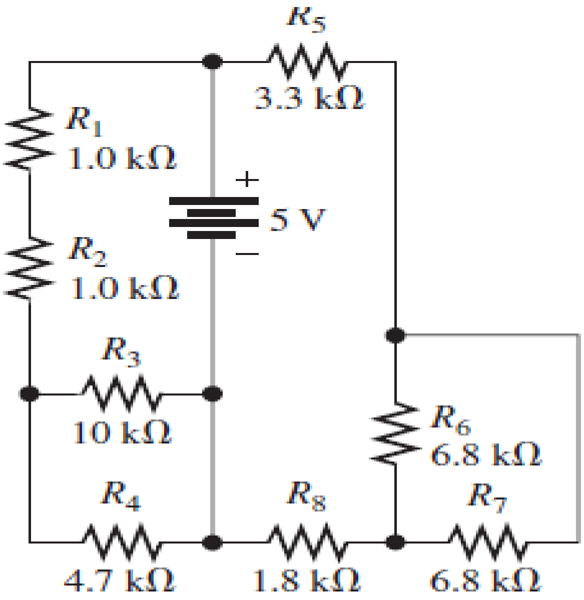
$$\boldsymbol{R_T = \frac{\left(\frac{R_1R_2}{R_1+R_2}\right)\left(\frac{R_3R_4}{R_3+R_4}\right)}{\frac{R_1R_2}{R_1+R_2} + \frac{R_3R_4}{R_3+R_4}}};$$

$$R_T = \frac{R_1R_2R_3R_4}{R_1R_2(R_3+R_4) + R_3R_4(R_1+R_2)};$$

$$R_T = \frac{1(3.3)(6.2)(1)}{1(3.3)(6.2+1) + 1(6.2)(1+3.3)};$$

$$\boldsymbol{R_T \approx 0.41\ \mu\Omega}$$

c.



$$\boldsymbol{R_T = \frac{R_A R_B}{R_A + R_B}};$$

$$\boldsymbol{R_A = \frac{R_6 R_7}{R_6 + R_7} + R_5 + R_8};$$

$$R_A = \frac{6.8}{2} + 3.3 + 1.8$$

$$\boldsymbol{R_A = 8.5\ k\Omega}$$

$$\boldsymbol{R_B = \frac{R_3 4}{R_3 + R_4} + R_1 + R_2};$$

$$R_B = \frac{10(4.7)}{10 + 4.7} + 1 + 1$$

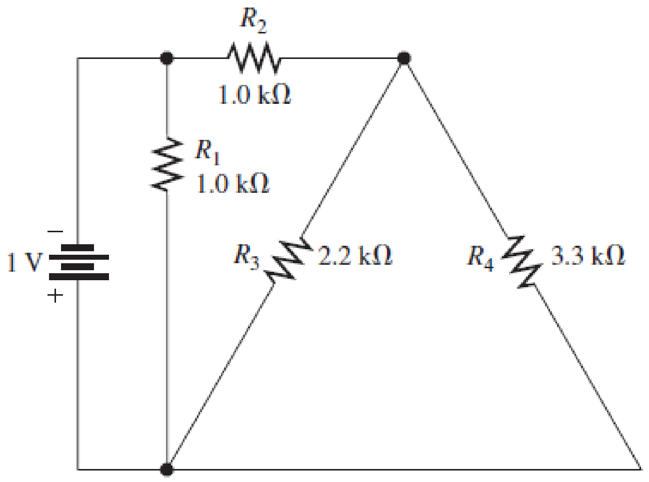
$$\boldsymbol{R_B = 5.19\ k\Omega}$$

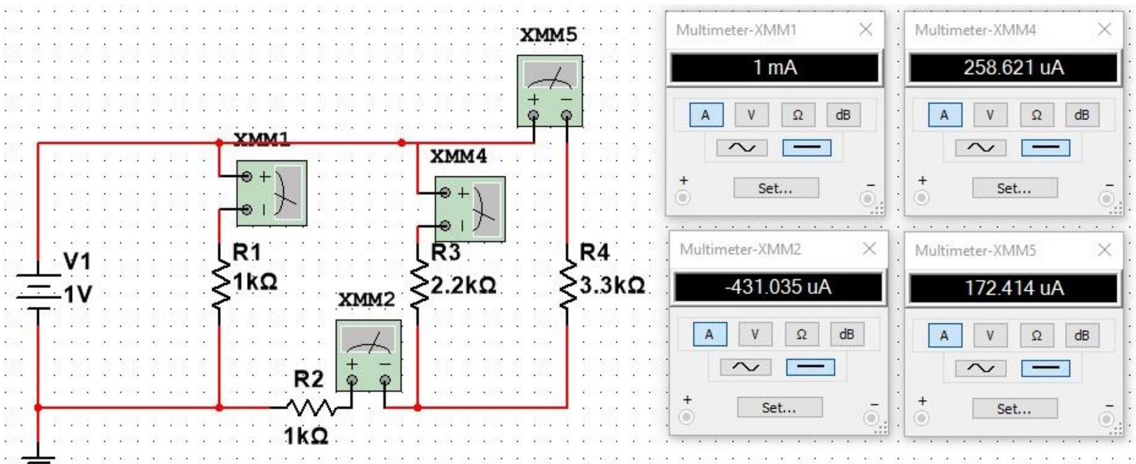
$$R_T = \frac{(8.5)(5.19)}{8.5 + 5.19};$$

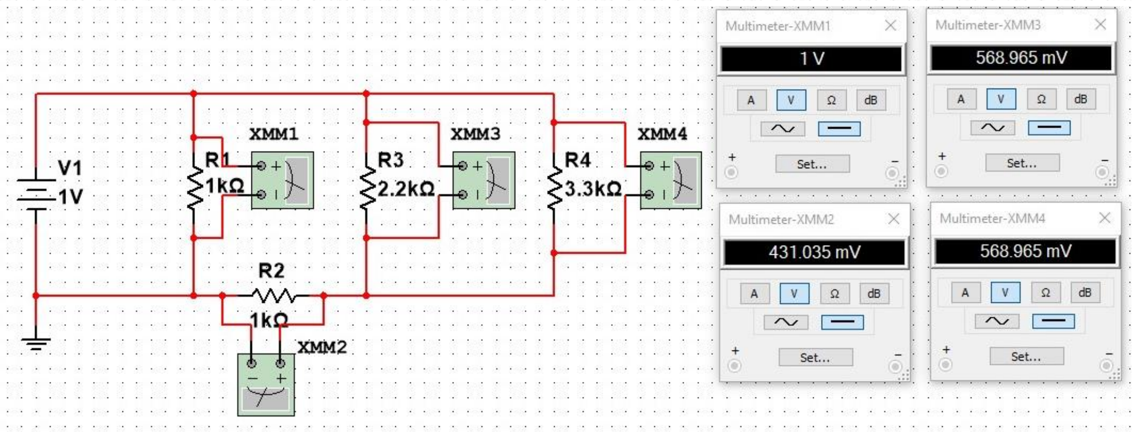
$$\boldsymbol{R_T = 3.22\ k\Omega}$$

12. Determine la corriente a través de cada resistor en cada circuito de la figura 7-63; luego calcule la caída del voltaje.

a.







$$V_1 = 1V$$
$$V_{3\|4+2} = 1V$$
$$I_1 = \frac{V_1}{R_1}$$

$$I_1 = \frac{1V}{1000\Omega}$$
$$I_1 = 1mA$$
$$I_{3\|4+2} = \frac{V_{3\|4+2}}{R_{3\|4+2}};$$
$$I_{3\|4+2} = \frac{1V}{2320\ \Omega};$$
$$I_{3\|4+2} = 431\ \mu A$$
$$I_{3\|4} = I_2 = 431\ \mu A$$

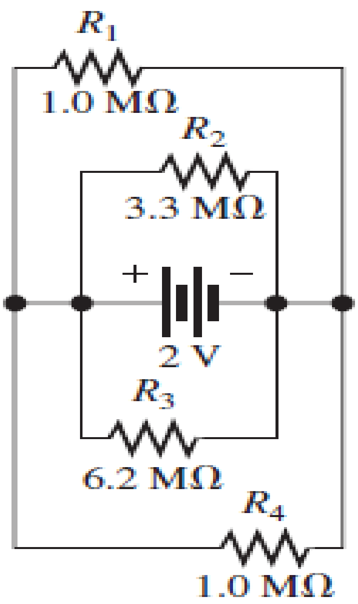
$$\boldsymbol{V_{3\|4} = I_{3\|4+2}R_{3\|4}};$$
$$V_{3\|4} = 0.000431(1320);$$
$$V_{3\|4} = 0.568\ V \approx 568\ mV$$
$$V_3 = V_4 = 568\ mV$$

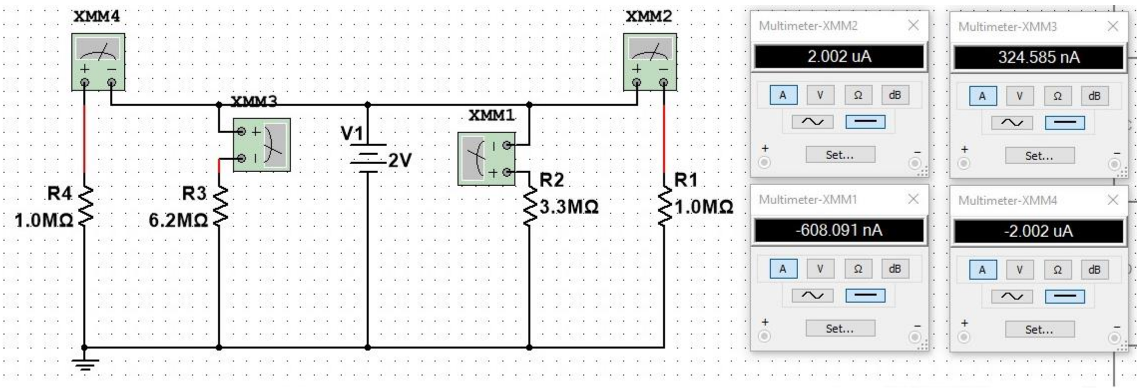
$$\boldsymbol{V_2} = I_{3\|4+2}R_2;$$
$$V_2 = 0.000431(1000);$$
$$V_2 = 0.431V \approx 431\ mV$$

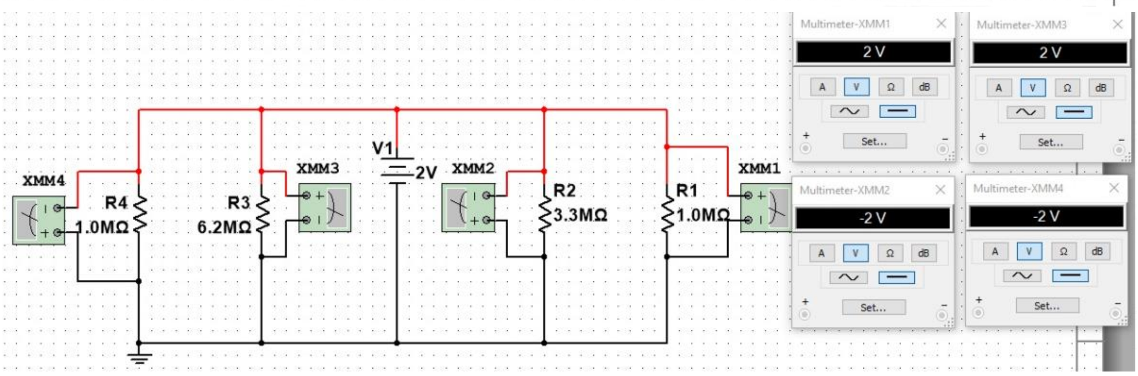
$$\boldsymbol{I_3 = \frac{V_{3\|4}}{R_3}};$$
$$I_3 = \frac{0.568}{2200};$$
$$I_3 = 258.18\ \mu A$$

$$\boldsymbol{I_4 = \frac{V_{3\|4}}{R_4}};$$
$$I_4 = \frac{0.568}{3300};$$
$$I_4 = 172.2\ \mu A$$

b.







$$\boldsymbol{I_T = \frac{V_1}{R_T}};$$

$$I_T = \frac{2}{0.41 * 10^6};$$

$$I_T = 4.88\ \mu A$$

$$V_1 = V_2 = V_3 = V_4 = 2V$$

$$\boldsymbol{I_1 = \frac{V_1}{R_1}};$$

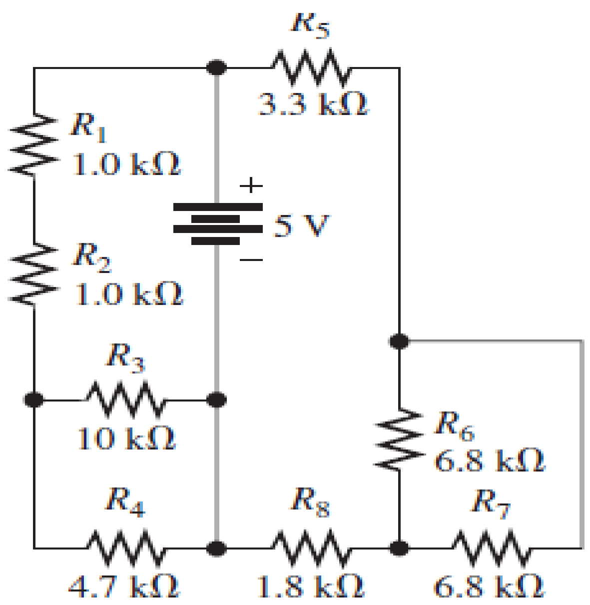
$$I_1 = \frac{2}{1 * 10^6};$$
$$I_1 = 2\ \mu A$$

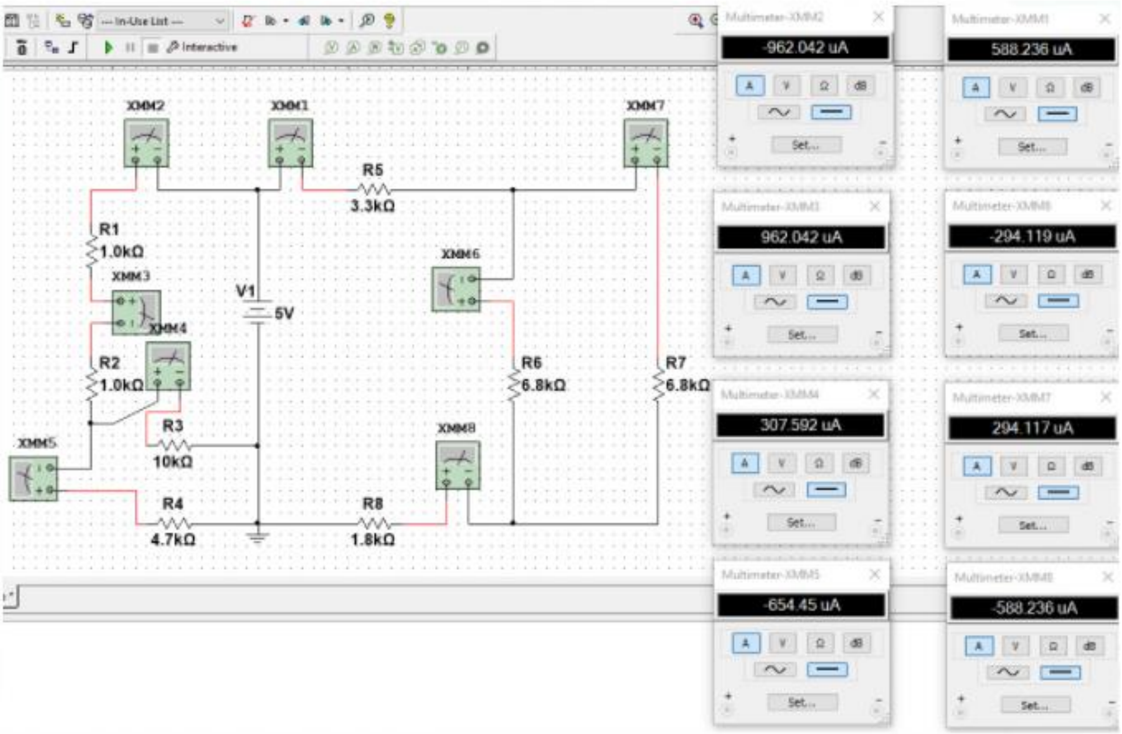
$$\boldsymbol{I_2} = \frac{\boldsymbol{V_2}}{\boldsymbol{R_2}};$$
$$I_2 = \frac{2}{3.3 * 10^6};$$
$$I_2 = 606\ nA$$

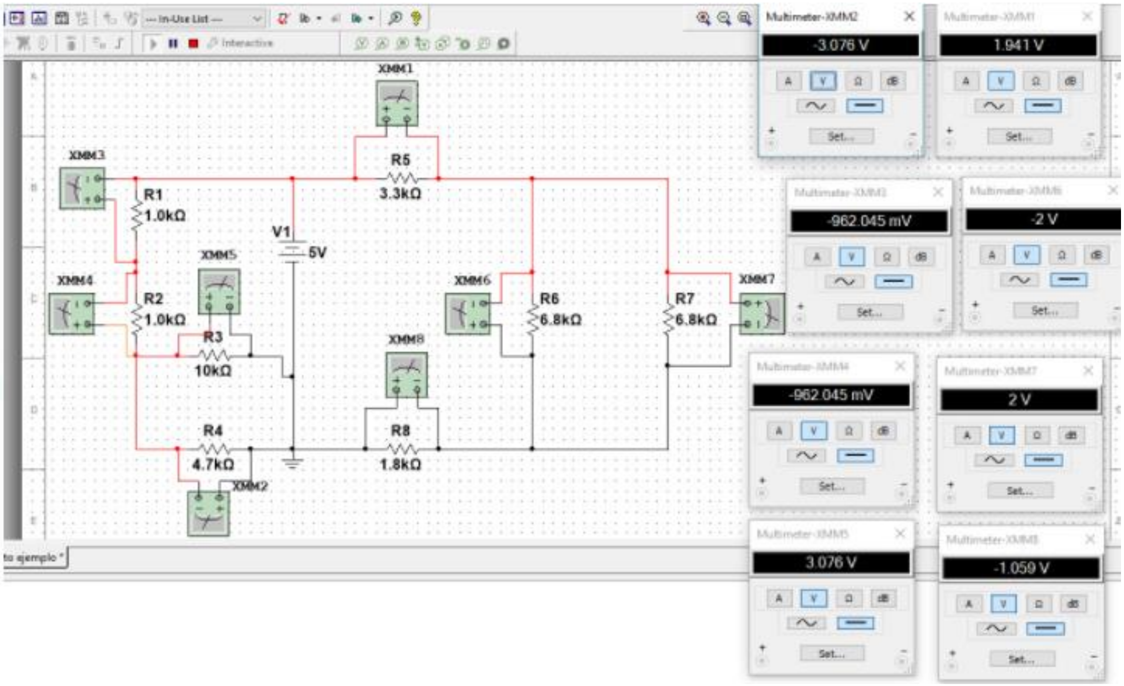
$$\boldsymbol{I_3} = \frac{\boldsymbol{V_3}}{\boldsymbol{R_3}};$$
$$I_3 = \frac{2}{6.2 * 10^6};$$
$$I_3 = 323\ nA$$

$$\boldsymbol{I_4} = \frac{\boldsymbol{V_4}}{\boldsymbol{R_4}};$$
$$I_4 = \frac{2}{1 * 10^6};$$
$$I_4 = 2\ \mu A$$

c.







$$\boldsymbol{I_T = \frac{V_S}{R_T};}$$

$$I_T = \frac{5}{3.23 * 10^6};$$

$$\boldsymbol{I_T = 1.55\ mA}$$

$$\boldsymbol{V_{3\|4+1+2} = V_{6\|7+5+8} = 5V}$$

$$\boldsymbol{I_5 = I_{6\|7};}$$

$$I_5 = \frac{5}{8500};$$
$$I_5 = 588.24\ \mu A$$

$$\boldsymbol{I_8 = \frac{V_{6\parallel 7+5+8}}{R_{6\parallel 7+5+8}}};$$
$$I_8 = 588.24\ \mu A$$
$$I_{6\parallel 7} = 588.24\ \mu A$$

$$\boldsymbol{V_5 = I_5 R_5};$$
$$V_5 = 588.24 * 10^{-6}(3300);$$
$$V_5 = 1.94\ V$$

$$\boldsymbol{V_{6\parallel 7} = I_{6\parallel 7}\, R_{6\parallel 7}};$$
$$V_{6\parallel 7} = 588.24 * 10^{-6}(3400);$$
$$V_{6\parallel 7} = 2V$$

$$\boldsymbol{V_6 = 2V}$$

$$\boldsymbol{V_7 = 2V}$$

$$\boldsymbol{V_8 = I_8 R_8};$$
$$V_8 = 588.24 * 10^{-6}(1800);$$
$$V_8 = 1.06\ V$$

$$\boldsymbol{I_6 = \frac{V_{6\parallel 7}}{R_6}};$$
$$I_6 = \frac{2}{6800};$$
$$I_6 = 294.18\ \mu A$$

$$\boldsymbol{I_7 = \frac{V_{6\parallel 7}}{R_7}};$$
$$I_7 = \frac{2}{6800};$$
$$I_7 = 294.218\ \mu A$$

$$\boldsymbol{V_{3\parallel 4+1+2} = 5V}$$

$$\boldsymbol{I_1 = I_2 = I_{2\parallel 4} = \frac{V_{3\parallel 4+1+2}}{R_{3\parallel 4+1+2}}};$$
$$I_1 = \frac{5}{5200};$$

$$\boldsymbol{I_1 = 962\ \mu A}$$

$$\boldsymbol{I_2 = 962\ \mu A}$$

$$\boldsymbol{I_{3\|4} = 962\ \mu A}$$

$$\boldsymbol{V_1 = I_1 R_1};$$
$$V_1 = 962 * 10^{-6}(1000);$$
$$V_1 = 0.96\ V$$

$$\boldsymbol{V_2 = I_2 R_2};$$
$$V_2 = 962 * 10^{-6}(1000);$$
$$V_2 = 0.96\ V$$

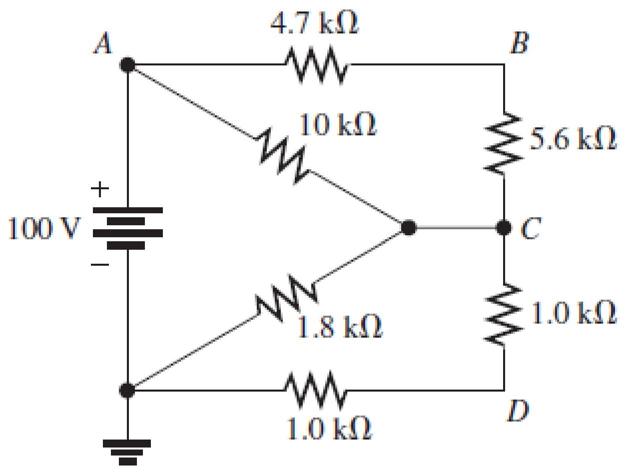
$$\boldsymbol{V_{3\|4} = I_{3\|4}}$$
$$R_{3\|4} \rightarrow V_{3\|4} = 962 * 10^{-6}(3200);$$
$$V_{3\|4} = 3.08\ V$$

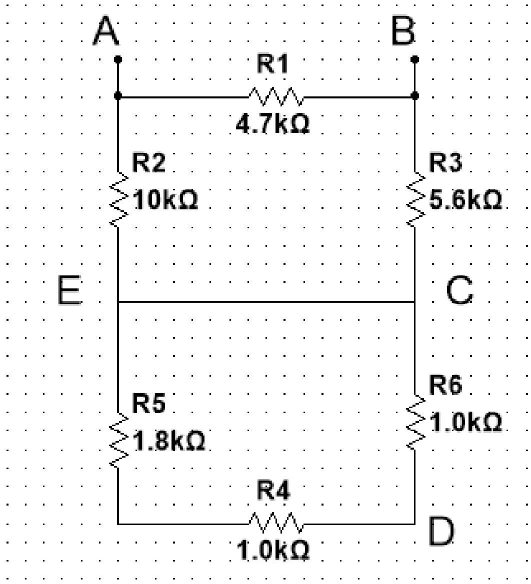
$$\boldsymbol{V_3 = V_4 = 3.08\ V}$$

$$\boldsymbol{I_3 = \frac{V_3}{R_3}};$$
$$I_3 = \frac{3.08}{10000};$$
$$I_3 = 3.08\ \mu A$$

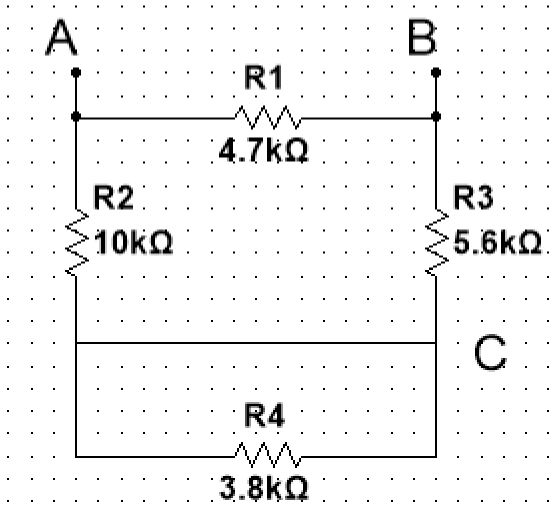
$$\boldsymbol{I_4 = \frac{V_4}{R_4}};$$
$$I_3 = \frac{3.08}{4700};$$
$$I_3 = 655.32\ \mu A$$

14. Determine la resistencia entre A y B en la figura 7-67 sin la fuente.

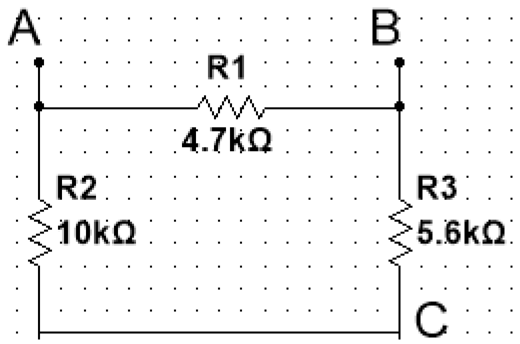




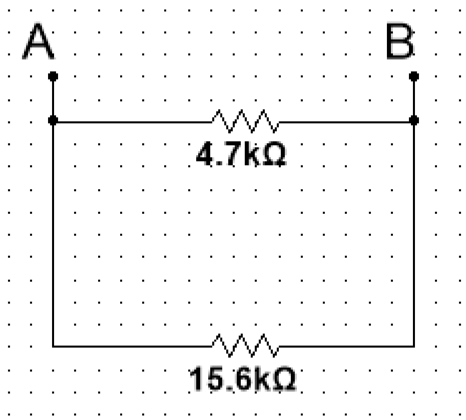
$$1.8 + 1.0 + 1.0 = 3.8\ k\Omega$$



$$0\Omega || 3.8\ k\Omega = 0\Omega$$



$$10 + 5.6 = 15.6\ k\Omega$$



La resistencia equivalente entre A y B es la combinación en paralelo de las resistencias $4.7\ k\Omega\ y\ 15.6\ k\Omega$.

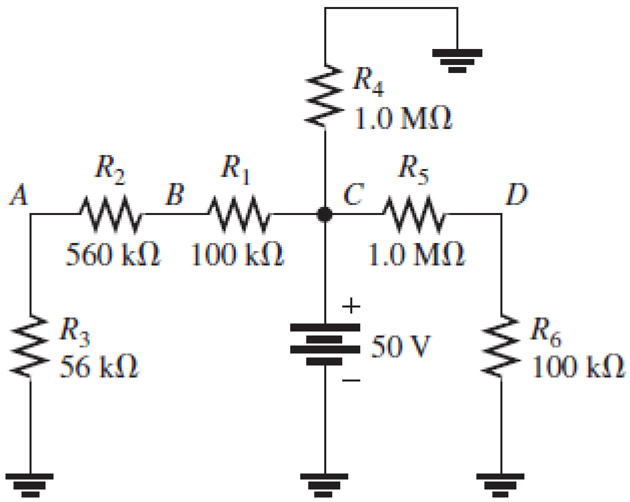
$$R_{AB} = 4.7||15.6;$$

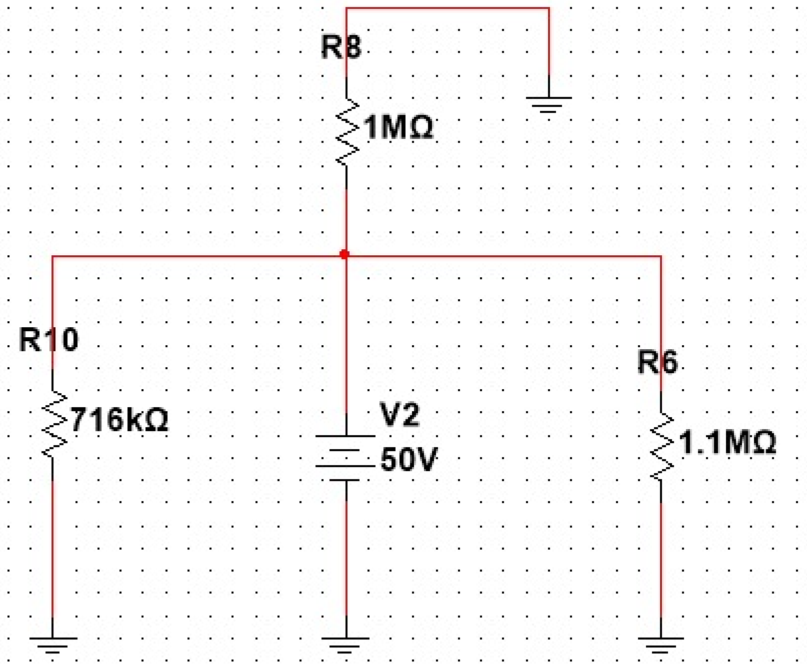
$$R_{AB} = \frac{4.7 * 15.6}{4.7 + 15.6};$$

$$R_{AB} = 3.61\ k\Omega$$

Por lo tanto, la resistencia entre A y B es $3.61\ k\Omega$

16. Determine el voltaje en cada nodo con respecto a tierra en la figura 7-68.

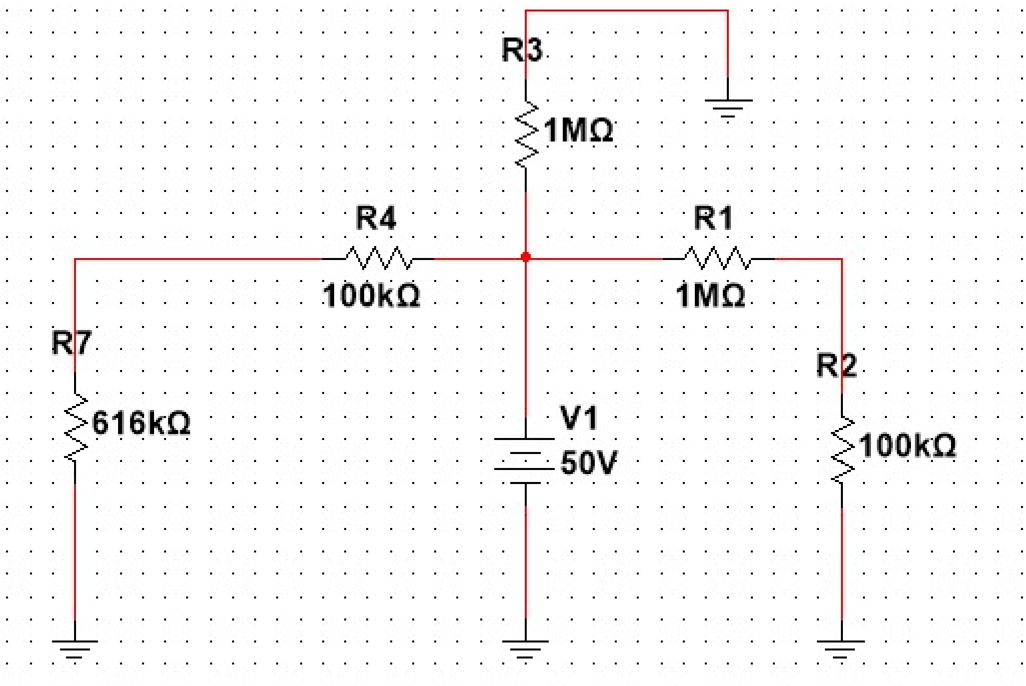




$$\boldsymbol{V_X} = \left(\frac{\boldsymbol{R_X}}{\boldsymbol{R_T}}\right)\boldsymbol{V_5};$$

$$V_A = \left(\frac{56}{716}\right)50;$$

$$V_A = 3.91\ V$$

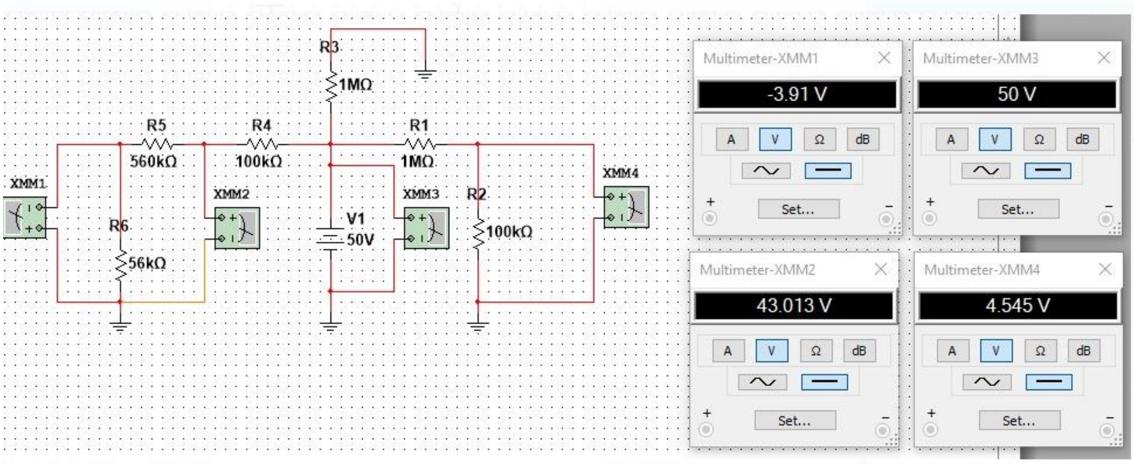


$$V_B = \left(\frac{56}{716}\right)50;$$

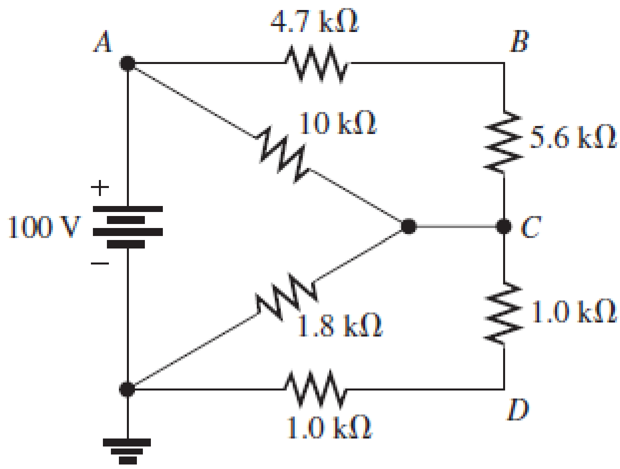
$$V_B = 43.02\ V$$

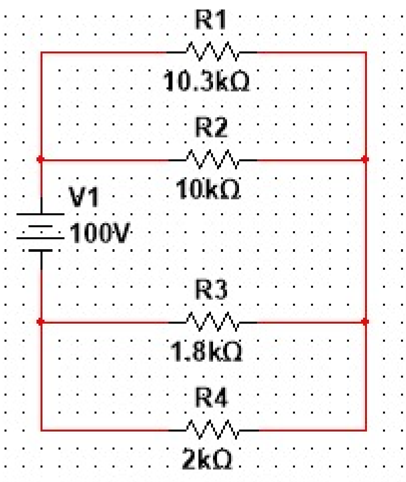
$$V_C = 50\ V$$

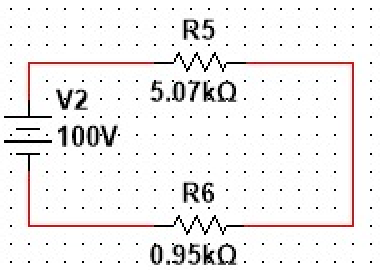
$$V_D = \left(\frac{1}{11}\right) 50;$$
$$V_D = 4.55\ V$$

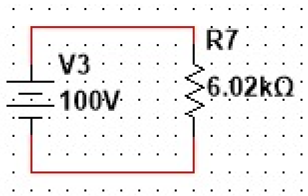


18. Determine la resistencia del circuito mostrado en la figura 7-67 como se ve desde la fuente de voltaje.









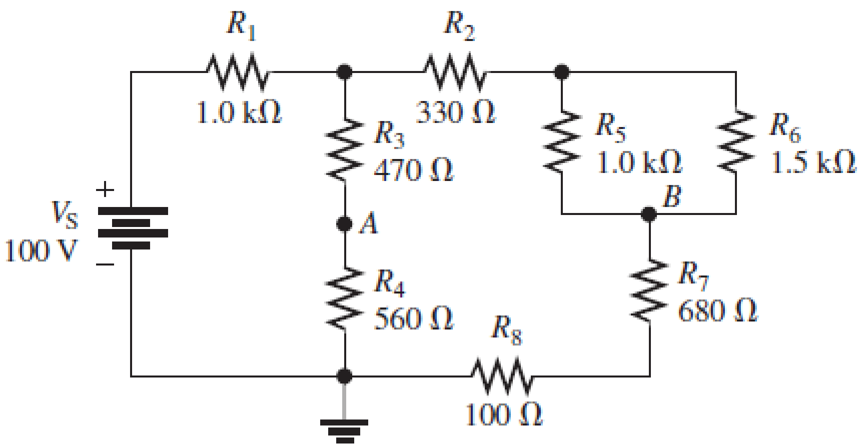
$$R_{AC} = 4.7 + 5.6;$$
$$R_{AC} = 10.3\ k\Omega$$

$$R_A' = \frac{10.3 * 10}{10.3 + 10};$$
$$R_A' = \frac{103}{20.3};$$
$$R_A' = 5.07\ k\Omega$$

$$R_C = 1.0 + 1.0;$$
$$R_C = 2.0\ k\Omega$$

$$R_C{}' = \frac{1.8 * 2.0}{1.8 + 2.0};$$
$$R_C{}' = \frac{3.6}{3.8};$$
$$R_C{}' = 0.95\ k\Omega$$
$$R_T = 5.07 + 0.94;$$
$$R_T = 6.02\ k\Omega$$

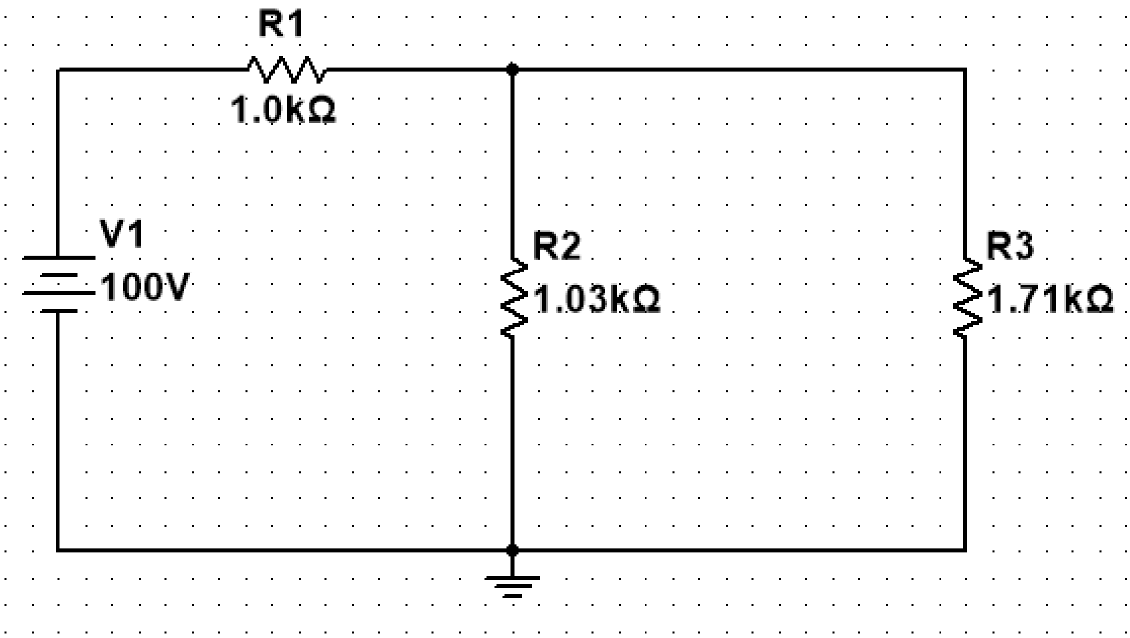
20. Determine el voltaje, V_{AB}, en la figura 7-69



$$\boldsymbol{V_{AB} = V_A - V_B};$$
$$R_{3+4} = R_3 + R_4;$$
$$R_{3+4} = 470 + 560;$$
$$R_{3+4} = 1.03\ k\Omega$$

$$R_{5\parallel 6} = \frac{R_5 R_6}{R_5 + R_6};$$
$$R_{5\parallel 6} = \frac{(1.0)(1.5)}{(1.0) + (1.5)};$$
$$R_{5\parallel 6} = 0.6\ k\Omega$$

$$R_{2+(5\parallel 6)7+8} = R_2 + R_{5\parallel 6} + R_7 + R_8;$$
$$R_{2+(5\parallel 6)7+8} = 330 + 0.6 + 680 + 100;$$
$$R_{2+(5\parallel 6)7+8} = 1.71\ k\Omega$$



$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)};$$
$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)} = \frac{R_{(2+(5\parallel 6)+7+8)} R_{3+4}}{R_{(2+(5\parallel 6)+7+8)} + R_{3+4}};$$
$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)} = \frac{(1.71)(1.03)}{(1.71) + (1.03)};$$
$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)} = \frac{1.76}{2.74};$$
$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)} = 0.642\ k\Omega$$

$$R_{(2+(5\parallel 6)+7+8)\parallel(3+4)}\ es\ V_{(2+(5\parallel 6)+7+8)\parallel(3+4)}$$
$$V_X = \left(\frac{R_X}{R_T}\right) V_S;$$
$$R_T = R_1 + R_{(2+(5\parallel 6)+7+8)\parallel(3+4)}$$

$$R_T = 1.0 + 0.642$$
$$R_T = 1.642\ k\Omega$$

$$V_{(2+(5\|6)+7+8)\|(3+4)} = \left(\frac{R_{(2+(5\|6)+7+8)\|(3+4)}}{R_T}\right)V_S;$$
$$V_{(2+(5\|6)+7+8)\|(3+4)} = \left(\frac{0.642}{1.642}\right)(100);$$
$$V_{(2+(5\|6)+7+8)\|(3+4)} = (0.39)(100);$$
$$V_{(2+(5\|6)+7+8)\|(3+4)} = 39\ V$$

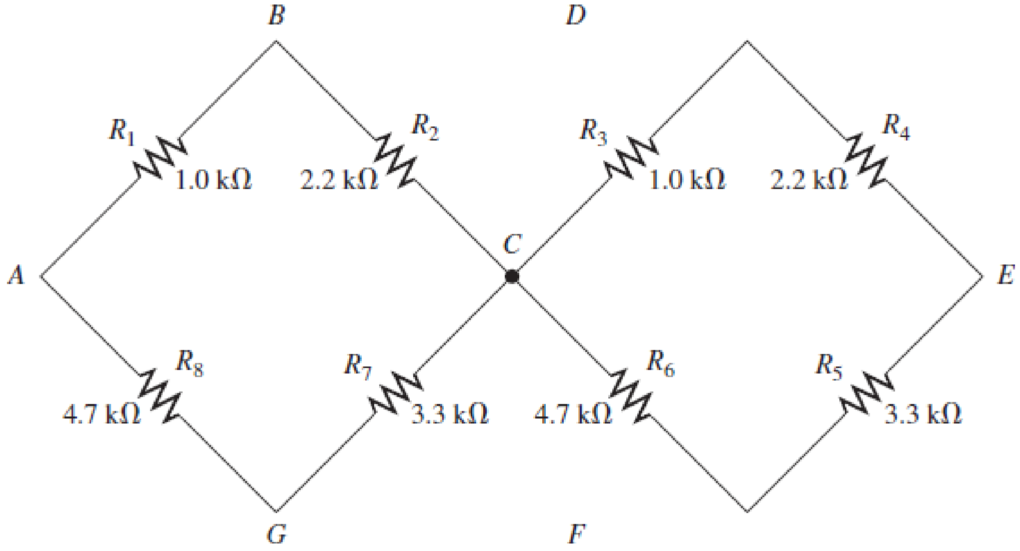
$$R_4 = V_A;$$
$$V_X = \left(\frac{R_X}{R_T}\right)V_S;$$
$$V_A = \left(\frac{R_4}{R_{3+4}}\right)(V_{(2+(5\|6)+7+8)\|(3+4)};$$
$$V_A = \left(\frac{R_4}{R_3 + R_4}\right)\left(V_{(2+(5\|6)+7+8)\|(3+4)}\right);$$
$$V_A = \left(\frac{560}{470 + 560}\right)(39);$$
$$V_A = \left(\frac{560}{1.03}\right)(39);$$
$$V_A = (0.544)(39);$$
$$V_A = 21.21\ V$$

$$R_{7+8}$$
$$V_B = \left(\frac{R_{7+8}}{R_{2+(5\|6)+7+8}}\right)\left(V_{(2+(5\|6)+7+8)\|(3+4)}\right);$$
$$V_B = \left(\frac{R_7 + R_8}{R_2 + R_{5\|6} + R_7 + R_8}\right)\left(V_{(2+(5\|6)+7+8)\|(3+4)}\right);$$
$$V_B = \left(\frac{680 + 100}{330 + 0.6 + 680 + 100}\right)(39);$$
$$V_B = \left(\frac{780}{1.71}\right)(39);$$
$$V_B = 17.78\ V$$

$$V_{AB} = V_A - V_B;$$
$$V_A = 21.21\ V$$
$$V_B = 17.78\ V$$

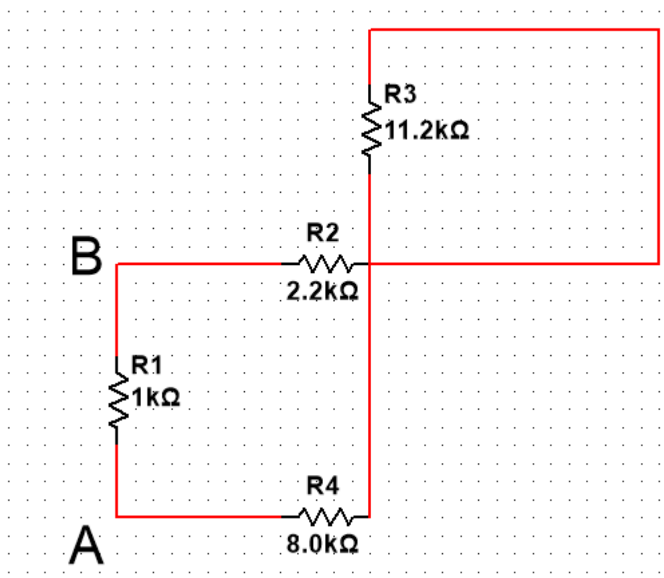
$$V_{AB} = 21.21 - 17.78;$$
$$V_{AB} = 3.43\ V$$

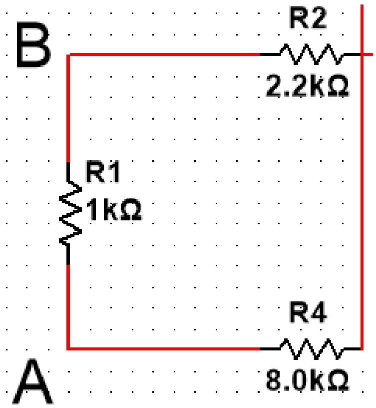
22. En la figura 7-71, determine la resistencia entre el nodo A y cada uno de los demás nodos ($\boldsymbol{R_{AB}, R_{AC}, R_{AD}, R_{AE}, R_{AF}, R_{AG}}$)



$$R_{3+4+5+6} = R_3 + R_4 + R_5 + R_6;$$
$$R_{3+4+5+6} = 1.0 + 2.2 + 3.3 + 4.7;$$
$$R_{3+4+5+6} = 11.20\ k\Omega$$

$$R_{7+8} = R_7 + R_8;$$
$$R_{7+8} = 3.3 + 4.7;$$
$$R_{7+8} = 8.0\ k\Omega$$





$$R_{2+(7+8)} = R_2 + R_{7+8};$$
$$R_{2+(7+8)} = 2.2 + 8.0;$$
$$R_{2+(7+8)} = 10.2\ k\Omega$$

$$R_{1\|(2+(7+8))} = \frac{R_1 R_{2+(7+8)}}{R_1 + R_{2+(7+8)}};$$
$$R_{1\|(2+(7+8))} = \frac{(1.0)(10.2)}{(1.0) + (10.2)};$$
$$R_{1\|(2+(7+8))} = \frac{10.2}{11.2};$$
$$R_{1\|(2+(7+8))} = 0.91\ k\Omega$$

$$R_{AB} = R_{1\|(2+(7+8))};$$
$$R_{AB} = 0.91\ k\Omega$$

$$R_{1+2} = R_1 + R_2;$$
$$R_{1+2} = 1.0 + 2.2;$$
$$R_{1+2} = 3.2\ k\Omega$$

$$R_{(1+2)\|(7+8)} = \frac{R_{1+2} R_{7+8}}{R_{1+2} + R_{7+8}};$$
$$R_{(1+2)\|(7+8)} = \frac{(3.2)(8.0)}{3.2 + 8.0};$$
$$R_{(1+2)\|(7+8)} = \frac{25.6}{11.2};$$
$$R_{(1+2)\|(7+8)} = 2.285\ k\Omega$$

$$R_{AC} = R_{(1+2)\|(7+8)};$$
$$R_{AC} = 2.28\ k\Omega$$

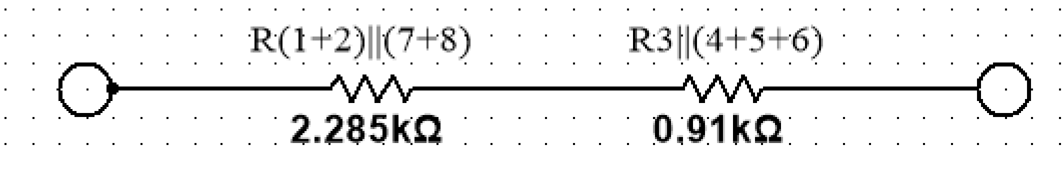
$$R_{4+5+6} = R_4 + R_5 + R_6;$$
$$R_{4+5+6} = 2.2 + 3.3 + 4.7;$$

$$R_{4+5+6} = 10.20$$

$$R_{1+2} = R_1 + R_2;$$
$$R_{1+2} = 1.0 + 2.2;$$
$$R_{1+2} = 3.2\ k\Omega$$

$$R_{3\parallel(4+5+6)} = \frac{R_3 R_{4+5+6}}{R_3 + R_{4+5+6}};$$
$$R_{3\parallel(4+5+6)} = \frac{(1.0)(10.2)}{(1.0) + (10.2)};$$
$$R_{3\parallel(4+5+6)} = \frac{10.2}{11.2};$$
$$R_{3\parallel(4+5+6)} = 0.91\ k\Omega$$

$$R_{(1+2)\parallel(7+8)} = \frac{R_{1+2} R_{7+8}}{R_{1+2} + R_{7+8}};$$
$$R_{(1+2)\parallel(7+8)} = \frac{(3.2)(8.0)}{3.2 + 8.0};$$
$$R_{(1+2)\parallel(7+8)} = \frac{25.6}{11.2};$$
$$R_{(1+2)\parallel(7+8)} = 2.285\ k\Omega$$



$$R_{[(1+2)\parallel(7+8)]+[3\parallel(4+5+6)]} = R_{1+2\parallel7+8} R_{3\parallel4+5+6}$$
$$R_{[(1+2)\parallel(7+8)]+[3\parallel(4+5+6)]} = 2.285 + 0.91;$$
$$R_{[(1+2)\parallel(7+8)]+[3\parallel(4+5+6)]} = 3.195\ k\Omega$$

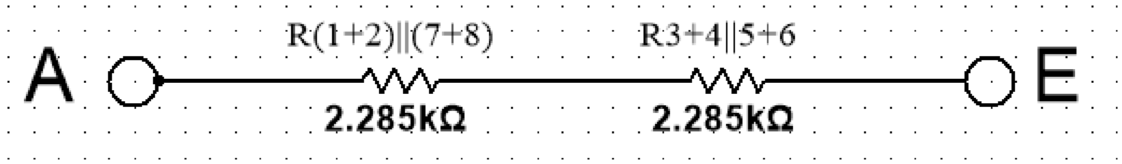
$$R_{AD} = R_{[(1+2)\parallel(7+8)]+[3\parallel(4+5+6)]}$$
$$R_{AD} = 3.195\ k\Omega$$

$$R_{5+6} = R_5 + R_6;$$
$$R_{5+6} = 3.3 + 4.7;$$
$$R_{5+6} = 8.0\ k\Omega$$

$$R_{3+4} = R_3 + R_4;$$
$$R_{3+4} = 1.0 + 2.2;$$
$$R_{3+4} = 3.2\ k\Omega$$

$$R_{(3+4)\parallel(5+6)} = \frac{R_{3+4} R_{5+4}}{R_{3+4} + R_{5+4}};$$

$$R_{(3+4)\|(5+6)} = \frac{(3.2)(8.0)}{3.2 + 8.0};$$
$$R_{(3+4)\|(5+6)} = \frac{25.6}{11.2};$$
$$R_{(3+4)\|(5+6)} = 2.285\ k\Omega$$

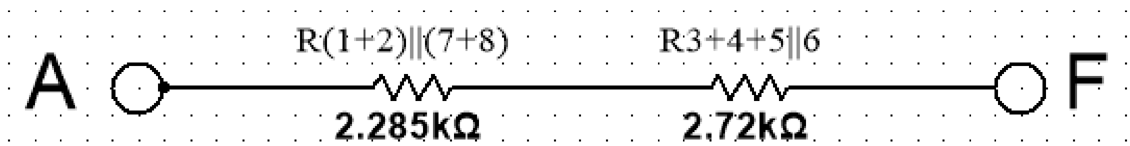


$$R_{[(1+2)\|(7+8)]+[3+4\|5+6]} = R_{1+2\|7+8}R_{3+4\|5+6}$$
$$R_{[(1+2)\|(7+8)]+[3+4\|5+6]} = 2.285 + 2.285;$$
$$R_{[(1+2)\|(7+8)]+[3+4\|5+6]} = 4.57\ k\Omega$$

$$R_{AE} = R_{[(1+2)\|(7+8)]+[3+4\|5+6]}$$
$$R_{AE} = 4.57\ k\Omega$$

$$R_{3+4+5} = R_3 + R_4 + R_5;$$
$$R_{3+4+5} = 1.0 + 2.2 + 3.3;$$
$$R_{3+4+5+6} = 6.5\ k\Omega$$

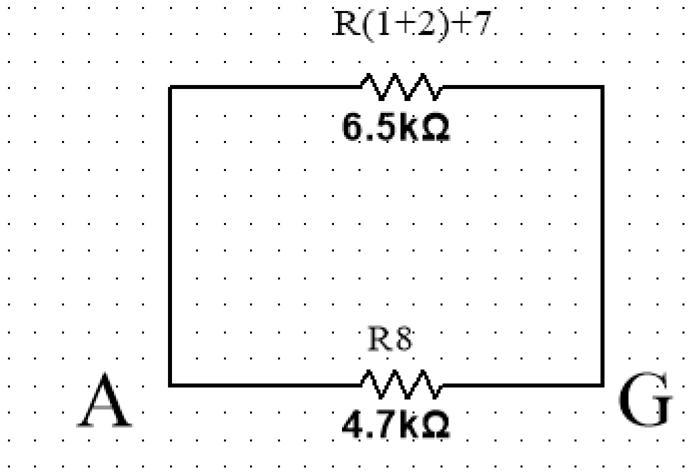
$$R_{6\|(3+4+5)} = \frac{R_6 R_{3+4+5}}{R_6 + R_{3+4+5}};$$
$$R_{6\|(3+4+5)} = \frac{(4.7)(6.5)}{(4.7) + (6.5)};$$
$$R_{6\|(3+4+5)} = \frac{30.55}{11.2};$$
$$R_{6\|(3+4+5)} = 2.727\ k\Omega$$



$$R_{[(1+2)\|(7+8)]+[6\|3+4+5]} = R_{1+2\|7+8}R_{6\|3+4+5}$$
$$R_{[(1+2)\|(7+8)]+[6\|3+4+5]} = 2.285 + 2.727;$$
$$R_{[(1+2)\|(7+8)]+[6\|3+4+5]} = 5.012\ k\Omega$$

$$R_{AF} = R_{[(1+2)\|(7+8)]+[6\|3+4+5]}$$
$$R_{AF} = 5.012\ k\Omega$$

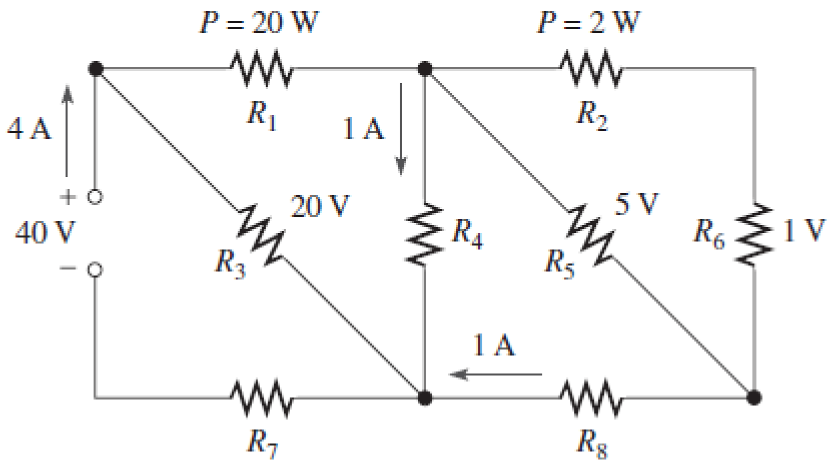
$$R_{(1+2)+7} = R_{1+2} + R_7;$$
$$R_{(1+2)+7} = 3.2 + 3.3;$$
$$R_{(1+2)+7} = 6.5\ k\Omega$$



$$R_{((1+2)+7)\parallel 8} = \frac{R_{(1+2)+7}R_8}{R_{(1+2)+7} + R_8};$$
$$R_{((1+2)+7)\parallel 8} = \frac{(6.5)(4.7)}{(6.54) + (4.7)};$$
$$R_{((1+2)+7)\parallel 8} = \frac{30.55}{11.2};$$
$$R_{((1+2)+7)\parallel 8} = 2.72\ k\Omega$$

$$R_{AG} = R_{((1+2)+7)\parallel 8};$$
$$R_{AG} = 2.72\ k\Omega$$

24. Determine el valor de cada resistor mostrado en la figura 7-73.



$$V_S = 40\ V$$
$$I_T = 4\ A$$
$$V_3 = 20\ V$$
$$V_5 = 5\ V$$
$$V_6 = 1\ V$$
$$P_1 = 20\ W$$
$$P_2 = 2\ W$$
$$I_4 = 1\ mA$$
$$I_8 = 1\ mA$$
$$V_{2+6} = 5V$$
$$V_{2+6} = V_2 + V_6$$
$$5 = V_2 + 1$$
$$V_2 = 4\ V$$

$$I_2 = \frac{P_2}{V_2};$$
$$I_2 = \frac{2}{4}$$
$$I_2 = 0.5\ A$$

$$R_2 = \frac{V_2}{I_2};$$
$$R_2 = \frac{4}{0.5};$$
$$R_2 = 8\Omega$$

$$R_6 = \frac{V_6}{I_2};$$
$$R_6 = \frac{1}{0.5};$$
$$R_6 = 2\Omega$$

$$I_8 - I_2 - I_5 = 0;$$
$$I_5 = I_8 - I_2;$$
$$I_5 = 1 - 0.5;$$
$$I_5 = 0.5\ A$$

$$R_5 = \frac{V_5}{I_5};$$
$$R_5 = \frac{5}{0.5};$$
$$R_5 = 10\ \Omega$$

$$-I_1 + I_2 + I_4 + I_5 = 0;$$

$$I_1 = I_2 + I_4 + I_5;$$
$$I_1 = 1 + 0.5 + 0.5;$$
$$I_1 = 2\ A$$

$$V_1 = \frac{P_1}{I_1};$$
$$V_1 = \frac{20}{2}$$
$$V_1 = 10\ V$$

$$R_1 = \frac{V_1}{I_1};$$
$$R_1 = \frac{10}{2};$$
$$R_1 = 5\Omega$$

$$V_S = V_3 + V_7;$$
$$V_7 = V_S - V_3;$$
$$V_7 = 40 - 20;$$
$$V_7 = 20\ V$$
$$I_T = I_7;$$
$$I_T = 4$$

$$R_7 = \frac{V_7}{I_7};$$
$$R_7 = \frac{20}{4};$$
$$R_7 = 5\Omega$$

$$I_7 - I_3 - I_4 - I_8 = 0$$
$$I_3 = I_7 - I_4 - I_8;$$
$$I_3 = 4 - 1 - 1;$$
$$I_3 = 2\ A$$

$$R_3 = \frac{V_3}{I_3};$$
$$R_3 = \frac{20}{2}$$
$$R_3 = 10\Omega$$

$$V_3 = V_1 + V_4;$$
$$V_4 = V_3 - V_1;$$
$$V_4 = 20 - 10$$
$$V_4 = 10\ V$$

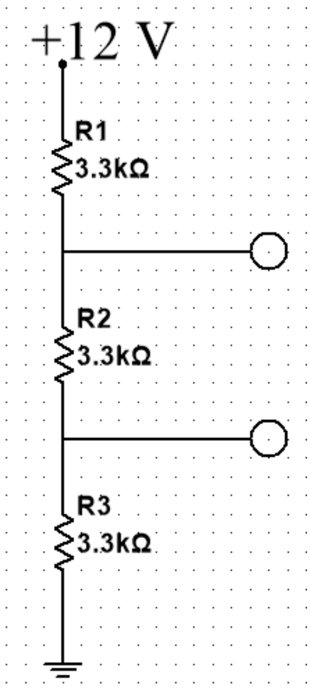
$$R_4 = \frac{V_4}{I_4};$$
$$R_4 = \frac{10}{1}$$
$$R_4 = 10\Omega$$

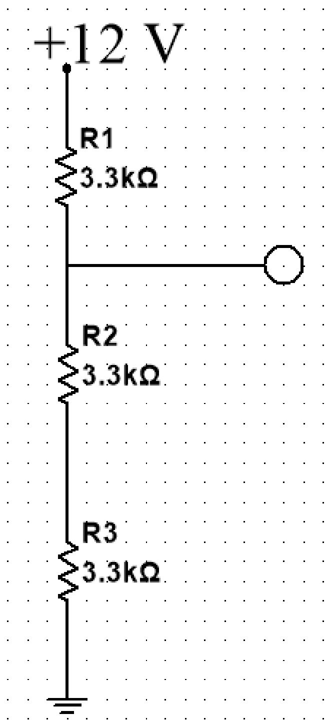
$$V_4 = V_8 + V_5;$$
$$V_8 = V_4 - V_5;$$
$$V_8 = 10 - 5;$$
$$V_8 = 5\ V$$

$$R_8 = \frac{V_8}{I_8};$$
$$R_8 = \frac{5}{1}$$
$$R_8 = 5\ \Omega$$

SECCIÓN 7-3 Divisores de voltaje con cargas resistivas.

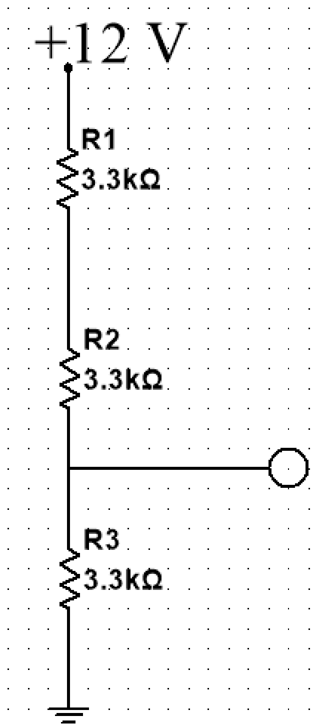
26. **La salida de una batería de $12\ V$ se divide para obtener dos voltajes de salida. Se utilizan tres resistores de $3.3\ k\Omega$ para proporcionar dos tomas. Determine los voltajes de salida. Si se conecta una carga de $10\ k\Omega$ a la más alta de las salidas. ¿Cuál será su valor con carga?**



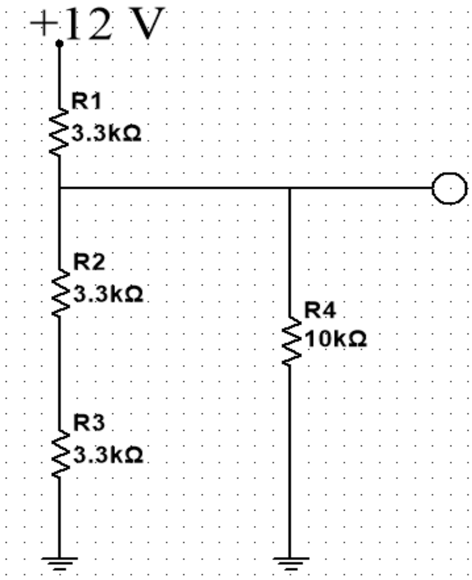


$$R_T = 3.3 + 3.3 + 3.3$$
$$R_T = 9.9\ k\Omega$$

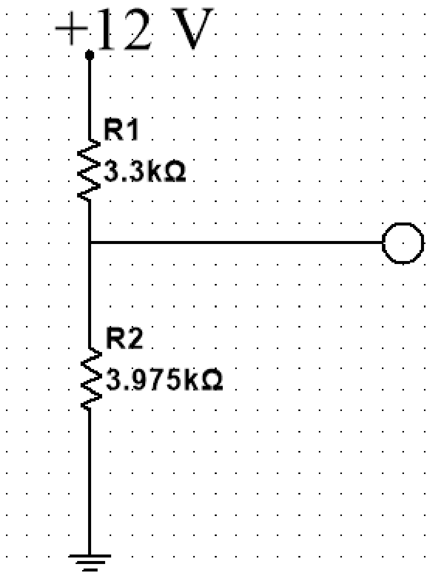
$$V_S = \left(\frac{3.3 + 3.3}{9.9}\right)(12)$$
$$V_S = \left(\frac{6.6}{9.9}\right)(12);$$
$$V_S = \left(\frac{2}{3}\right)(12);$$
$$V_S = 8\ V$$



$$V_S = \left(\frac{3.3}{9.9}\right)(12);$$
$$V_S = \left(\frac{1}{3}\right)(12)$$
$$V_S = 4\ V$$



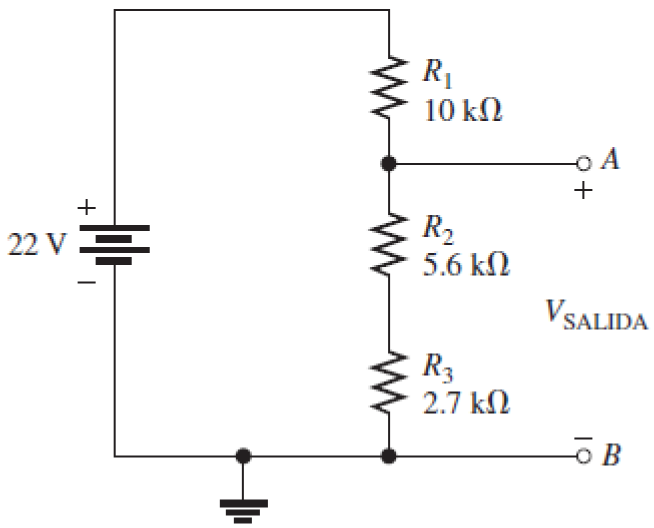
$$R_S = \frac{(6.6)(10)}{(6.6) + 10};$$
$$R_S = \frac{66}{16.6};$$
$$R_S = 3.975\ k\Omega$$



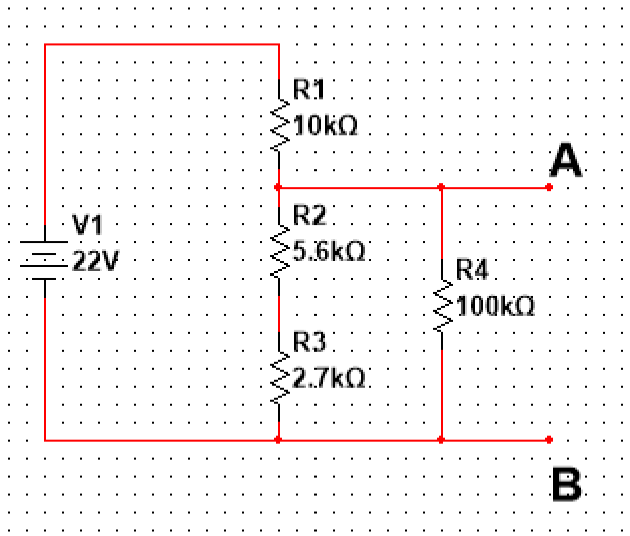
$$R_S = 3.3 + 3.975;$$
$$R_S = 7.275\ k\Omega$$

$$V_S = \left(\frac{3.975}{7.275}\right)(12)$$
$$V_S = (0.54644)(12);$$
$$V_S = 6.557\ v$$

28. En la figura 7-74, determine el voltaje de salida sin carga entra las terminales de salida. Con una carga de $100\ k\Omega$ conectada de A hacia B, ¿Cuál es el voltaje de salida?



$$R_{2+3} = R_2 + R_3$$
$$R_{2+3} = 5.6k\Omega + 2.7k\Omega$$
$$R_{2+3} = 8.3k\Omega$$
$$V_{AB} = \left(\frac{R_{2+3}}{R_T}\right)V_S$$
$$R_T = R_1 + R_2 + R_3$$
$$R_T = 18.3k\Omega$$
$$V_{AB} = \left(\frac{8.3}{18.3}\right)22$$
$$V_{AB} = 9.97V$$



$$R_{(2+3)ll4} = \left(\frac{R_{2+3}\ x\ R_4}{R_{2+3} +\ R_4}\right)$$

$$R_{(2+3)ll4} = \left(\frac{8.3\ x\ 100}{8.3 + 100}\right)$$

$$R_{(2+3)ll4} = 7.66k\Omega$$

$$V_{AB} = \left(\frac{R_{(2+3)ll4}}{R_T}\right)V_S$$

$$R_{1+((2+3)ll4)} = R_1 + R_{(2+3)ll4}$$

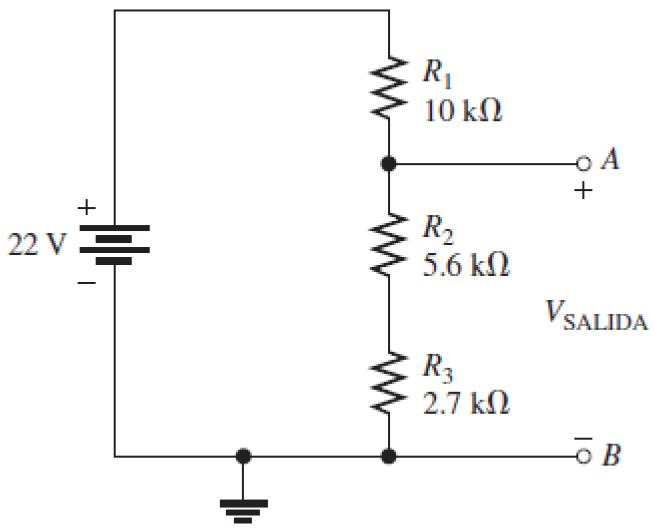
$$R_{1+((2+3)ll4)} = 10 + 7.66$$

$$R_{1+((2+3)ll4)} = 17.66k\Omega$$

$$V_{AB} = \left(\frac{7.66}{17.66}\right)22$$

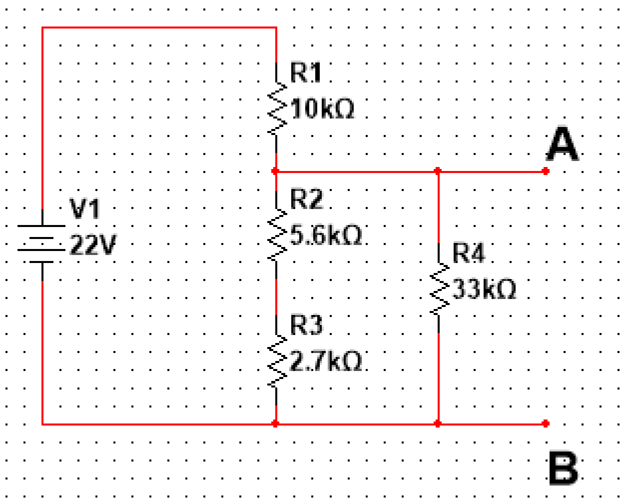
$$V_{AB} = 9.54V$$

30. En la figura 7-74, determine la corriente continua extraída de la fuente sin carga entre las terminales de salida. Con una carga de 33 $k\Omega$, ¿Cuál es la corriente extraída?



$$R_{2+3} = R_2 + R_3$$
$$R_{2+3} = 5.6 + 2.7$$
$$R_{2+3} = 8.3k\Omega$$
$$R_T = R_1 + R_2 + R_3$$
$$R_T = 10 + 5.6 + 2.7$$
$$R_T = 18.3k\Omega$$

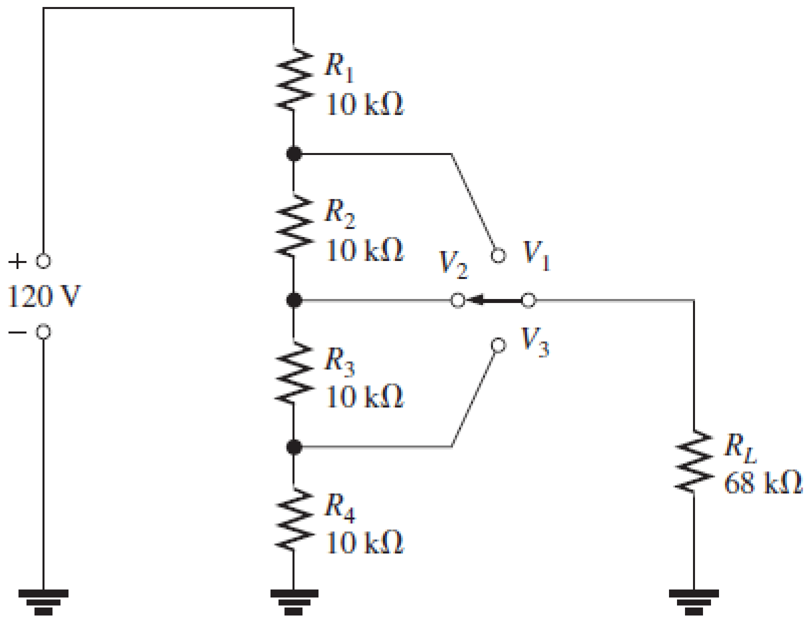
$$I_T = \left(\frac{V_S}{R_T}\right)$$
$$I_T = \left(\frac{22}{18300}\right)$$
$$I_T = 1.2mA$$

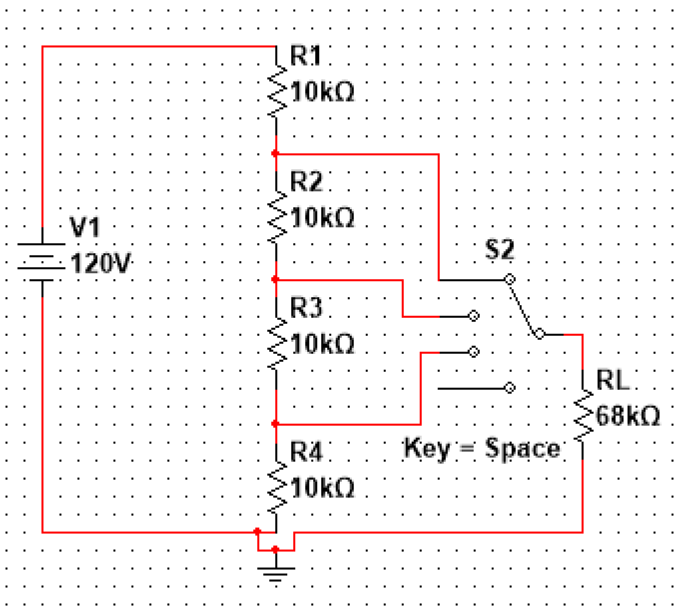


$$R_{(2+3)ll4} = \left(\frac{R_{2+3}\ x\ R_4}{R_{2+3} +\ R_4}\right)$$
$$R_{(2+3)ll4} = \left(\frac{8.3\ x\ 33}{8.3 + 33}\right)$$
$$R_{(2+3)ll4} = 6.63k\Omega$$
$$V_{AB} = \left(\frac{R_{(2+3)ll4}}{R_T}\right)V_S$$
$$R_{1+((2+3)ll4)} = R_1 + R_{(2+3)ll4}$$
$$R_{1+((2+3)ll4)} = 10 + 6.63$$
$$R_{1+((2+3)ll4)} = 16.63k\Omega$$
$$V_{AB} = \left(\frac{6.63}{16.63}\right)22$$
$$V_{AB} = 8.78V$$

$$I_4 = \frac{V_{AB}}{R_4}$$
$$I_4 = \frac{8.78}{33000}$$
$$I_4 = 0.27mA$$

32. El divisor de voltaje de la figura 7-75 tiene una carga controlada por interruptor. Determine el voltaje en cada toma (V_1, V_2, V_3) para cada posición del interruptor.





$$R_{2+3+4} = R_2 + R_3 + R_4$$
$$R_{2+3+4} = 10 + 10 + 10$$
$$R_{2+3+4} = 30k\Omega$$

$$R_{(2+3+4)llL} = \left(\frac{R_{2+3+4}\ x\ R_L}{R_{2+3+4} +\ R_L}\right)$$

$$R_{(2+3+4)llL} = \left(\frac{30\ x\ 68}{30 +\ 68}\right)$$

$$R_{(2+3+4)llL} = 20.81k\Omega$$

$$R_T = R_1 + R_{(2+3+4)llL}$$

$$R_T = 10 + 20.81$$

$$R_T = 30.81k\Omega$$

$$V_1 = \left(\frac{20.81}{30.81}\right)120$$

$$V_1 = 81.07V$$

$$V_2 = \left(\frac{R_{3+4}}{R_{2+3+4}}\right)V_1$$

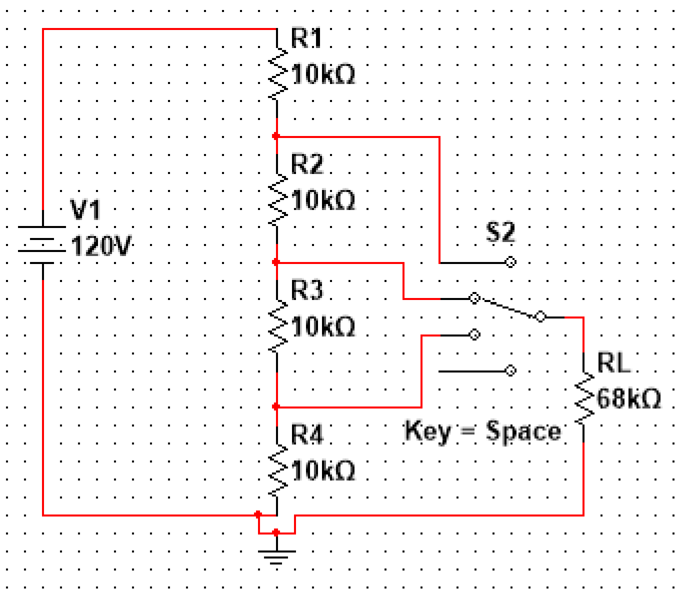
$$V_2 = \left(\frac{10 + 10}{10 + 10 + 10}\right)81.07$$

$$V_2 = 54.05V$$

$$V_3 = \left(\frac{R_4}{R_{2+3+4}}\right)V_1$$

$$V_3 = \left(\frac{10}{10 + 10 + 10}\right)81.07$$

$$V_3 = 27.02V$$



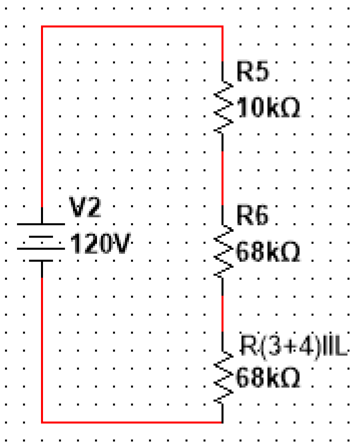
$$R_{3+4} = R_3 + R_4$$

$$R_{3+4} = 10 + 10$$

$$R_{3+4} = 20k\Omega$$

$$R_{(3+4)llL} = \left(\frac{R_{3+4}\ x\ R_L}{R_{3+4} +\ R_L}\right)$$

$$R_{(3+4)llL} = \left(\frac{20\ x\ 68}{20 +\ 68}\right)$$
$$R_{(3+4)llL} = 15.45k\Omega$$



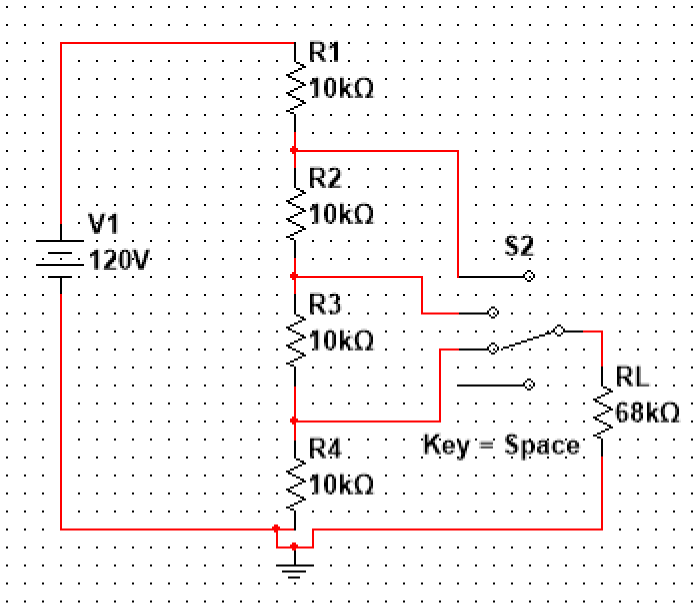
$$R_{2+((3+4)llL)} = R_2 + R_{(3+4)llL}$$
$$R_{2+((3+4)llL)} = 10 + 15.45$$
$$R_{2+((3+4)llL)} = 25.45k\Omega$$

$$R_T = R_1 + R_{2+((3+4)llL)}$$
$$R_T = 10 + 25.45$$
$$R_T = 35.45k\Omega$$

$$V_1 = \left(\frac{R_{2+((3+4)llL)}}{R_T}\right)V_S$$
$$V_1 = \left(\frac{25.45}{35.45}\right)120$$
$$V_1 = 86.14V$$

$$V_2 = \left(\frac{R_{((3+4)llL)}}{R_{2+((3+4)llL)}}\right)V_1$$
$$V_2 = \left(\frac{15.45}{25.45}\right)86.14$$
$$V_2 = 52.28V$$

$$V_3 = \left(\frac{R_4}{R_{3+4}}\right)V_2$$
$$V_3 = \left(\frac{R_4}{R_3 + R_4}\right)V_2$$
$$V_3 = \left(\frac{10}{10 + 10}\right)52.28$$
$$V_3 = 26.14V$$



$$R_{4llL} = \left(\frac{R_4 \; x \; R_L}{R_4 + \; R_L}\right)$$
$$R_{4llL} = \left(\frac{10 \; x \; 68}{10 + 68}\right)$$
$$R_{4llL} = 8.71k\Omega$$

$$R_T = R_{1+2+3+(4llL)}$$
$$R_T = R_1 + R_2 + R_3 + R_{4llL}$$
$$R_T = 10 + 10 + 10 + 8.71$$
$$R_T = 38.71k\Omega$$

$$R_{2+3+(4llL)} = R_2 + R_3 + R_{4llL}$$
$$R_{2+3+(4llL)} = 10 + 10 + 8.71$$
$$R_{2+3+(4llL)} = 28.71k\Omega$$

$$V_1 = \left(\frac{R_{2+3+(4llL)}}{R_T}\right) V_S$$
$$V_1 = \left(\frac{28.71}{38.71}\right) 120$$
$$V_1 = 88.92V$$

$$V_2 = \left(\frac{R_{(3+4)llL}}{R_{2+((3+4)llL)}}\right) V_1$$
$$V_2 = \left(\frac{R_3 + R_{4llL}}{R_2 + R_3 + R_{4llL}}\right) V_1$$
$$V_2 = \left(\frac{10 + 8.71}{10 + 10 + 8.71}\right) 88.92V$$

$$V_2 = 57.88V$$

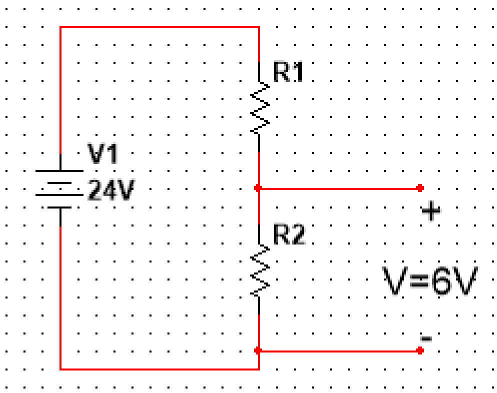
$$V_3 = \left(\frac{R_{4llL}}{R_{(3+4)llL}}\right)V_2$$

$$V_3 = \left(\frac{R_{4llL}}{R_3 + R_{4llL}}\right)V_2$$

$$V_3 = \left(\frac{8.71}{10 + 8.71}\right)57.88V$$

$$V_3 = 41.34V$$

34. Diseñe un divisor de voltaje que produzca una salida de $6V$ sin carga y un mínimo de $5.5V$ entre los extremos de una carga de $1.0\ k\Omega$. El voltaje de fuente es de $24V$ y la corriente extraída sin carga no debe exceder de $100\ mA$



$$V_{Salida} = \left(\frac{R_2}{R_T}\right)V_S$$

$$R_T = R_1 + R_2$$

$$V_{Salida} = \left(\frac{R_2}{R_1 + R_2}\right)24$$

$$6 = \left(\frac{R_2}{R_1 + R_2}\right)24$$

$$\frac{R_1 + R_2}{R_2} = 4$$

$$\frac{R_1}{R_2} = 3$$

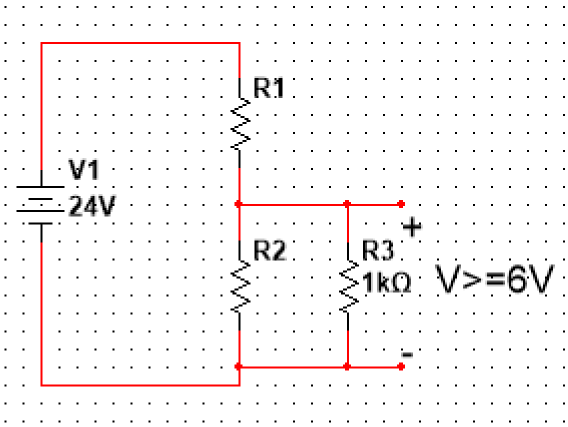
$$R_1 = 3R_2$$

$$\frac{V_{Salida}}{R_2} \leq 100mA$$

$$\frac{6}{R_2} \leq 100mA$$

$$R_2 \geq \frac{6}{100mA}$$

$$R_2 \geq 60\Omega$$



$$R_{2\,ll\,L} = \frac{R_2\ x\ R_L}{R_2 + R_L}$$

$$R_{2\,ll\,L} = \frac{R_2\ x\ 1}{R_2 + 1}$$

$$V_{Salida} = \left(\frac{R_{2\,ll\,L}}{R_T}\right)24$$

$$R_T = R_1 + R_{2\,ll\,L}$$

$$R_T = 3R_2 + \frac{R_2\ x\ 1}{R_2 + 1}$$

$$V_{Salida} = \left(\frac{\frac{R_2\ x\ 1}{R_2 + 1}}{3R_2 + \frac{R_2\ x\ 1}{R_2 + 1}}\right)24 \geq 5.5V$$

$$\left(\frac{3R_2 + \frac{R_2\ x\ 1}{R_2 + 1}}{\frac{R_2\ x\ 1}{R_2 + 1}}\right) \leq \frac{24}{5.5}$$

$$\left(\frac{3(R_2 + 1)}{1}\right) \leq 3.36$$

$$R_2 + 1k \leq \frac{3.36\ x\ 1k}{3}$$

$$R_2 \leq 0.12k\Omega$$

$$60\Omega \leq R_2 \leq 120\Omega$$

$$R_1 = 3R_2$$

$$180\Omega \leq R_1 \leq 360\Omega$$

SECCIÓN 7-4 Efecto de carga de un voltímetro.

36. Determine la resistencia interna de un voltímetro de $20.000\Omega/V$ en cada uno de los siguientes ajustes de intervalo.

a. $0.5\ V$

$$R_I = 20\ 000\frac{\Omega}{V}\ (0.5V)$$

$$R_I = 10\,000\Omega$$
$$R_I = 10k\Omega$$

b. 1 V

$$R_I = 20\,000\frac{\Omega}{V}\ (1V)$$
$$R_I = 20\,000\Omega$$
$$R_I = 20k\Omega$$

c. 5 V

$$R_I = 20\,000\frac{\Omega}{V}\ (5V)$$
$$R_I = 100\,000\Omega$$
$$R_I = 100k\Omega$$

d. 50 V

$$R_I = 20\,000\frac{\Omega}{V}\ (50V)$$
$$R_I = 1\,000\,000\Omega$$
$$R_I = 1M\Omega$$

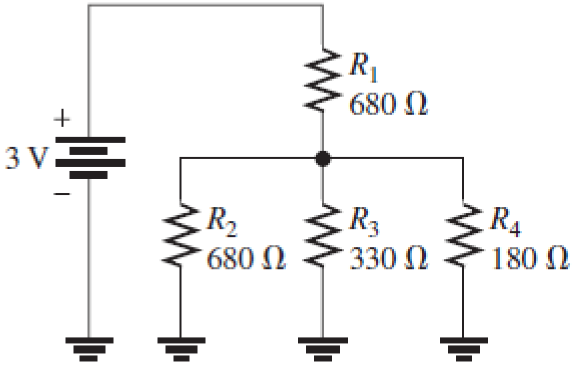
e. 100 V

$$R_I = 20\,000\frac{\Omega}{V}\ (100V)$$
$$R_I = 2\,000\,000\Omega$$
$$R_I = 2M\Omega$$

f. 1000 V

$$R_I = 20\,000\frac{\Omega}{V}\ (1000V)$$
$$R_I = 20\,000\,000\Omega$$
$$R_I = 20M\Omega$$

38. Repita el problema 37 si se utiliza el voltímetro para medir voltaje entre los extremos de R_4 en el circuito de la figura 7-62 (b)



(a) ¿Qué intervalo se deberá utilizar?

$$R_{2ll3ll4} = \frac{1}{\frac{1}{680} + \frac{1}{330} + \frac{1}{180}}$$

$$R_{2ll3ll4} = \frac{1}{1.47m\Omega + 3.03m\Omega + 5.55m\Omega}$$

$$R_{2ll3ll4} = 99.5\Omega$$

$$R_{2ll3ll4lli} = \frac{1}{\frac{1}{R_{2ll3ll4}} + \frac{1}{R_i}}$$

Por efecto carga del voltímetro se reduce el 10%

$$99.4 \leq \frac{1}{\frac{1}{99.5} + \frac{1}{R_i}}$$

$$\frac{1}{R_i} \leq \frac{1}{99.4} - \frac{1}{99.5}$$

$$R_i \geq 98.903k\Omega$$

$$R_I = 20\,000 \frac{\Omega}{V} (5V)$$

$$R_I = 100\,000\Omega$$

$$R_I = 100k\Omega$$

Intervalo de voltaje: 5V

(b) ¿En cuánto se reduce el voltaje medido por el medidor con respecto al voltaje real?

$$R_{1+(2ll3ll4)} = 680 + \frac{1}{\frac{1}{680} + \frac{1}{330} + \frac{1}{180}}$$

$$R_{1+(2ll3ll4)} = 680 + \frac{1}{10.05m\Omega}$$

$$R_{2ll3ll4} = 779.5\Omega$$

$$I_T = \frac{V_S}{R_T}$$
$$I_T = \frac{3}{799.5}$$
$$I_T = 3.84mA$$

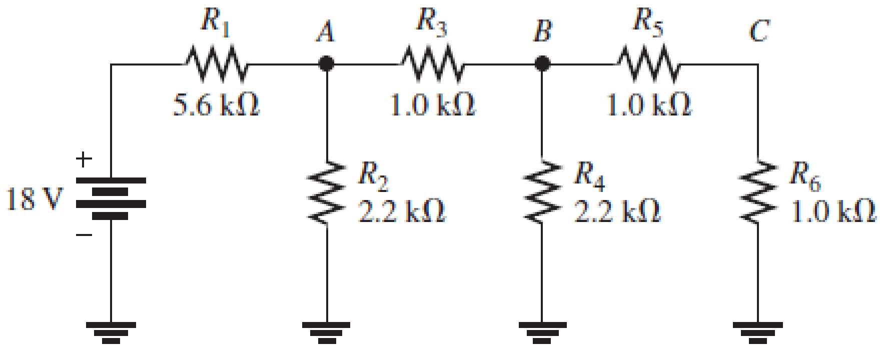
$$V_1 = I_1 R_1$$
$$V_1 = 3.84mA * 680$$
$$V_1 = 2.61V$$
$$V_S + V_1 + V_4 = 0$$
$$3V - 2.61V + V_4 = 0$$
$$V_4 = 0.3880V$$
$$R_{2ll3ll4lli} = \frac{1}{\frac{1}{R_{2ll3ll4}} + \frac{1}{R_i}}$$
$$R_{2ll3ll4lli} = \frac{1}{\frac{1}{99.5} + \frac{1}{100k}}$$
$$R_{2ll3ll4lli} = 99.4\Omega$$

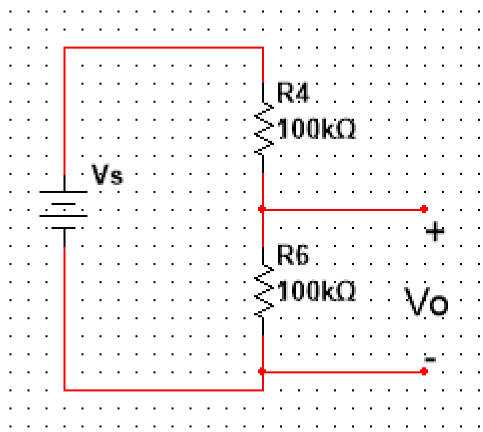
$$V_4 = \left(\frac{R_{2ll3ll4lli}}{R_{1+(2ll3ll4lli)}}\right) V_S$$
$$V_4 = \left(\frac{99.4}{680 + 99.4}\right) 3$$
$$V_4 = 0.3825V$$

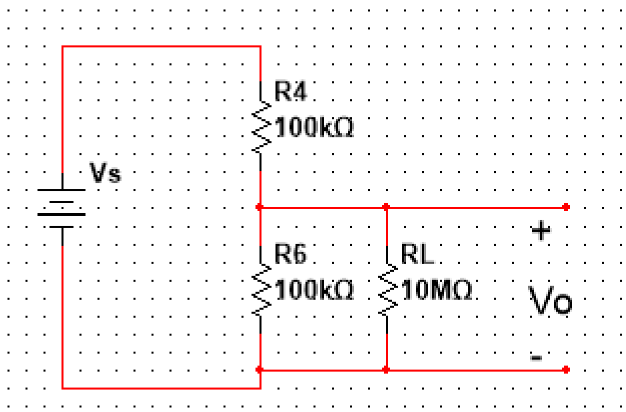
$$0.3880V - 0.3825V = 5.5mV$$

SECCIÓN 7-5 Redes en escalera.

40. Determine la resistencia total y el voltaje en los nodos A, B y C de la red en escalera mostrada en la figura 7-78





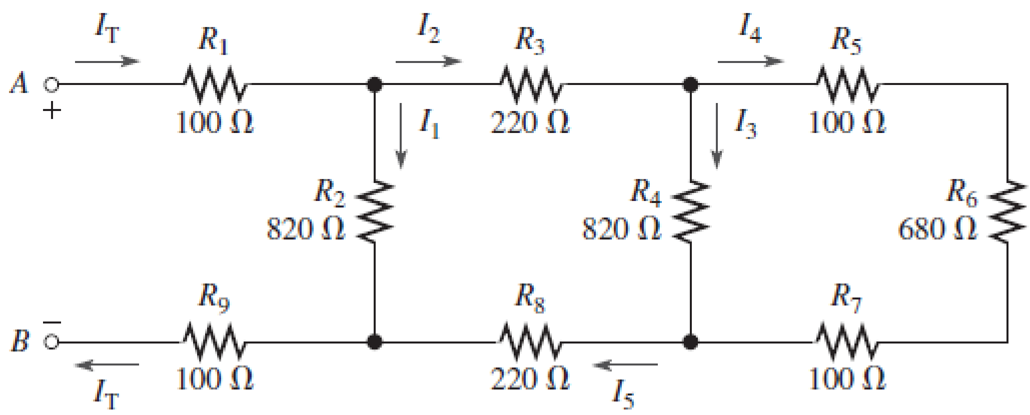


$$R_T = R_T + \frac{R_2 R_L}{R_2 + R_L}$$
$$R_T = 100k + \frac{100k\ x\ 10M}{100k + 10M}$$
$$R_T = 199.01\Omega$$

$$V_O = \left(\frac{R_{2llL}}{R_T}\right) V_S$$
$$V_O = \left(\frac{99.01}{199.01}\right) V_S$$
$$V_O = 0.497 V_S$$

$$\%V = \left(\frac{Valor\ calculado}{Voltaje\ de\ la\ fuente}\right) x100$$
$$\%V = \left(\frac{0.497 V_S}{V_S}\right) x100$$
$$\%V = 49.7\%$$

42. En la figura 7-79, ¿Cuál es el voltaje entre los extremos de cada resistor con $10V$ entre A y B?



Datos:

$R_1 = 100\Omega$
$R_2 = 820\ \Omega$
$R_3 = 220\ \Omega$
$R_4 = 820\ \Omega$
$R_5 = 100\ \Omega$
$R_6 = 680\ \Omega$
$R_7 = 100\ \Omega$
$R_8 = 220\ \Omega$
$R_9 = 100\Omega$

$V_{AB} = 10\ V$

$$R_A = R_5 + R_6 + R_7;$$
$$R_A = 100 + 680 + 100;$$
$$R_A = 880\ \Omega$$

$$R_B = R_{A||4};$$
$$R_B = \frac{R_A R_4}{R_A + R_4};$$
$$R_B = \frac{820 * 880}{820 + 880};$$
$$R_B = \frac{721600}{1700};$$
$$R_B = 424.47\ \Omega$$

$$R_C = R_B + R_3 + R_9;$$
$$R_C = 424.47 + 220 + 220+;$$
$$R_C = 864.47\ \Omega$$

$$R_D = R_C||R_2;$$
$$R_D = \frac{R_C R_2}{R_C + R_2};$$

$$R_D = \frac{820 * 864.47}{820 + 864.47};$$
$$R_D = \frac{708865}{1684.47};$$
$$R_D = 420.82\ \Omega$$

$$R_T = R_D + R_1 + R_9;$$
$$R_T = 420.82 + 100 + 100;$$
$$R_T = 620.82\ \Omega$$

$$I_T = \frac{V_{AB}}{R_T};$$
$$I_T = \frac{10}{620.82};$$
$$I_T = 16 * 10^{-3}\ A;$$
$$I_T = 16.1\ mA$$

$$I_1 = \frac{R_C}{R_C + R_2} * I_T;$$
$$I_1 = 16.1 * 10^{-3} * \frac{864.47}{864.47 + 820};$$
$$I_1 = 8.27 * 10^{-3} A;$$
$$I_1 = 8.27\ mA;$$
$$I_1 = 8.27\ mA$$

Aplicando Kirchhoff en el nodo D:

$$I_T - I_1 - I_5 = 0;$$
$$I_5 = I_T - I_1;$$
$$I_5 = 16.1 * 10^{-3} - 8.27 * 10^{-3};$$
$$I_5 = 7.83 * 10^{-3}\ A;$$
$$I_5 = 7.83\ mA$$

Aplicando Kirchhoff en el nodo C:

$$-I_T + I_1 + I_2 = 0;$$
$$I_2 = I_T - I_1;$$
$$\boldsymbol{I_2} = 16.1 * 10^{-3} - 8.27 * 10^{-3};$$
$$I_2 = 7.83 * 10^{-3}\ A;$$
$$I_2 = 7.83\ mA$$

$$I_3 = \frac{R_A}{R_A + R_4} * I_5;$$
$$I_3 = 7.83 * 10^{-3}\left(\frac{880}{880 + 820}\right);$$
$$I_3 = 4.06\ mA$$

Aplicando Kirchhoff en el nodo F:

$$I_5 - I_3 - I_4 = 0;$$
$$I_4 = I_5 - I_3;$$
$$I_4 = 7.83 * 10^{-3} - 4.06 * 10^{-3};$$
$$I_4 = 3.78\ mA$$

La corriente a través de las resistencias R_1 y R_2 es la corriente total y la $I_T = 16.1\ mA$
La corriente a través de las resistencias $R_5, R_6\ y\ R_7$ es $I_4 = 3.78\ mA$.
La corriente a través de la resistencia $R_2\ la\ I_1 = 8.27\ mA$.
La corriente a través de la resistencia $R_3\ la\ I_2 = 7.84\ mA$
La corriente a través de la resistencia $R_4\ la\ I_3 = 4.06\ mA$
La corriente a través de la resistencia $R_9\ la\ I_5 = 87.84\ mA$

$$V_1 = I_T R_1;$$
$$V_1 = 16.1 * 10^{-3} * 100;$$
$$V_1 = 1.61\ V$$

$$V_2 = I_1 R_2;$$
$$V_2 = 8.27 * 10^{-3} * 820;$$
$$V_2 = 6.78\ V$$

$$V_3 = I_2 R_3;$$
$$V_3 = 7.84 * 10^{-3} * 220;$$
$$V_3 = 1.72\ V$$

$$V_4 = I_3 R_4;$$
$$V_4 = 4.06 * 10^{-3} * 820;$$
$$V_4 = 3.3\ V$$

$$V_5 = I_4 R_5;$$
$$V_5 = 3.78 * 10^{-3} * 100;$$
$$V_5 = 0.38\ V$$

$$V_6 = I_4 R_6;$$
$$V_6 = 3.78 * 10^{-3} * 680;$$
$$V_6 = 2.57\ V$$

$$V_7 = I_4 R_7;$$
$$V_7 = 3.78 * 10^{-3} * 100;$$
$$V_7 = 0.38\ V$$

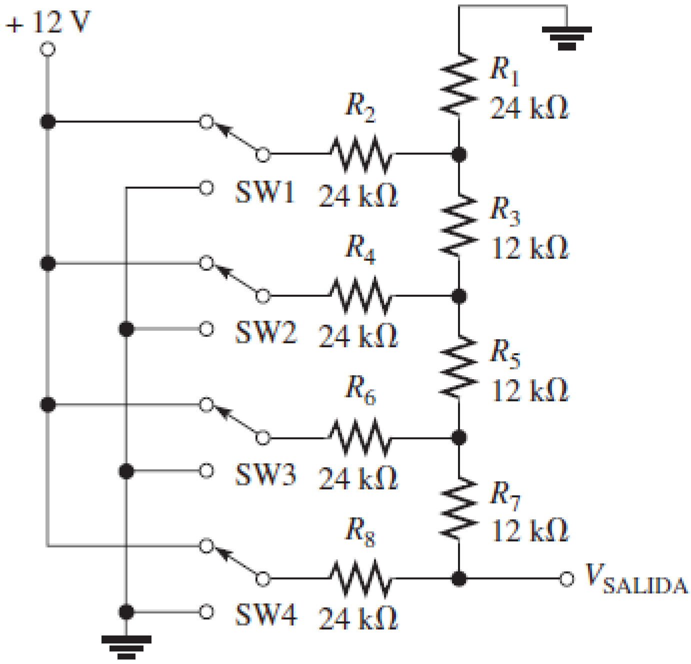
$$V_8 = I_5 R_8;$$
$$V_8 = 16.1 * 10^{-3} * 100;$$

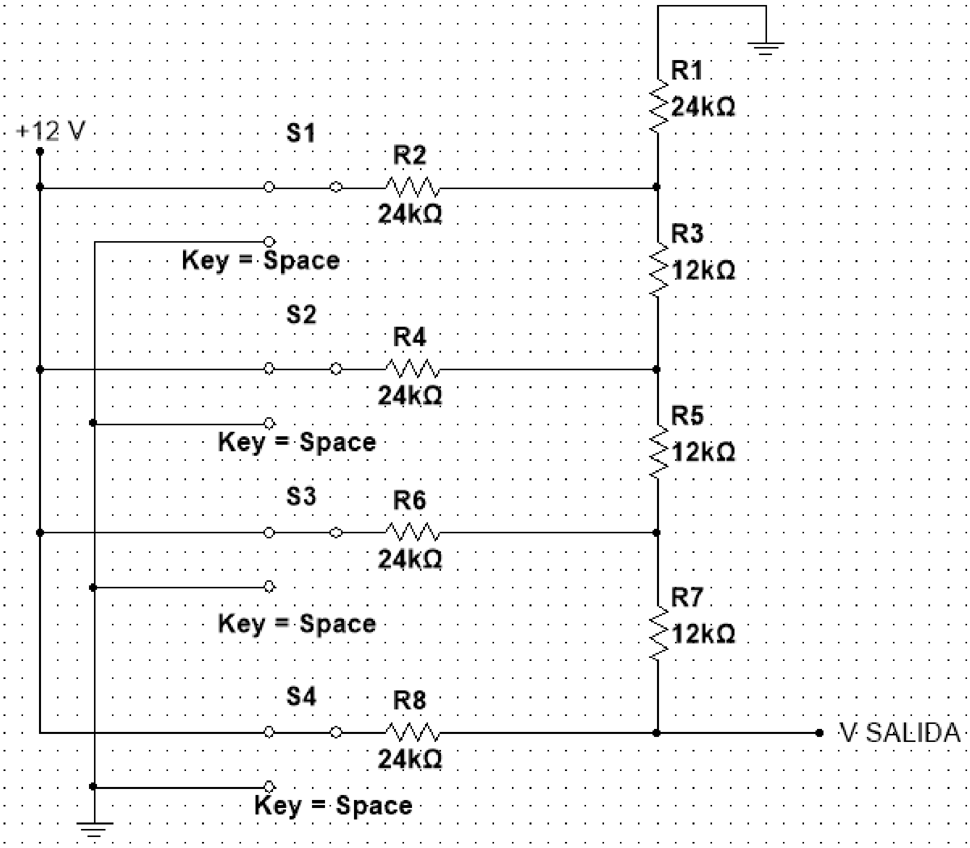
$V_8 = 1.61\ V$

$V_9 = I_T R_9;$
$V_9 = 16.1 * 10^{-3} * 100;$
$V_9 = 1.61\ V$

44. Determine V_{SALIDA} para la red $R/2R$ en escalera mostrada en la figura 7-81 para las siguientes condiciones.

a. Interruptor $SW2$ conectado a $+12V$ y los demás conectados a tierra.





$$R_{1\|2} = \frac{R_1 R_2}{R_1 + R_2};$$

$$R_{1\|2} = \frac{24 * 24}{24 + 24};$$

$$R_{1\|2} = \frac{576}{48};$$

$$R_{1\|2} = 12\ k\Omega$$

$$R_{(1\|2)+3} = R_{1\|2} + R_3;$$

$$R_{(1\|2)+3} = 12 + 12;$$

$$R_{(1||2)+3} = 24\ k\Omega$$

$$R_{7+8} = R_7 + R_8;$$

$$R_{7+8} = 12 + 24;$$

$$R_{7+8} = 36\ k\Omega$$

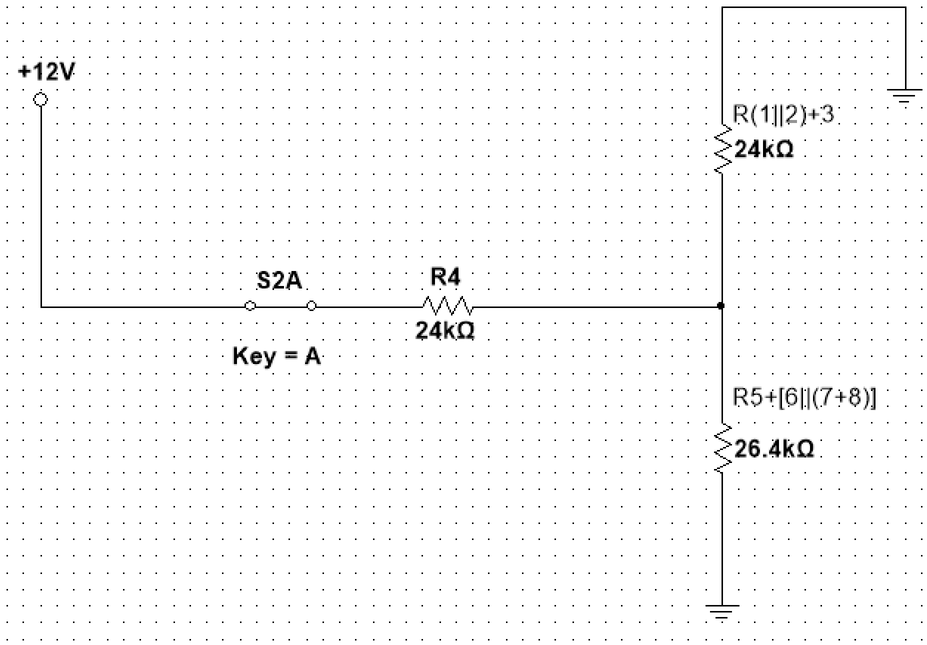
$$R_{6||(7+8)} = \frac{R_6 R_{7+8}}{R_6 + R_{7+8}};$$

$$R_{6||(7+8)} = \frac{24 * 36}{24 + 36};$$

$$R_{6||(7+8)} = \frac{864}{60};$$

$$R_{6||(7+8)} = 14.4\ k\Omega$$

$$R_{5+[6||(7+8)]} = R_5 + R_{6||7+8};$$
$$R_{5+[6||(7+8)]} = 12 + 14.4;$$
$$R_{5+[6||(7+8)]} = 26.4\ k\Omega$$



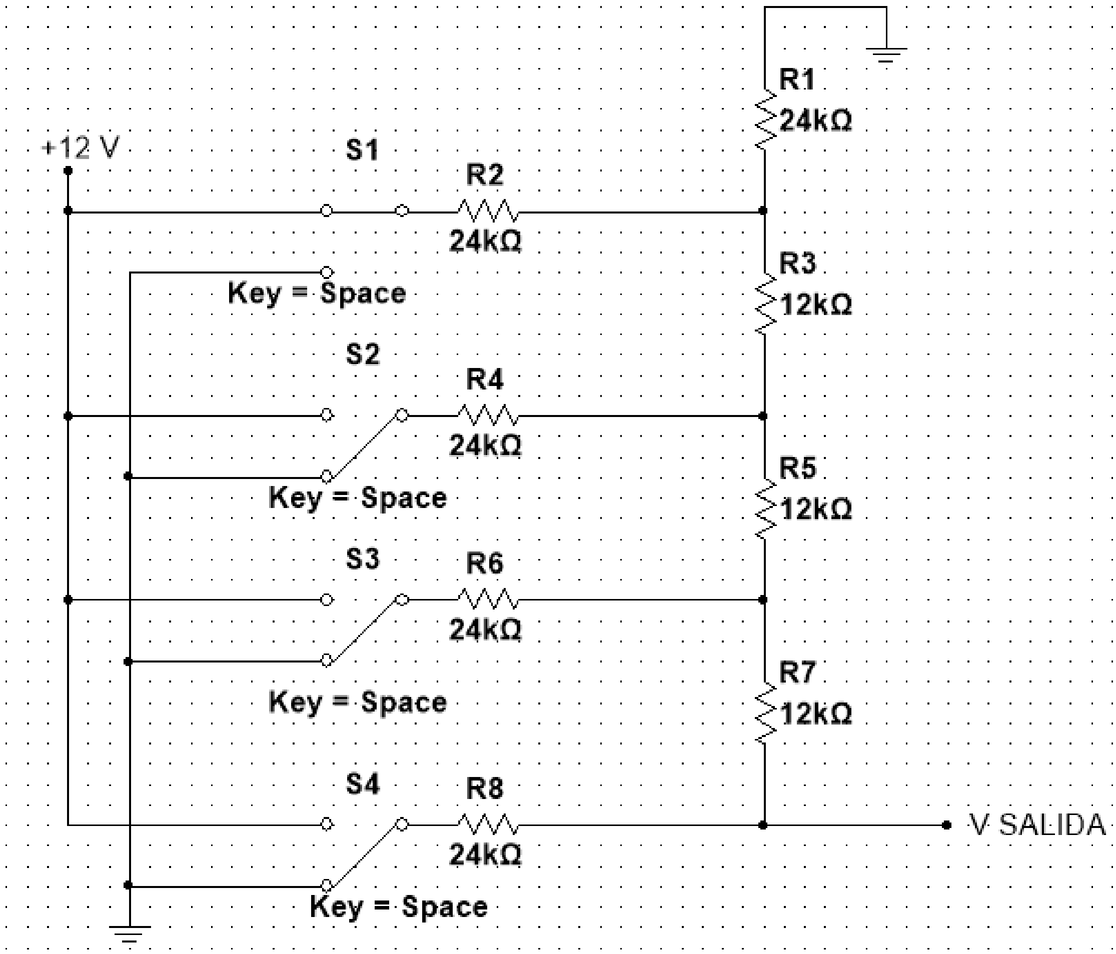
$$R_{[(1||2)+3]||[5+[6||(7+8)]]} = \frac{R_{(1||2)+3}R_{5+(6||7+8)}}{R_{(1||2)+3} + R_{5+(6||7+8)}};$$
$$R_{[(1||2)+3]||[5+[6||(7+8)]]} = \frac{24 * 26.4}{24 + 26.4};$$
$$R_{[(1||2)+3]||[5+[6||(7+8)]]} = \frac{633.6}{50.4};$$
$$R_{[(1||2)+3]||[5+[6||(7+8)]]} = 12.571\ k\Omega$$

$$V_1 = \frac{R_{[(1||2)+3]||[5+[6||(7+8)]]}}{R_4 + R_{[(1||2)+3]||[5+[6||(7+8)]]}} * V_S;$$
$$V_1 = \left(\frac{12.571}{24 + 12.571}\right) * 12;$$
$$V_1 = 0.344 * 12;$$
$$V_1 = 4.128\ V$$

$$V_2 = \left(\frac{R_{6||(7+8)}}{R_5 + R_{6||(7+8)}}\right) * V_1;$$
$$V_2 = \left(\frac{14.4}{12 + 14.4}\right) * 4.128;$$
$$V_2 = 0.545 * 4.128;$$
$$V_2 = 2.249\ V$$

$$V_{SALIDA} = \left(\frac{R_8}{R_7 + R_8}\right) * V_2;$$
$$V_{SALIDA} = \left(\frac{24}{12 + 24}\right) * 2.249;$$
$$V_{SALIDA} = 0.667 * 2.249;$$
$$V_{SALIDA} = 1.5\ V$$

b. Interruptor $SW1$ conectado a $+12V$ y los demás conectados a tierra.



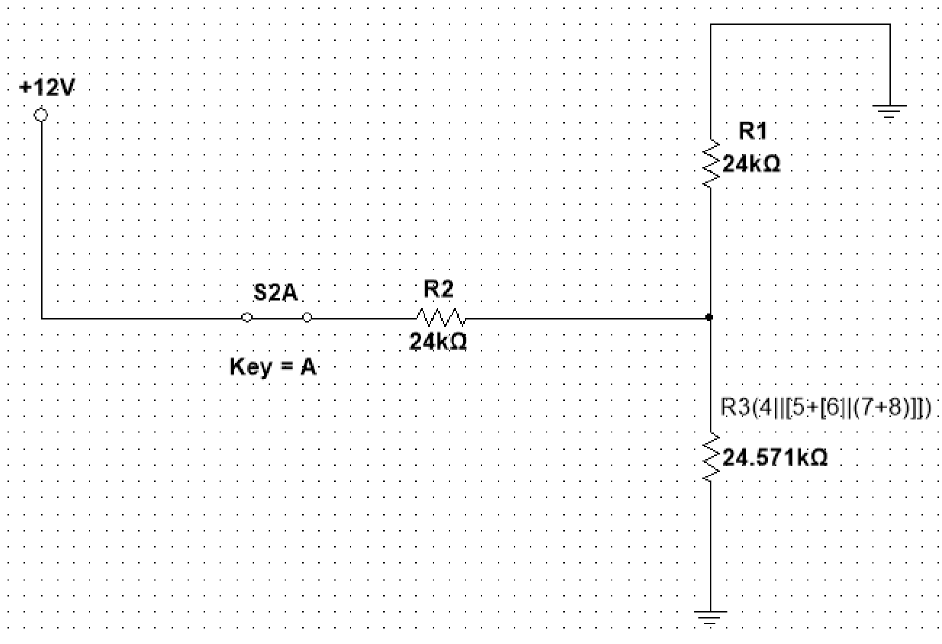
$$R_{7+8} = R_7 + R_8;$$
$$R_{7+8} = 12 + 24;$$
$$R_{7+8} = 32\ k\Omega$$

$$R_{6||(7+8)} = \frac{R_6 R_{7+8}}{R_6 + R_{7+8}};$$
$$R_{6||(7+8)} = \frac{24 * 36}{24 + 36};$$
$$R_{6||(7+8)} = 14.4\ k\Omega$$

$$R_{4[5+[6||(7+8)]]} = \frac{R_4 R_{5+(6||7+8)}}{R_4 + R_{5+(6||7+8)}};$$

$$R_{4[5+[6||(7+8)]]} = \frac{24 * 26.4}{24 + 26.4};$$
$$R_{4[5+[6||(7+8)]]} = \frac{633.6}{50.4};$$
$$R_{4[5+[6||(7+8)]]} = 12.571\ k\Omega$$

$$R_{3+(4[5+[6||(7+8)]]))} = R_3 + R_{4[5+[6||(7+8)]]};$$
$$R_{3+(4[5+[6||(7+8)]]))} = 12 + 12.571;$$
$$R_{3+(4[5+[6||(7+8)]]))} = 24.571\ k\Omega$$



$$R_{1||[3+(4[5+[6||(7+8)]]))]} = \frac{R_1 R_{3+[4[5+[6||(7+8)]]}}{R_1 + R_{3+[4[5+[6||(7+8)]]}};$$
$$R_{1||[3+(4[5+[6||(7+8)]]))} = \frac{24 * 24.571}{24 + 24.571}$$
$$R_{3+(4[5+[6||(7+8)]]))} = 12.14\ k\Omega$$

$$V_1 = \left(\frac{R_{1||[3+(4[5+[6||(7+8)]]))]}}{R_2 + R_{1||[3+(4[5+[6||(7+8)]]}}\right) * V_S;$$
$$V_1 = \left(\frac{12.14}{24 + 12.14}\right) * 12;$$
$$V_1 = 0.335 * 12;$$
$$V_1 = 4.02\ V$$

$$V_2 = \left(\frac{R_{4[5+[6||(7+8)]}}{R_3 + R_{4[5+[6||(7+8)]}}\right) * 4.02;$$
$$V_2 = \left(\frac{12.571}{12 + 12.571}\right) * 4.02;$$
$$V_2 = 0.512 * 4.02;$$

$$V_2 = 2.05\, V$$

$$V_3 = \left(\frac{R_{[6||(7+8)]}}{R_5 + R_{[6||(7+8)]}}\right) * V_2;$$
$$V_3 = \left(\frac{14.4}{12 + 14.4}\right) * 2.05;$$
$$V_3 = 0.545 * 2.05;$$
$$V_3 = 1.12\, V$$

$$V_{SALIDA} = \left(\frac{R_8}{R_7 + R_8}\right) * V_2;$$
$$V_{SALIDA} = \left(\frac{24}{12 + 24}\right) * 1.12;$$
$$V_{SALIDA} = 0.667 * 1.12;$$
$$V_{SALIDA} = 0.75\, V$$

SECCIÓN 7-6 El puente Wheatstone

46. Se conecta un resistor de valor desconocido a un circuito puente Wheatstone. Los parámetros del puente en equilibrio se establecen como sigue: $R_v = 18\ k\Omega$ y $\frac{R_2}{R_4} = 0.02$. ¿Cuál es R_x?

Datos:

$R_V = 18\ k\Omega$

$\frac{R_2}{R_4} = 0.02$

$R_X = ?$

El factor de escala es 0.02.

$\frac{R_2}{R_4} = 0.02$

$V_O = 0\ V$

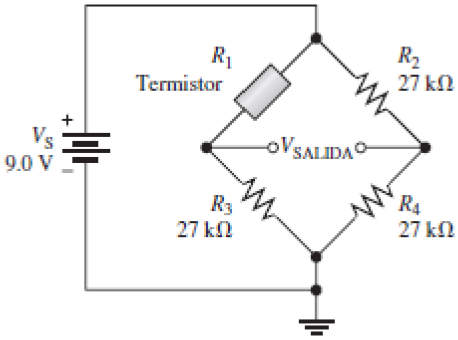
Se calcula de la siguiente manera:

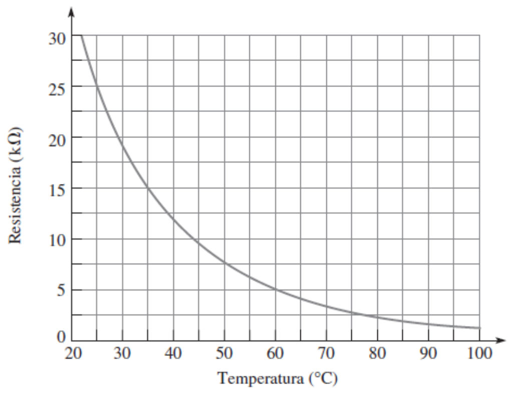
$R_X = R_V \left(\frac{R_2}{R_4}\right);$

$R_X = 18 * 0.02$

$R_X = 360\ \Omega$

48. Determine el voltaje de salida para el puente desequilibrado mostrado en la figura 7-83 a una temperatura de $60°C$. La característica de resistencia según la temperatura del termistor se muestra en la figura 7-60





A partir de las características de resistencia a la temperatura del termistor que el valor de resistencia es de 27 $k\Omega$ a una temperatura de 24°C.
El puente se equilibra a una temperatura de 24°C ya que las cuatro resistencias son iguales. En condiciones equilibradas, el voltaje de salida es 0 V.

$$V_S = 0\ V\ a\ 24°C$$

$$R_1\ a\ 60°C \text{ es } 5\ k\Omega$$

De 24°C a 60°C

$$\Delta R_1 = R_{1.24°C} - R_{1.60°C};$$

$$\Delta R_1 = 27 - 5;$$

$$\Delta R_1 = 22\ k\Omega$$

$$\Delta V_O = \Delta R_1 \left(\frac{V_S}{4R}\right);$$

Sustituyendo 22 $k\Omega$ para ΔR_1, 9V para V_S y 27 $k\Omega$ para R.

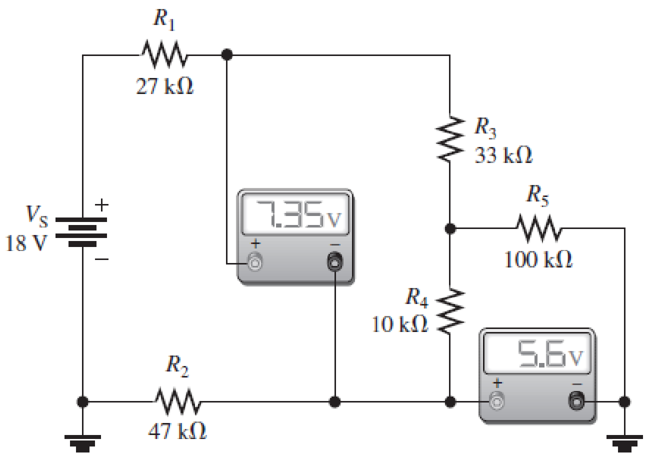
$$\Delta V_O = 22\left(\frac{9}{4 * 27}\right);$$

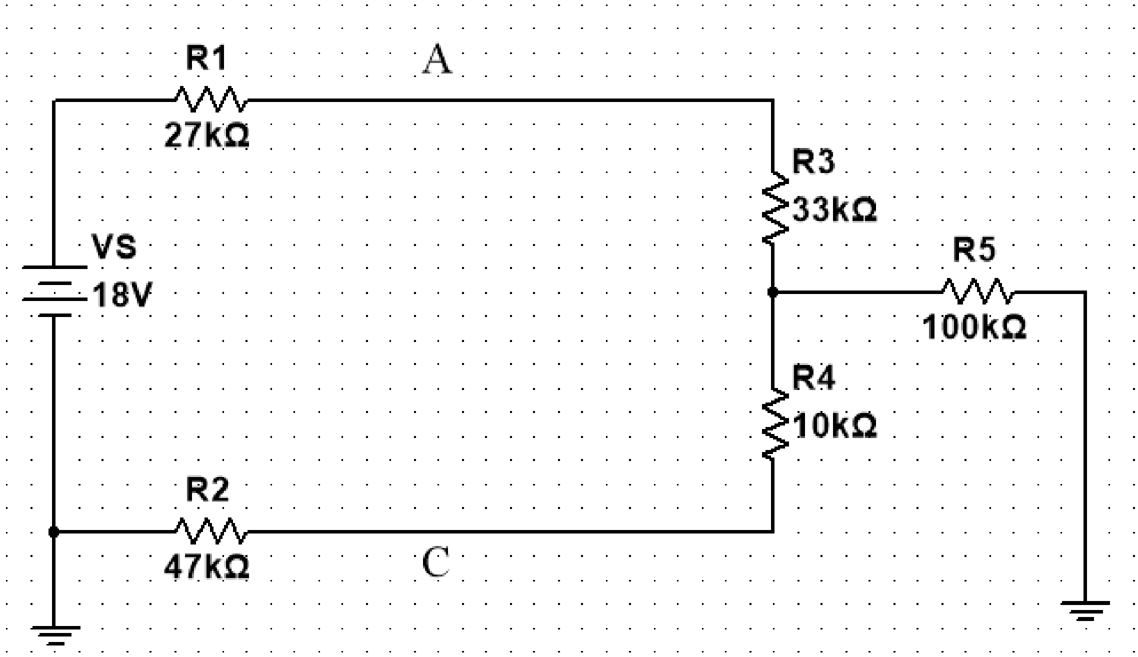
$$\Delta V_O = 1.83\ V$$

Como ΔV_O es 0 V cuando el puente está equilibrado a 24°C y cambia de 1.83 V a 60°C. Concluyendo, el voltaje ΔV_O para el puente desbalanceado a 60°C es 1.83 V.

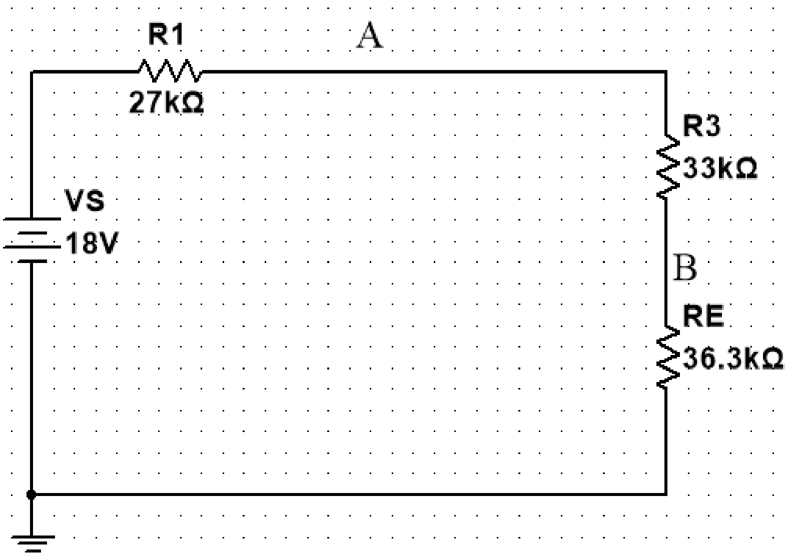
SECCIÓN 7-7 Localización de fallas

50. ¿Son correctas las lecturas del medidor mostrado en la figura 7-85?





$$R_E = (R_2 + R_4) \parallel R_5;$$
$$R_E = (47 + 10) \parallel 100;$$
$$R_E = (57) \parallel 100;$$
$$R_E = \frac{57 * 100}{57 + 100};$$
$$R_E = \frac{5700}{157};$$
$$R_E = 36.3\ k\Omega$$



$$V_A = \left(\frac{R_3 + R_E}{R_1 + R_3 + R_E}\right)(V_S);$$
$$V_A = \left(\frac{33 + 36.3}{27 + 33 + 36.3}\right)(18);$$

$$V_A = \left(\frac{69.3}{96.3}\right)(18);$$
$$V_A = 0.719 * 18;$$
$$V_A = 12.95\ V$$

$$V_B = \left(\frac{R_E}{R_1 + R_3 + R_E}\right)(V_S);$$
$$V_B = \left(\frac{36.3}{27 + 33 + 36.3}\right)(18);$$
$$V_B = \left(\frac{36.3}{96.3}\right)(18);$$
$$V_B = 0.377 * 18;$$
$$V_B = 6.785\ V$$

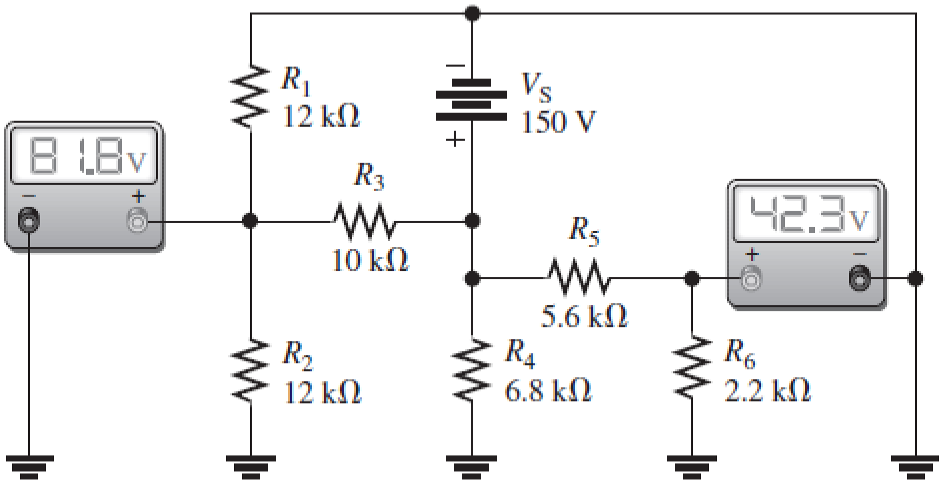
$$V_C = \left(\frac{R_2}{R_2 + R_4}\right)(V_B);$$
$$V_C = \left(\frac{47}{47 + 10}\right)(6.785);$$
$$V_C = \left(\frac{47}{57}\right)(6.785);$$
$$V_C = 0.8245 * 6.785;$$
$$V_C = 5.596\ V$$

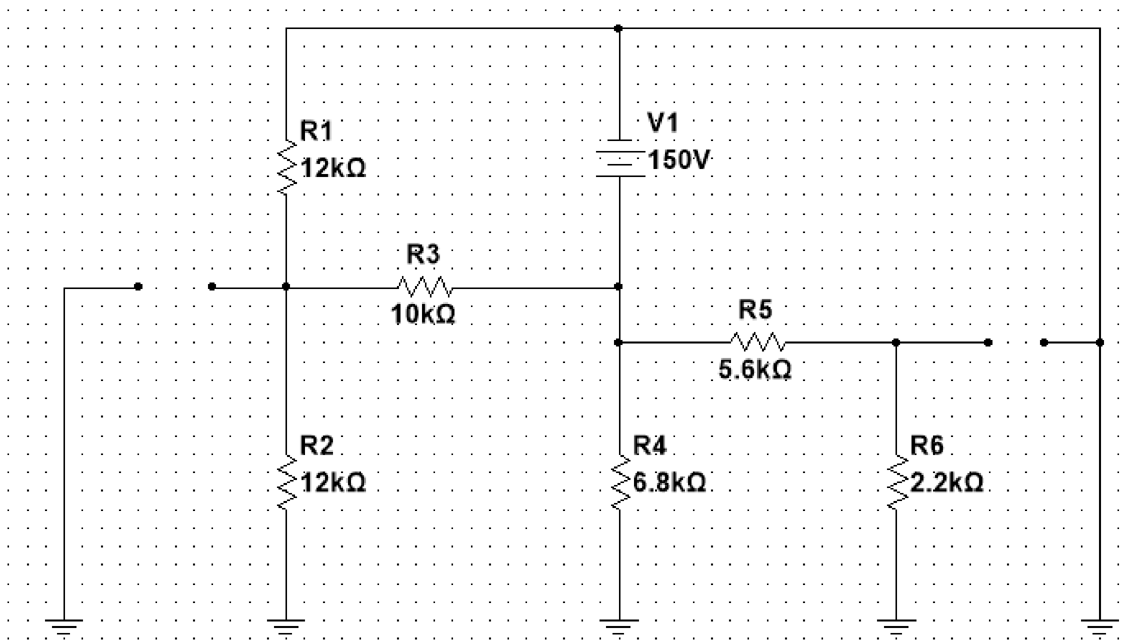
Por tanto, el voltímetro leyendo desde el extremo inferior una resistencia a R_4 con respecto a tierra es correcta.

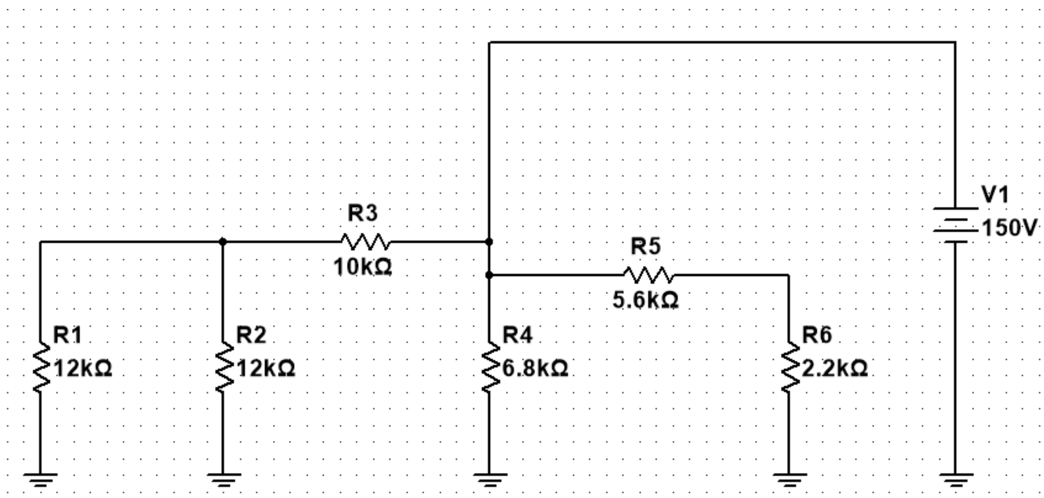
$$V_{AC} = V_A - V_C;$$
$$V_{AC} = 12.95 - 5.6;$$
$$V_{AC} = 7.35\ V$$

En conclusión, el voltímetro leyendo desde el extremo inferior una resistencia a R_1 con respecto a R_4 es correcta.

52. Vea los medidores ilustrados en la figura 7-87 y determine si hay una falla en el circuito. Si la hay, identifíquela.

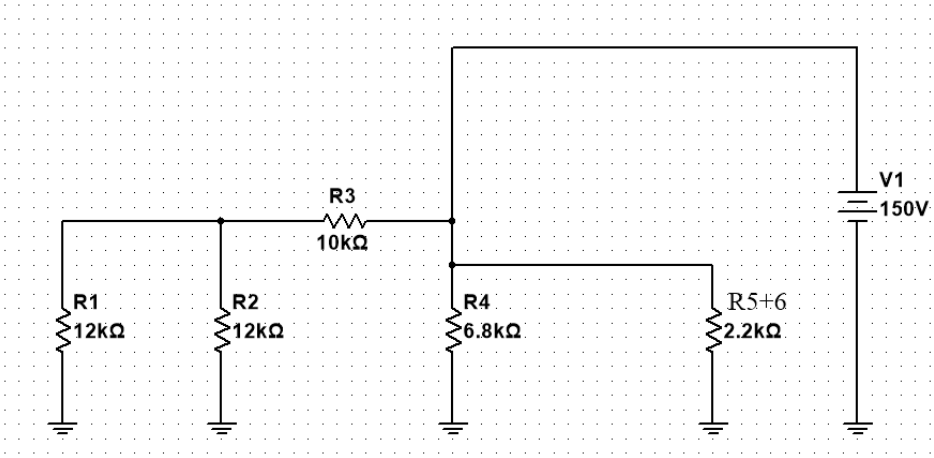

81.8V
R_1
12 kΩ
V_S
150 V
R_3
10 kΩ
R_5
5.6 kΩ
42.3V
R_2
12 kΩ
R_4
6.8 kΩ
R_6
2.2 kΩ


R1
12kΩ
V1
150V
R3
10kΩ
R5
5.6kΩ
R2
12kΩ
R4
6.8kΩ
R6
2.2kΩ


R3
10kΩ
R5
5.6kΩ
V1
150V
R1
12kΩ
R2
12kΩ
R4
6.8kΩ
R6
2.2kΩ

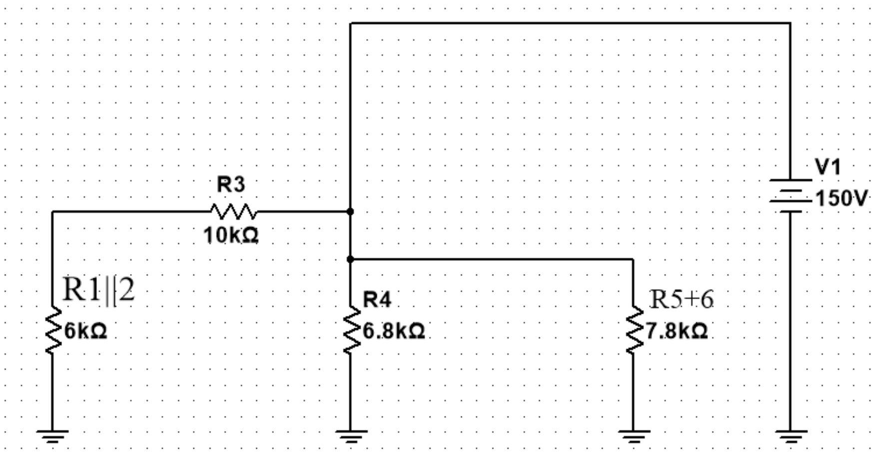
$$R_4 \to 150V$$

$$R_{5+6} = R_5 + R_6;$$
$$R_{5+6} = 5.6 + 2.2;$$
$$R_{5+6} = 7.8\ k\Omega$$



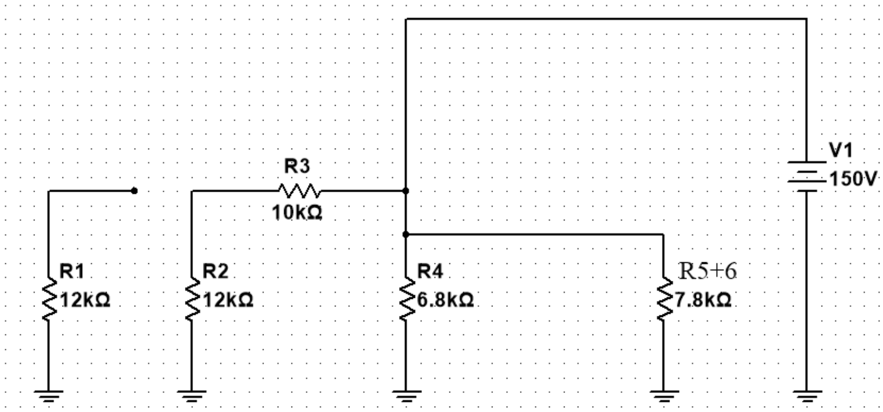
$$V_1 = \left(\frac{R_6}{R_6 + R_5}\right)(V_S);$$
$$V_1 = \left(\frac{2.2}{2.2 + 5.6}\right)(150);$$
$$V_1 = \left(\frac{2.2}{7.8}\right)(150);$$
$$V_1 = (0.282)(150);$$
$$V_1 = 42.3\ V$$

$$R_{1\parallel 2} = \frac{R_1 R_2}{R_1 + R_2};$$
$$R_{1\parallel 2} = \frac{(12)(12)}{(12) + (12)};$$
$$R_{1\parallel 2} = \frac{144}{24}$$
$$R_{1\parallel 2} = 6\ k\Omega$$



$$R_{1\parallel 2} \rightarrow V_2$$

$$V_2 = \left(\frac{R_{1\parallel 2}}{R_{1\parallel 2} + R_3}\right)(V_S)$$
$$V_2 = \left(\frac{6}{6 + 10}\right)(150);$$
$$V_2 = \left(\frac{6}{16}\right)(150);$$
$$V_2 = 0.375 * 150;$$
$$V_2 = 56.25\ V$$



$$R_2 \rightarrow V_3$$
$$V_3 = \left(\frac{R_2}{R_2 + R_3}\right)(V_S)$$
$$V_3 = \left(\frac{12}{12 + 10}\right)(150);$$
$$V_3 = \left(\frac{12}{22}\right)(150);$$
$$V_3 = 0.545 * 150;$$
$$V_3 = 81.8\ V$$

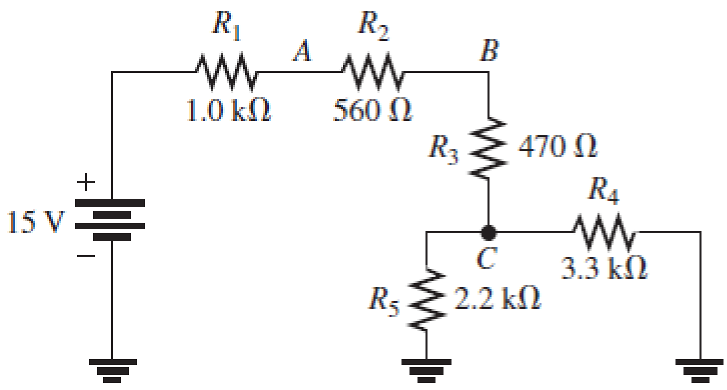
La lectura del medidor a través de la resistencia R_2 es 81.8 V.

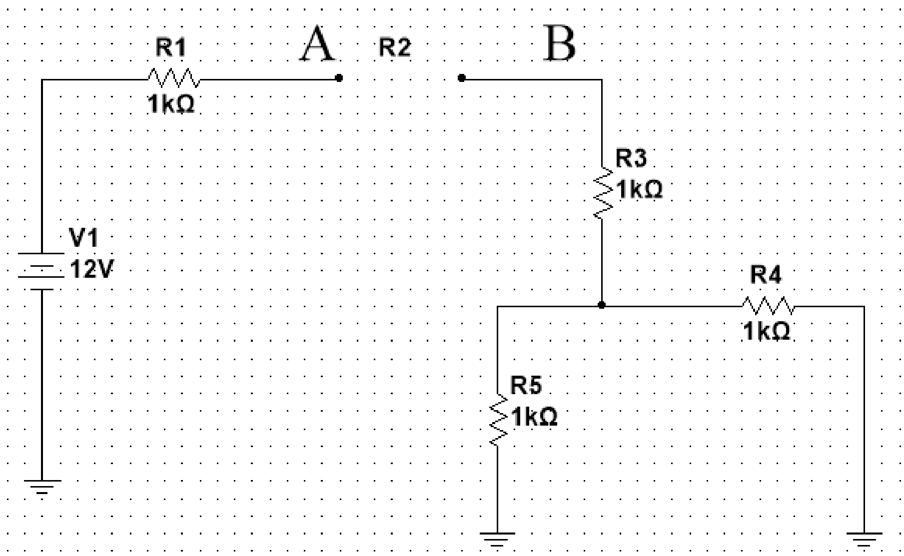
Por lo tanto, la lectura del medidor a través de la resistencia R_2 es correcta.

La falla en el circuito es que la resistencia R_1 está desconectada del circuito para producir la lectura incorrecta del medidor.

En conclusión, conecte la resistencia R_1 al nodo.

54. Si en la figura 7-89 R_2 se abre, ¿Qué voltajes se leerán en los puntos A, B y C?





El voltaje en todas las resistencias es cero. Porque el voltaje a través de las resistencias para una red sin fuente es cero. Todos los componentes están desconectados de la fuente de voltaje. Por lo tanto, el voltaje en los puntos A, B y C, es cero.