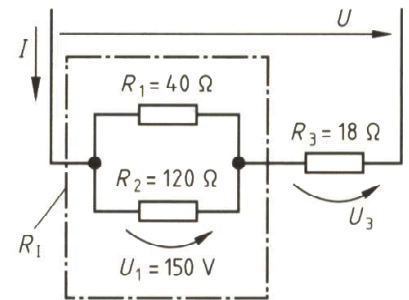




Lösungen

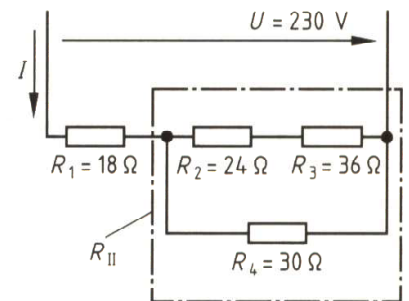
Thema: Gemischte Schaltung – Seite 1

1. b) $R_1 = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{40 \Omega \cdot 120 \Omega}{40 \Omega + 120 \Omega} = 30 \Omega$
 $R = R_1 + R_3 = 30 \Omega + 18 \Omega = 48 \Omega$
 c) $I_1 = \frac{U_1}{R_1} = \frac{150 \text{ V}}{40 \Omega} = 3,75 \text{ A}$
 $I_2 = \frac{U_1}{R_2} = \frac{150 \text{ V}}{120 \Omega} = 1,25 \text{ A}$
 d) $I = I_1 + I_2 = 3,75 \text{ A} + 1,25 \text{ A} = 5 \text{ A}$
 e) $U_3 = I \cdot R_3 = 5 \text{ A} \cdot 18 \Omega = 90 \text{ V}$
 f) $U = U_1 + U_3 = 150 \text{ V} + 90 \text{ V} = 240 \text{ V}$



zu 1.a)

2. b) $R_1 = R_2 + R_3 = 24 \Omega + 36 \Omega = 60 \Omega$
 $R_{II} = \frac{R_1 \cdot R_4}{R_1 + R_4} = \frac{60 \Omega \cdot 30 \Omega}{60 \Omega + 30 \Omega} = 20 \Omega$
 $R = R_1 + R_{II} = 18 \Omega + 20 \Omega = 38 \Omega$
 c) Spannung an R_4 : $\frac{U_{II}}{U} = \frac{R_{II}}{R}$
 $U_4 = U_{II} = \frac{U \cdot R_{II}}{R} = \frac{230 \text{ V} \cdot 20 \Omega}{38 \Omega} = 121 \text{ V}$
 d) Strom durch R_2 : $I_2 = \frac{U_{II}}{R_1} = \frac{121 \text{ V}}{60 \Omega} = 2,02 \text{ A}$



zu 2.a)

3. a) $U_1 = R_1 \cdot I_1 = 150 \Omega \cdot 0,2 \text{ A} = 30 \text{ V}$; $U = U_1 + U_2 = 30 \text{ V} + 20 \text{ V} = 50 \text{ V}$
 b) $R_2 = \frac{U_2}{I_1} = \frac{20 \text{ V}}{0,2 \text{ A}} = 100 \Omega$;
 $\frac{1}{R} = \frac{1}{R_1 + R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{150 \Omega + 100 \Omega} + \frac{1}{220 \Omega} + \frac{1}{470 \Omega} = 0,01067 \frac{1}{\Omega}$
 $R = \frac{1}{0,01067} \Omega = 93,69 \Omega$
 c) $I = \frac{U}{R} = \frac{50 \text{ V}}{93,69 \Omega} = 0,5337 \text{ A} = 533,7 \text{ mA}$; $I_{34} = I - I_1 = 533,7 \text{ mA} - 200 \text{ mA} = 333,7 \text{ mA}$
 $I_3 = \frac{U}{R_3} = \frac{50 \text{ V}}{220 \Omega} = 227,3 \text{ mA}$; $I_4 = \frac{U}{R_4} = \frac{50 \text{ V}}{470 \Omega} = 106,4 \text{ mA}$

4. $U_1 = R_1 \cdot I_1 = 560 \Omega \cdot 34,8 \text{ mA} = 19,49 \text{ V}$; $I_4 = I - I_1 = 50 \text{ mA} - 34,8 \text{ mA} = 15,2 \text{ mA}$
 $R_4 = \frac{U}{I_4} = \frac{24 \text{ V}}{0,0152 \text{ A}} = 1579 \Omega$; $R = \frac{U}{I} = \frac{24 \text{ V}}{0,05 \text{ A}} = 480 \Omega$
 $U_2 = U - U_1 = 24 \text{ V} - 19,49 \text{ V} = 4,51 \text{ V}$; $I_3 = \frac{U_2}{R_3} = \frac{4,51 \text{ V}}{180 \Omega} = 25,1 \text{ mA}$
 $I_2 = I_1 - I_3 = 34,8 \text{ mA} - 25,1 \text{ mA} = 9,7 \text{ mA}$; $R_2 = \frac{U_2}{I_2} = \frac{4,51 \text{ V}}{9,7 \text{ mA}} = 465 \Omega$



Lösungen

Thema: Gemischte Schaltung – Seite 2

5. b) $R_{12} = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{5,6 \text{ k}\Omega \cdot 4,7 \text{ k}\Omega}{5,6 \text{ k}\Omega + 4,7 \text{ k}\Omega} = 2,555 \text{ k}\Omega$

$R_{34} = \frac{R_3 \cdot R_4}{R_3 + R_4} = \frac{1,2 \text{ k}\Omega \cdot 1,8 \text{ k}\Omega}{1,2 \text{ k}\Omega + 1,8 \text{ k}\Omega} = 0,72 \text{ k}\Omega$

$R = R_{12} + R_{34} = 2,555 \text{ k}\Omega + 0,72 \text{ k}\Omega = \mathbf{3,275 \text{ k}\Omega}$

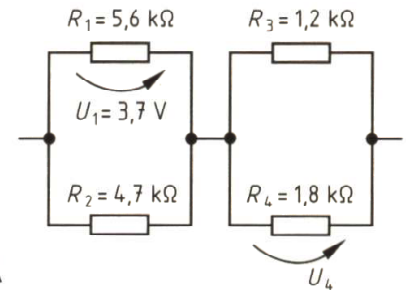
c) $\frac{U_4}{U_1} = \frac{R_{34}}{R_{12}} \Rightarrow U_4 = U_1 \cdot \frac{R_{34}}{R_{12}} = 3,7 \text{ V} \cdot \frac{0,72 \text{ k}\Omega}{2,555 \text{ k}\Omega} = \mathbf{1,043 \text{ V}}$

d) $I_1 = \frac{U_1}{R_1} = \frac{3,7 \text{ V}}{5,6 \text{ k}\Omega} = \mathbf{0,661 \text{ mA}}$; $I_3 = \frac{U_4}{R_3} = \frac{1,043 \text{ V}}{1,2 \text{ k}\Omega} = \mathbf{0,869 \text{ mA}}$

$I_2 = \frac{U_1}{R_2} = \frac{3,7 \text{ V}}{4,7 \text{ k}\Omega} = \mathbf{0,787 \text{ mA}}$; $I_4 = \frac{U_4}{R_4} = \frac{1,043 \text{ V}}{1,8 \text{ k}\Omega} = \mathbf{0,579 \text{ mA}}$

e) $I = I_1 + I_2 = 0,661 \text{ mA} + 0,787 \text{ mA} = \mathbf{1,448 \text{ mA}}$

f) $U = I \cdot R = 1,448 \text{ mA} \cdot 3,275 \text{ k}\Omega = \mathbf{4,74 \text{ V}}$



zu 5.a)

6. b) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3 + R_4} = \frac{1}{680 \Omega} + \frac{1}{390 \Omega} + \frac{1}{560 \Omega + 1200 \Omega}$
 $= 4,60 \cdot 10^{-3} \frac{1}{\Omega}$; $R = \mathbf{217,3 \Omega}$

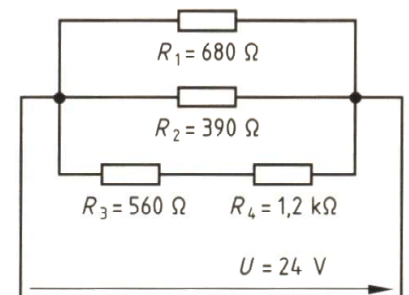
c) $I = \frac{U}{R} = \frac{24 \text{ V}}{217,3 \Omega} = \mathbf{110,4 \text{ mA}}$

d) $I_1 = \frac{U_1}{R_1} = \frac{24 \text{ V}}{680 \Omega} = \mathbf{35,29 \text{ mA}}$; $I_2 = \frac{U_2}{R_2} = \frac{24 \text{ V}}{390 \Omega} = \mathbf{61,54 \text{ mA}}$

$I_3 = I_4 = \frac{U}{R_3 + R_4} = \frac{24 \text{ V}}{560 \Omega + 1200 \Omega} = \mathbf{13,64 \text{ mA}}$

e) $U_1 = U_2 = U_{34} = \mathbf{24 \text{ V}}$

$U_3 = R_3 \cdot I_3 = 560 \Omega \cdot 13,64 \text{ mA} = \mathbf{7,64 \text{ V}}$; $U_4 = R_4 \cdot I_4 = 1,2 \text{ k}\Omega \cdot 13,64 \text{ mA} = \mathbf{16,37 \text{ V}}$



zu 6.a)

7. R_3, R_4, R_5 und R_6 sind zueinander parallel geschaltet.

a) $R = R_1 + R_2 + \frac{1}{\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6}} = 120 \Omega + 150 \Omega + \frac{1}{\frac{1}{180 \Omega} + \frac{1}{270 \Omega} + \frac{1}{100 \Omega} + \frac{1}{120 \Omega}}$
 $R = 270 \Omega + \frac{1}{0,02759 \frac{1}{\Omega}} = 270 \Omega + 36,24 \Omega = \mathbf{306,24 \Omega}$

b) $I = \frac{U}{R} = \frac{6 \text{ V}}{306,24 \Omega} = \mathbf{19,6 \text{ mA}}$

$U_3 = U - (R_1 + R_2) \cdot I = 6 \text{ V} - (120 \Omega + 150 \Omega) \cdot 0,0196 \text{ A} = 6 \text{ V} - 5,29 \text{ V} = \mathbf{0,71 \text{ V}}$

$I_5 = \frac{U_3}{R_5} = \frac{0,71 \text{ V}}{100 \Omega} = \mathbf{7,1 \text{ mA}}$

c) $U_2 = R_2 \cdot I = 150 \Omega \cdot 0,0196 \text{ A} = \mathbf{2,94 \text{ V}}$



Lösungen

Thema: Gemischte Schaltung – Seite 3

$$8. \text{ a) } R_I = R_1 + R_2 = 10 \Omega + 20 \Omega = 30 \Omega; \quad R_{II} = \frac{R_I \cdot R_3}{R_I + R_3} = \frac{30 \Omega \cdot 30 \Omega}{30 \Omega + 30 \Omega} = 15 \Omega$$

$$R_{III} = R_{II} + R_4 = 15 \Omega + 40 \Omega = 55 \Omega$$

$$R = \frac{R_{III} \cdot R_5}{R_{III} + R_5} = \frac{55 \Omega \cdot 50 \Omega}{55 \Omega + 50 \Omega} = \frac{2750 \Omega^2}{105 \Omega} = \mathbf{26,19 \Omega}$$

$$\text{b) } I_2 = \frac{U_2}{R_2} = \frac{3 \text{ V}}{20 \Omega} = 0,15 \text{ A}; \quad U_{12} = U_3 = R_{12} \cdot I_2 = 30 \Omega \cdot 0,15 \text{ A} = 4,5 \text{ V}$$

$$I_3 = \frac{U_3}{R_3} = \frac{4,5 \text{ V}}{30 \Omega} = 0,15 \text{ A}; \quad I_4 = I_2 + I_3 = 0,15 \text{ A} + 0,15 \text{ A} = \mathbf{0,3 \text{ A}}$$

$$\text{c) } U_4 = R_4 \cdot I_4 = 40 \Omega \cdot 0,3 \text{ A} = 12 \text{ V}; \quad U = U_5$$

$$U_5 = U_3 + U_4 = 4,5 \text{ V} + 12 \text{ V} = 16,5 \text{ V}$$

$$I = \frac{U_5}{R} = \frac{16,5 \text{ V}}{26,19 \Omega} = \mathbf{0,63 \text{ A}}$$

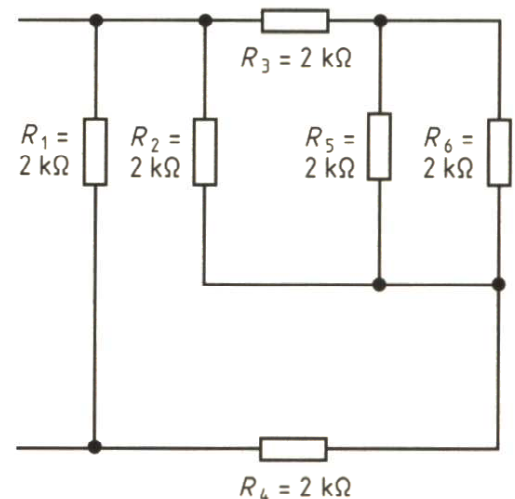
$$9. \quad R_I = \frac{R_5 \cdot R_6}{R_5 + R_6} = \frac{2 \text{ k}\Omega \cdot 2 \text{ k}\Omega}{2 \text{ k}\Omega + 2 \text{ k}\Omega} = 1 \text{ k}\Omega$$

$$R_{II} = R_I + R_3 = 1 \text{ k}\Omega + 2 \text{ k}\Omega = 3 \text{ k}\Omega$$

$$R_{III} = \frac{R_{II} \cdot R_2}{R_{II} + R_2} = \frac{3 \text{ k}\Omega \cdot 2 \text{ k}\Omega}{3 \text{ k}\Omega + 2 \text{ k}\Omega} = 1,2 \text{ k}\Omega$$

$$R_{IV} = R_{III} + R_4 = 1,2 \text{ k}\Omega + 2 \text{ k}\Omega = 3,2 \text{ k}\Omega$$

$$R = \frac{R_{IV} \cdot R_1}{R_{IV} + R_1} = \frac{3,2 \text{ k}\Omega \cdot 2 \text{ k}\Omega}{3,2 \text{ k}\Omega + 2 \text{ k}\Omega} = \mathbf{1,23 \text{ k}\Omega}$$



zu 9.

$$10. \text{ a) } \frac{1}{R_I} = \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6} = \frac{1}{80 \Omega} + \frac{1}{100 \Omega} + \frac{1}{120 \Omega} = \frac{15 + 12 + 10}{1200 \Omega} = \frac{37}{1200 \Omega}$$

$$R_I = \frac{1200 \Omega}{37} = 32,4 \Omega; \quad R_{II} = \frac{R_2 \cdot R_3}{R_2 + R_3} = \frac{200 \Omega \cdot 50 \Omega}{200 \Omega + 50 \Omega} = 40 \Omega$$

$$R = R_1 + R_I + R_{II} = 60 \Omega + 32,4 \Omega + 40 \Omega = 132,4 \Omega$$

$$U = I \cdot R = 1,5 \text{ A} \cdot 132,4 \Omega = \mathbf{198,6 \text{ V}}$$

$$\text{b) } U \text{ an } R_5 = U_I = I \cdot R_I = 1,5 \text{ A} \cdot 32,4 \Omega = \mathbf{48,6 \text{ V}}$$

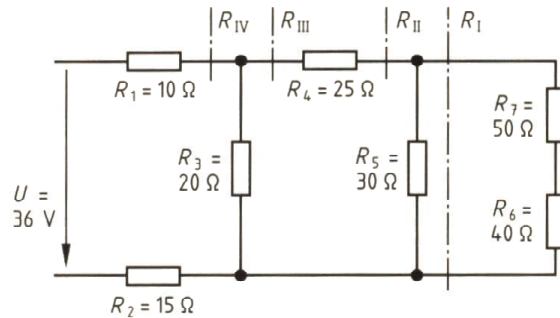
$$\text{c) } I_4 = \frac{U_I}{R_4} = \frac{48,6 \text{ V}}{80 \Omega} = \mathbf{0,608 \text{ A}}$$



Lösungen

Thema: Gemischte Schaltung – Seite 4

11. a) $R_1 = R_6 + R_7 = 40 \Omega + 50 \Omega = 90 \Omega$
 $R_{II} = \frac{R_1 \cdot R_5}{R_1 + R_5} = \frac{90 \Omega \cdot 30 \Omega}{90 \Omega + 30 \Omega} = 22,5 \Omega$
 $R_{III} = R_4 + R_{II} = 25 \Omega + 22,5 \Omega = 47,5 \Omega$
 $R_{IV} = \frac{R_3 \cdot R_{III}}{R_3 + R_{III}} = \frac{20 \Omega \cdot 47,5 \Omega}{20 \Omega + 47,5 \Omega} = 14,07 \Omega$
 $R = R_1 + R_2 + R_{IV} = 10 \Omega + 15 \Omega + 14,07 \Omega = 39,07 \Omega = \mathbf{39,1 \Omega}$



zu 11.

b) $\frac{U_3}{U} = \frac{R_{IV}}{R}; U_3 = U_{IV} = \frac{U \cdot R_{IV}}{R} = \frac{36 \text{ V} \cdot 14,07 \Omega}{39,1 \Omega} = \mathbf{12,96 \text{ V}}$
 $U_2 = \frac{U \cdot R_2}{R} = \frac{36 \text{ V} \cdot 15 \Omega}{39,07 \Omega} = \mathbf{13,82 \text{ V}}; U_1 = \frac{U \cdot R_1}{R} = \frac{36 \text{ V} \cdot 10 \Omega}{39,07 \Omega} = \mathbf{9,21 \text{ V}}$
 $\frac{U_4}{U_3} = \frac{R_4}{R_{III}}; U_4 = \frac{U_3 \cdot R_4}{R_{III}} = \frac{12,96 \text{ V} \cdot 25 \Omega}{47,5 \Omega} = \mathbf{6,82 \text{ V}}$

Probe: $U_3 + U_2 + U_1 = 12,96 \text{ V} + 13,82 \text{ V} + 9,21 \text{ V} = 35,99 \text{ V} \approx 36 \text{ V}$

$U_5 = U_3 - U_4 = 12,96 \text{ V} - 6,82 \text{ V} = \mathbf{6,14 \text{ V}}; U_6 = \frac{U_5 \cdot R_6}{R_1} = \frac{6,14 \text{ V} \cdot 40 \Omega}{90 \Omega} = \mathbf{2,73 \text{ V}}$

$U_7 = U_5 - U_6 = 6,14 \text{ V} - 2,73 \text{ V} = \mathbf{3,41 \text{ V}}$

c) $I_6 = I_7 = \frac{U_6}{R_6} = \frac{2,73 \text{ V}}{40 \Omega} = \mathbf{68,3 \text{ mA}};$

$I_5 = \frac{U_5}{R_5} = \frac{6,14 \text{ V}}{30 \Omega} = \mathbf{204,7 \text{ mA}}$

$I_4 = I_6 + I_5 = 68,3 \text{ mA} + 204,7 \text{ mA} = \mathbf{273 \text{ mA}}; I_3 = \frac{U_3}{R_3} = \frac{12,96 \text{ V}}{20 \Omega} = \mathbf{0,648 \text{ A}}$

$I = I_4 + I_3 = 0,273 \text{ A} + 0,648 \text{ A} = \mathbf{0,921 \text{ A}}; \text{Probe: } I = \frac{U}{R} = \frac{36 \text{ V}}{39,07 \Omega} = \mathbf{0,921 \text{ A}}$

12. $\frac{1}{R_{\text{ges}}} = \frac{1}{R} + \frac{1}{2R} = \frac{1+2}{2R} = \frac{3}{2R} \Rightarrow R_{\text{ges}} = \frac{3}{2} \cdot R = \frac{3}{2} \cdot 10 \Omega = \mathbf{15 \Omega}$

13. b) $U_4 = R_4 \cdot I_4 = 120 \Omega \cdot 0,03 \text{ A} = 3,6 \text{ V};$

$I_{45} = \frac{U_4}{\frac{R_4 \cdot R_5}{R_4 + R_5}} = \frac{U_4 (R_4 + R_5)}{R_4 \cdot R_5} = \frac{3,6 \text{ V} \cdot (120 \Omega + 220 \Omega)}{120 \Omega \cdot 220 \Omega}$

$I_{45} = 0,04636 \text{ A} = 46,36 \text{ mA}$

$\frac{1}{R_{123}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{270 \Omega} + \frac{1}{390 \Omega} + \frac{1}{470 \Omega}$

$\frac{1}{R_{123}} = 0,008395 \frac{1}{\Omega}; R_{123} = 119,1 \Omega$

$U_1 = R_{123} \cdot I_{45} = 119,1 \Omega \cdot 0,04636 \text{ A} = \mathbf{5,52 \text{ V}}$

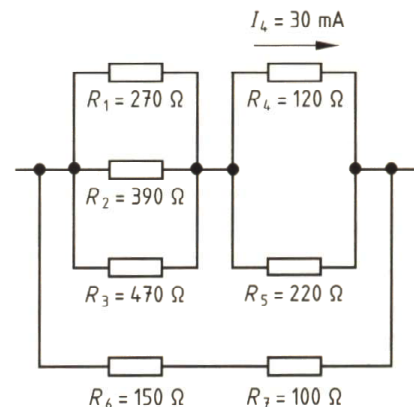
c) $I_2 = \frac{U_2}{R_2} = \frac{5,52 \text{ V}}{390 \Omega} = 0,014154 \text{ A} = \mathbf{14,15 \text{ mA}}$

d) $R_{67} = R_6 + R_7 = 150 \Omega + 100 \Omega = 250 \Omega$

$I_6 = \frac{U_1 + U_4}{R_{67}} = \frac{5,52 \text{ V} + 3,6 \text{ V}}{250 \Omega} = \frac{9,12 \text{ V}}{250 \Omega} = 0,03648 \text{ A} = 36,5 \text{ mA}$

$I = I_{45} + I_6 = 46,36 \text{ mA} + 36,48 \text{ mA} = \mathbf{82,84 \text{ mA}}$

e) $U = U_1 + U_4 = 5,52 \text{ V} + 3,6 \text{ V} = \mathbf{9,12 \text{ V}}$



zu 13.a)



Lösungen

Thema: Gemischte Schaltung – Seite 5

14. a) **A-C:** $R_{23} = R_2 + R_3 = 35 \Omega + 35 \Omega = 70 \Omega$
 $R_{56} = R_5 + R_6 = 120 \Omega + 120 \Omega = 240 \Omega$
 $R = R_1 + \frac{R_{23} \cdot R_{56}}{R_{23} + R_{56}} + R_7 = 480 \Omega + \frac{70 \Omega \cdot 240 \Omega}{70 \Omega + 240 \Omega} + 460 \Omega = 480 \Omega + 54,2 \Omega + 460 \Omega = 994 \Omega$
 $I = \frac{U}{R} = \frac{50 \text{ V}}{994 \Omega} = \mathbf{50,3 \text{ mA}}$ (gefährlich)
- b) **B-D:** $R_{25} = R_2 + R_5 = 35 \Omega + 120 \Omega = 155 \Omega$; $R_{25} = R_{36}$
 $R = R_4 + \frac{R_{25}}{2} + R_8 + R_{10} = 40 \Omega + \frac{155 \Omega}{2} + 20 \Omega + 850 \Omega = 987,5 \Omega$
 $I = \frac{U}{R} = \frac{50 \text{ V}}{987,5 \Omega} = \mathbf{50,6 \text{ mA}}$ (gefährlich)
- c) **A-D:** $R_{236} = R_2 + R_3 + R_6 = 35 \Omega + 35 \Omega + 120 \Omega = 190 \Omega$
 $R_1 = \frac{R_5 \cdot R_{236}}{R_5 + R_{236}} = \frac{120 \Omega \cdot 190 \Omega}{120 \Omega + 190 \Omega} = 73,55 \Omega$
 $R = R_1 + R_1 + R_8 + R_9 = 480 \Omega + 73,55 \Omega + 20 \Omega + 850 \Omega = 1423,55 \Omega$
 $I = \frac{U}{R} = \frac{50 \text{ V}}{1,4236 \text{ k}\Omega} = \mathbf{35,1 \text{ mA}}$ (nicht ungefährlich)
- d) **A-B:** $R_{356} = R_3 + R_5 + R_6 = 35 \Omega + 120 \Omega + 120 \Omega = 275 \Omega$
 $R_1 = \frac{R_2 \cdot R_{356}}{R_2 + R_{356}} = \frac{35 \Omega \cdot 275 \Omega}{35 \Omega + 275 \Omega} = 31,05 \Omega$
 $R = R_1 + R_1 + R_4 = 480 \Omega + 31,05 \Omega + 40 \Omega = 551,05 \Omega$
 $I = \frac{U}{R} = \frac{50 \text{ V}}{551,05 \Omega} = \mathbf{90,7 \text{ mA}}$ (lebensgefährlich!)

15. a) Taster geöffnet: $U_{\text{rel}} = R_{\text{rel}} \cdot I = 3 \text{ k}\Omega \cdot 8 \text{ mA} = 24 \text{ V}$
 $U_1 = U - U_{\text{rel}} = 48 \text{ V} - 24 \text{ V} = 24 \text{ V}$
 $R_1 = \frac{U_1}{I} = \frac{24 \text{ V}}{8 \text{ mA}} = \mathbf{3 \text{ k}\Omega}$
 Taster geschlossen: $U_{\text{rel}} = 24 \text{ V} - 8 \text{ V} = 16 \text{ V}$
 $I_1 = \frac{U_{\text{rel}}}{R_{\text{rel}}} = \frac{16 \text{ V}}{3 \text{ k}\Omega} = 5,3 \text{ mA}$
 $I = \frac{U - U_{\text{rel}}}{R_1} = \frac{48 \text{ V} - 16 \text{ V}}{3 \text{ k}\Omega} = \frac{32 \text{ V}}{3 \text{ k}\Omega} = 10,6 \text{ mA}$
 $I_2 = I - I_1 = 10,6 \text{ mA} - 5,3 \text{ mA} = 5,3 \text{ mA}$
 $R_2 = \frac{U_{\text{rel}}}{I_2} = \frac{16 \text{ V}}{5,3 \text{ mA}} = \mathbf{3 \text{ k}\Omega}$ b) $I_{\text{rel}} = \frac{U_{\text{rel}}}{R_{\text{rel}}} = \frac{16 \text{ V}}{3 \text{ k}\Omega} = \mathbf{5,3 \text{ mA}}$

16. für $n = 10$: $R_m = R_p \cdot (n - 1) \Rightarrow R_m = (R_{p1} + R_{p2} + R_{p3}) \cdot 9$
 $\Rightarrow \frac{R_m}{9} = R_{p1} + R_{p2} + R_{p3} \Rightarrow \frac{R_m}{9} - R_{p1} = R_{p2} + R_{p3}$ (1)

für $n = 50$: $49(R_{p2} + R_{p3}) = (R_{p1} + R_m) \Rightarrow R_{p2} + R_{p3} = \frac{R_{p1}}{49} + \frac{R_m}{49}$ (2)

für $n = 250$: $249R_{p3} = R_{p1} + R_{p2} + R_m$ (3)

(1) = (2): $\frac{R_m}{9} - R_{p1} = \frac{R_{p1}}{49} + \frac{R_m}{49} \Rightarrow \frac{R_m}{9} - \frac{R_m}{49} = \frac{50}{49} R_{p1}$

$R_m \left(\frac{1}{9} - \frac{1}{49} \right) = \frac{50}{49} R_{p1} \Rightarrow R_{p1} = 10 \Omega \left(\frac{1}{11,025} \right) \cdot \frac{49}{50} = \mathbf{0,8 \Omega}$



Lösungen

Thema: Gemischte Schaltung – Seite 6

$$(1) = (3): \quad 249 R_{p3} - R_m = \frac{R_m}{9} - R_{p3}$$

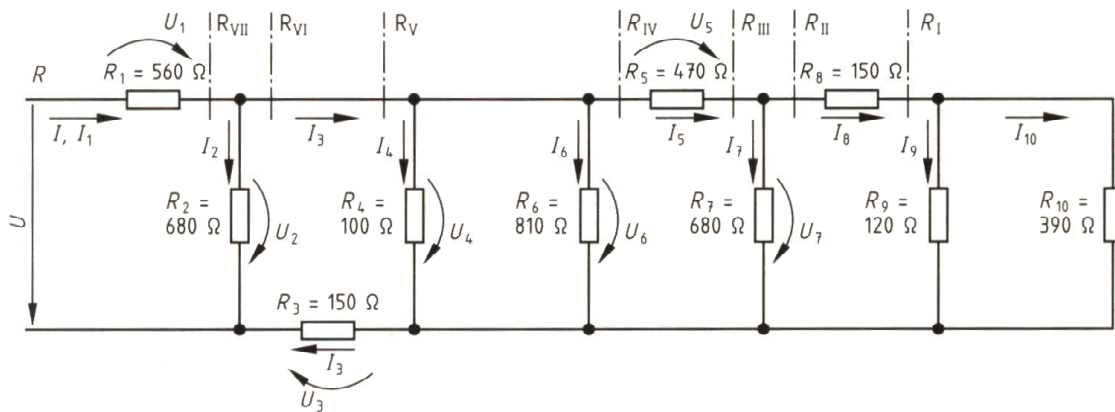
$$\frac{R_m}{9} + R_m = 249 R_{p3} + R_{p3}$$

$$\frac{10}{9} R_m = 250 R_{p3}$$

$$R_{p3} = 0,04 \Omega$$

$$R_{p2} = \frac{R_m}{9} - R_{p1} - R_{p3} = \frac{10}{9} \Omega - 0,8 \Omega - 0,04 \Omega = 0,17 \Omega$$

17.



zu 17.

$$a) R_I = \frac{R_9 \cdot R_{10}}{R_9 + R_{10}} = \frac{120 \Omega \cdot 390 \Omega}{120 \Omega + 390 \Omega} = 91,8 \Omega; \quad R_{II} = R_8 + R_I = 150 \Omega + 91,8 \Omega = 241,8 \Omega$$

$$R_{III} = \frac{R_{II} \cdot R_7}{R_{II} + R_7} = \frac{241,8 \Omega \cdot 680 \Omega}{241,8 \Omega + 680 \Omega} = 178,4 \Omega; \quad R_{IV} = R_5 + R_{III} = 470 \Omega + 178,4 \Omega = 648,4 \Omega$$

$$R_V = \frac{1}{\frac{1}{R_4} + \frac{1}{R_6} + \frac{1}{R_{IV}}} = \frac{1}{\frac{1}{100 \Omega} + \frac{1}{810 \Omega} + \frac{1}{648,4 \Omega}} = 78,3 \Omega$$

$$R_{VI} = R_V + R_3 = 78,3 \Omega + 150 \Omega = 228,3 \Omega$$

$$R_{VII} = \frac{R_{VI} \cdot R_2}{R_{VI} + R_2} = \frac{228,3 \Omega \cdot 680 \Omega}{228,3 \Omega + 680 \Omega} = 170,9 \Omega$$

$$R = R_1 + R_{VII} = 170,9 \Omega + 560 \Omega = 730,9 \Omega$$

$$b) I = \frac{U}{R} = \frac{220 \text{ V}}{730,9 \Omega} = 0,3010 \text{ A} = 301,0 \text{ mA}; \quad U_1 = R_1 \cdot I_1 = 560 \Omega \cdot 0,301 \text{ A} = 168,6 \text{ V}$$

$$U_2 = U - U_1 = 220 \text{ V} - 168,6 \text{ V} = 51,4 \text{ V}; \quad I_2 = \frac{U_2}{R_2} = \frac{51,4 \text{ V}}{680 \Omega} = 0,0756 \text{ A} = 75,6 \text{ mA}$$

$$I_3 = I - I_2 = 301,0 \text{ mA} - 75,6 \text{ mA} = 225,4 \text{ mA}$$

$$U_3 = R_3 \cdot I_3 = 150 \Omega \cdot 0,2254 \text{ A} = 33,81 \text{ V}; \quad U_4 = U_6 = U_2 - U_3 = 51,44 \text{ V} - 33,81 \text{ V} = 17,63 \text{ V}$$

$$c) I_4 = \frac{U_4}{R_4} = \frac{17,63 \text{ V}}{100 \Omega} = 0,1763 \text{ A} = 176,3 \text{ mA}; \quad I_6 = \frac{U_6}{R_6} = \frac{17,63 \text{ V}}{810 \Omega} = 0,0218 \text{ A} = 21,8 \text{ mA}$$

$$I_5 = I_3 - I_4 - I_6 = 225,4 \text{ mA} - 176,3 \text{ mA} - 21,8 \text{ mA} = 27,3 \text{ mA}$$

$$U_5 = R_5 \cdot I_5 = 470 \Omega \cdot 0,0273 \text{ A} = 12,83 \text{ V}; \quad U_7 = U_6 - U_5 = 17,63 \text{ V} - 12,83 \text{ V} = 4,80 \text{ V}$$

$$I_7 = \frac{U_7}{R_7} = \frac{4,80 \text{ V}}{680 \Omega} = 7,1 \text{ mA}$$



Lösungen

Thema: Gemischte Schaltung – Seite 7

18. a) Anschluss zwischen A und B: $U = 9\text{ V}$

$$R_I = \frac{R_5 \cdot R_6}{R_5 + R_6} = \frac{470\ \Omega \cdot 220\ \Omega}{470\ \Omega + 220\ \Omega} = 149,86\ \Omega$$

$$R_{II} = R_I + R_4 = 149,86\ \Omega + 150\ \Omega = 299,86\ \Omega$$

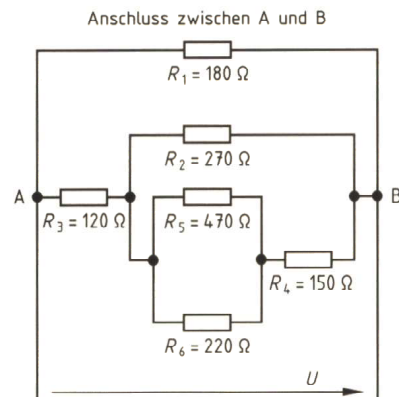
$$R_{III} = \frac{R_2 \cdot R_{II}}{R_2 + R_{II}} = \frac{270\ \Omega \cdot 299,86\ \Omega}{270\ \Omega + 299,86\ \Omega} = 142,07\ \Omega$$

$$R_{VI} = R_3 + R_{III} = 120\ \Omega + 142,07\ \Omega = 262,07\ \Omega$$

$$R = \frac{R_1 \cdot R_{IV}}{R_1 + R_{IV}} = \frac{180\ \Omega \cdot 262,07\ \Omega}{180\ \Omega + 262,07\ \Omega} = \mathbf{106,71\ \Omega}$$

$$U_1 = U = 9\text{ V}; \quad I_1 = \frac{U_1}{R_1} = \frac{9\text{ V}}{180\ \Omega} = \mathbf{50\text{ mA}}$$

$$I_3 = \frac{U}{R_{IV}} = \frac{9\text{ V}}{262,07\ \Omega} = \mathbf{34,34\text{ mA}}$$



zu 18.a)

$$U_3 = R_3 \cdot I_3 = 120\ \Omega \cdot 34,34\text{ mA} = \mathbf{4,121\text{ V}}$$

$$U_2 = U - U_3 = 9\text{ V} - 4,121\text{ V} = \mathbf{4,879\text{ V}}$$

$$I_2 = \frac{U_2}{R_2} = \frac{4,879\text{ V}}{270\ \Omega} = \mathbf{18,07\text{ mA}}; \quad I_4 = I_3 - I_2 = 34,34\text{ mA} - 18,07\text{ mA} = \mathbf{16,27\text{ mA}}$$

$$U_4 = R_4 \cdot I_4 = 150\ \Omega \cdot 16,27\text{ mA} = \mathbf{2,441\text{ V}}$$

$$U_5 = U_6 = U_2 - U_4 = 4,879\text{ V} - 2,441\text{ V} = \mathbf{2,438\text{ V}}$$

$$I_5 = \frac{U_5}{R_5} = \frac{2,438\text{ V}}{470\ \Omega} = \mathbf{5,187\text{ mA}}; \quad I_6 = \frac{U_6}{R_6} = \frac{2,438\text{ V}}{220\ \Omega} = \mathbf{11,08\text{ mA}}$$

18. b) Anschluss zwischen A und C:

$$R_I = \frac{R_5 \cdot R_6}{R_5 + R_6} = \frac{470\ \Omega \cdot 220\ \Omega}{470\ \Omega + 220\ \Omega} = 149,86\ \Omega$$

$$R_{II} = R_I + R_4 = 149,86\ \Omega + 150\ \Omega = 299,86\ \Omega$$

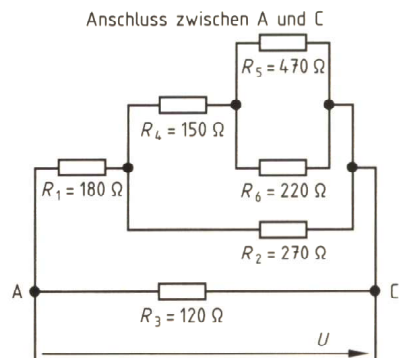
$$R_{III} = \frac{R_{II} \cdot R_2}{R_{II} + R_2} = \frac{299,86\ \Omega \cdot 270\ \Omega}{299,86\ \Omega + 270\ \Omega} = 142,07\ \Omega$$

$$R_{IV} = R_1 + R_{III} = 180\ \Omega + 142,07\ \Omega = 322,07\ \Omega$$

$$R = \frac{R_3 \cdot R_{IV}}{R_3 + R_{IV}} = \frac{120\ \Omega \cdot 322,07\ \Omega}{120\ \Omega + 322,07\ \Omega} = \mathbf{87,43\ \Omega}$$

$$I = \frac{U}{R} = \frac{9\text{ V}}{87,43\ \Omega} = \mathbf{102,94\text{ mA}}$$

$$I_3 = \frac{U}{R_3} = \frac{9\text{ V}}{120\ \Omega} = \mathbf{75\text{ mA}}$$



zu 18.b)

$$I_1 = I - I_3 = 102,94\text{ mA} - 75\text{ mA} = \mathbf{27,94\text{ mA}}; \quad U_1 = I_1 \cdot R_1 = 27,94\text{ mA} \cdot 180\ \Omega = \mathbf{5,03\text{ V}}$$

$$U_2 = U - U_1 = 9\text{ V} - 5,03\text{ V} = \mathbf{3,97\text{ V}}; \quad I_2 = \frac{U_2}{R_2} = \frac{3,97\text{ V}}{270\ \Omega} = \mathbf{14,7\text{ mA}}$$

$$I_4 = I_1 - I_2 = 27,94\text{ mA} - 14,7\text{ mA} = \mathbf{13,24\text{ mA}}; \quad U_4 = I_4 \cdot R_4 = 13,24\text{ mA} \cdot 150\ \Omega = \mathbf{1,986\text{ V}}$$

$$U_5 = U_6 = U_2 - U_4 = 3,97\text{ V} - 1,986\text{ V} = \mathbf{1,984\text{ V}}$$

$$I_5 = \frac{U_5}{R_5} = \frac{1,984\text{ V}}{470\ \Omega} = \mathbf{4,22\text{ mA}}; \quad I_6 = \frac{U_6}{R_6} = \frac{1,984\text{ V}}{220\ \Omega} = \mathbf{9,02\text{ mA}}$$

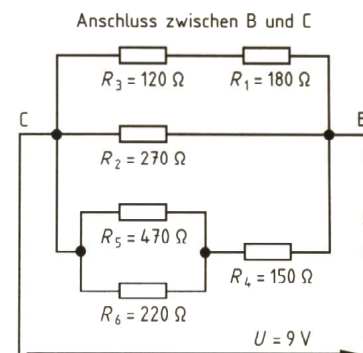
18. c) Anschluss zwischen B und C:

$$R_I = \frac{R_5 \cdot R_6}{R_5 + R_6} = \frac{470\ \Omega \cdot 220\ \Omega}{470\ \Omega + 220\ \Omega} = 149,86\ \Omega$$

$$R_{II} = R_I + R_4 = 149,86\ \Omega + 150\ \Omega = 299,86\ \Omega$$

$$R_{III} = R_I + R_3 = 180\ \Omega + 120\ \Omega = 300\ \Omega$$

$$R = \frac{1}{\frac{1}{R_{II}} + \frac{1}{R_2} + \frac{1}{R_{III}}} = \frac{1}{\frac{1}{299,86\ \Omega} + \frac{1}{270\ \Omega} + \frac{1}{300\ \Omega}} = \mathbf{96,4\ \Omega}$$



zu 18.c)



Lösungen

Thema: Gemischte Schaltung – Seite 8

$$I_1 = \frac{U}{R_{III}} = \frac{9 \text{ V}}{300 \Omega} = 30 \text{ mA}; \quad U_2 = U = 9 \text{ V};$$

$$U_1 = I_1 \cdot R_1 = 30 \text{ mA} \cdot 180 \Omega = 5,4 \text{ V}; \quad U_3 = I_1 \cdot R_3 = 30 \text{ mA} \cdot 120 \Omega = 3,6 \text{ V}$$

$$I_2 = \frac{U}{R_2} = \frac{9 \text{ V}}{270 \Omega} = 33,3 \text{ mA}; \quad I_4 = \frac{U}{R_{II}} = \frac{9 \text{ V}}{299,86 \Omega} = 30 \text{ mA}$$

$$U_4 = R_4 \cdot I_4 = 150 \Omega \cdot 30 \text{ mA} = 4,5 \text{ V}; \quad U_5 = U - U_4 = 9 \text{ V} - 4,50 \text{ V} = 4,498 \text{ V} \approx 4,50 \text{ V}$$

$$I_5 = \frac{U_5}{R_5} = \frac{4,50 \text{ V}}{470 \Omega} = 9,57 \text{ mA}; \quad I_6 = \frac{U_5}{R_6} = \frac{4,50 \text{ V}}{220 \Omega} = 20,5 \text{ mA}$$

18. d) Anschluss zwischen B und D:

$$R_I = R_1 + R_3 = 180 \Omega + 120 \Omega = 300 \Omega$$

$$R_{II} = \frac{R_I \cdot R_2}{R_I + R_2} = \frac{300 \Omega \cdot 270 \Omega}{300 \Omega + 270 \Omega} = 142,11 \Omega$$

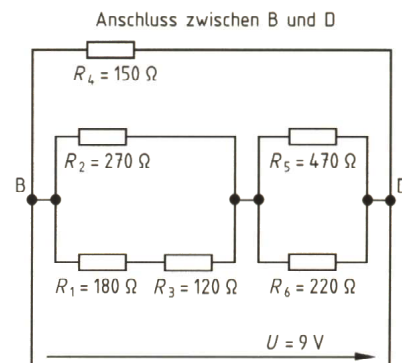
$$R_{III} = \frac{R_5 \cdot R_6}{R_5 + R_6} = \frac{470 \Omega \cdot 220 \Omega}{470 \Omega + 220 \Omega} = 149,86 \Omega$$

$$R_{IV} = R_{II} + R_{III} = 142,11 \Omega + 149,86 \Omega = 291,97 \Omega$$

$$R = \frac{R_4 \cdot R_{IV}}{R_4 + R_{IV}} = \frac{150 \Omega \cdot 291,86 \Omega}{150 \Omega + 291,86 \Omega} = 99,09 \Omega$$

$$U_4 = U = 9 \text{ V}; \quad I_4 = \frac{U_4}{R_4} = \frac{9 \text{ V}}{150 \Omega} = 60 \text{ mA}$$

$$I_{5+6} = \frac{U}{R_{IV}} = \frac{9 \text{ V}}{291,86 \Omega} = 30,84 \text{ mA}$$



zu 18.d)

$$U_5 = U_6 = R_{III} \cdot I_{5+6} = 149,86 \Omega \cdot 0,03084 \text{ A} = 4,62 \text{ V}$$

$$I_5 = U_5 / R_5 = 4,62 \text{ V} / 470 \Omega = 9,83 \text{ mA};$$

$$I_6 = U_6 / R_6 = 4,62 \text{ V} / 220 \Omega = 21 \text{ mA}$$

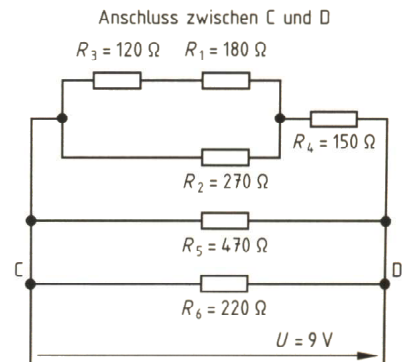
$$U_2 = U - U_5 = 9,00 \text{ V} - 4,62 \text{ V} = 4,38 \text{ V}$$

$$I_2 = U_2 / R_2 = 4,38 \text{ V} / 270 \Omega = 16,22 \text{ mA};$$

$$I_1 = I_3 = U_2 / R_1 = 4,38 \text{ V} / 300 \Omega = 14,6 \text{ mA}$$

$$U_1 = R_1 \cdot I_1 = 180 \Omega \cdot 14,6 \text{ mA} = 2,628 \text{ V}$$

$$U_3 = R_3 \cdot I_1 = 120 \Omega \cdot 14,6 \text{ mA} = 1,752 \text{ V}$$



zu 18.e)

18. e) Anschluss zwischen C und D:

$$R_I = R_1 + R_3 = 180 \Omega + 120 \Omega = 300 \Omega$$

$$R_{II} = \frac{R_I \cdot R_2}{R_I + R_2} = \frac{300 \Omega \cdot 270 \Omega}{300 \Omega + 270 \Omega} = 142,11 \Omega$$

$$R_{III} = R_{II} + R_4 = 142,11 \Omega + 150 \Omega = 292,11 \Omega$$

$$R = \frac{1}{\frac{1}{R_{III}} + \frac{1}{R_5} + \frac{1}{R_6}} = \frac{1}{\frac{1}{292,11 \Omega} + \frac{1}{470 \Omega} + \frac{1}{220 \Omega}} = \frac{1}{0,010096 \frac{1}{\Omega}} = 99,04 \Omega$$

$$U = U_5 = U_6 = 9 \text{ V}; \quad I_5 = \frac{U_5}{R_5} = \frac{9 \text{ V}}{470 \Omega} = 19,15 \text{ mA}; \quad I_6 = \frac{9 \text{ V}}{220 \Omega} = 40,91 \text{ mA}$$

$$I_4 = \frac{U}{R_{III}} = \frac{9 \text{ V}}{292,11 \Omega} = 30,81 \text{ mA}; \quad U_4 = I_4 \cdot R_4 = 30,81 \text{ mA} \cdot 150 \Omega = 4,62 \text{ V}$$

$$U_2 = U - U_4 = 9 \text{ V} - 4,62 \text{ V} = 4,38 \text{ V}; \quad I_2 = \frac{U_2}{R_2} = \frac{4,38 \text{ V}}{270 \Omega} = 16,22 \text{ mA}$$

$$I_1 = I_3 = \frac{U_2}{R_1} = \frac{4,38 \text{ V}}{300 \Omega} = 14,6 \text{ mA}$$

$$U_1 = I_1 \cdot R_1 = 14,6 \text{ mA} \cdot 180 \Omega = 2,63 \text{ V}; \quad U_3 = I_1 \cdot R_3 = 14,6 \text{ mA} \cdot 120 \Omega = 1,75 \text{ V}$$