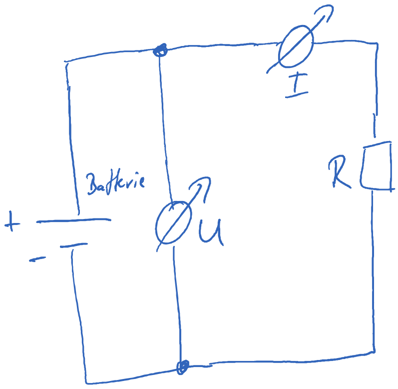
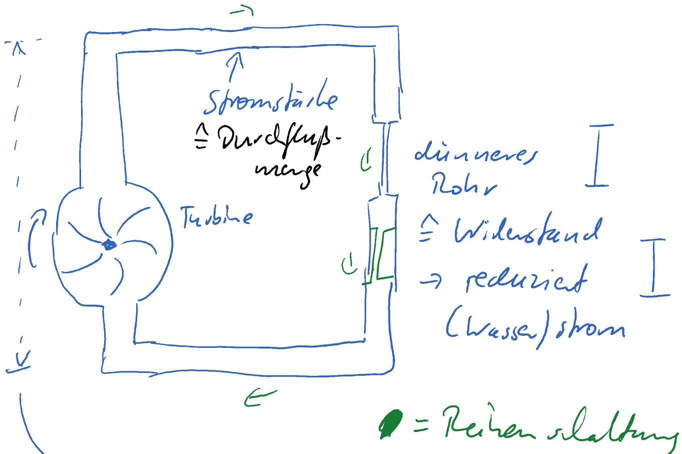
3.3. ELEKTRISCHE SCHALTUNGEN

3.3.0. ANALOGON: WASSER



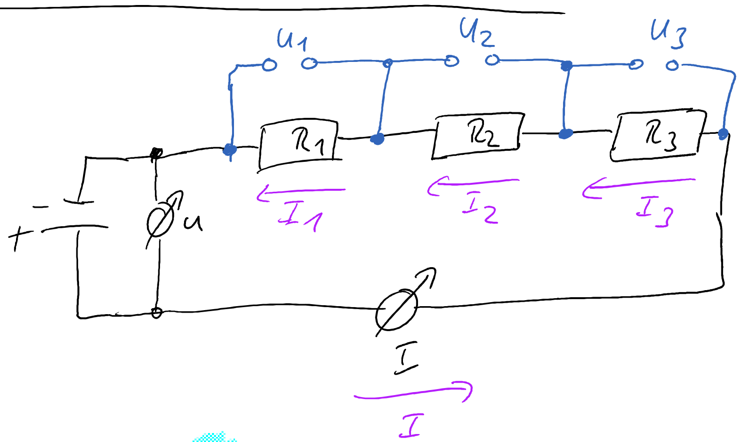


Ohm'sches Gesetz
$R = U/I$

Höhenunterschied
≙ Potenzialdifferenz
≙ Spannung

3.3.1. KOMBINATION VON WIDERSTÄNDEN

Reihenschaltung



- Stromstärke:

  $I = I_1 = I_2 = I_3$

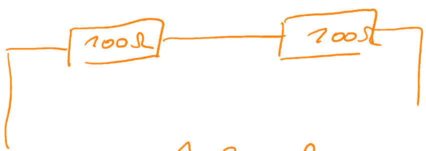
- Spannung

  $U_i = R_i \cdot I$

  $$U = \sum_{i=1}^{N} U_i = \sum_{i=1}^{N} R_i \cdot I = I \cdot \underbrace{\sum_{i=1}^{N} R_i}_{R}$$

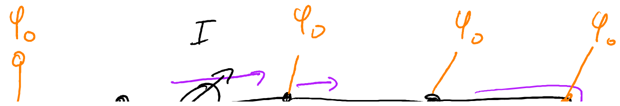
Gesamtwiderstand Reihenschaltung: $\boxed{R = \sum_{i=1}^{N} R_i}$

Versuch:



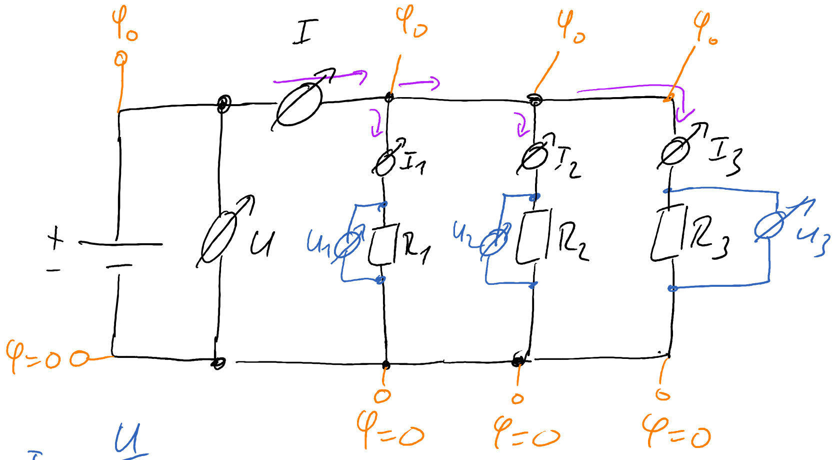
≙ 200Ω

Parallelschaltung



Parallelschaltung

- Spannung
  ↳ über alle Widerstände gleich



$$U = U_1 = U_2 = U_3$$

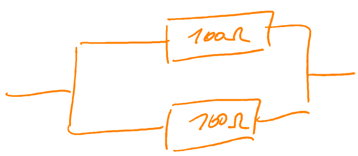
$$U = U_i \underset{\text{Ohm}}{=} R_i \cdot I_i \mapsto I_i = \frac{U}{R_i}$$

- Gesamtstrom

$$I = \sum_{i=1}^{N} I_i = \sum_{i=1}^{N} \frac{U}{R_i} = U \cdot \sum_{i=1}^{N} \frac{1}{R_i} \rightarrow \frac{1}{R}$$

Gesamtwiderstand $\boxed{\frac{1}{R} = \sum_{i=1}^{N} \frac{1}{R_i}}$

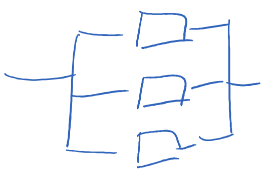
Versuch:



$= 50\,\Omega$

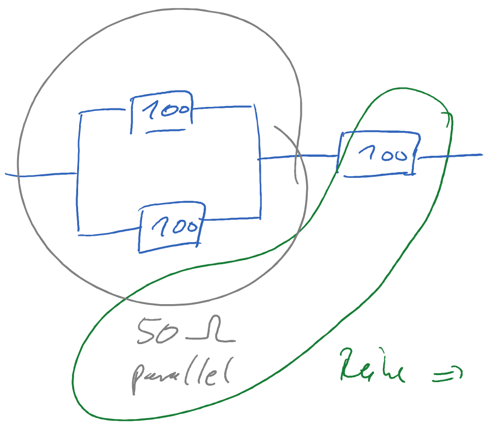
weil $\frac{1}{R} = \frac{1}{100\,\Omega} + \frac{1}{100\,\Omega} = \frac{2}{100\,\Omega}$

$\Rightarrow R = \frac{100\,\Omega}{2} = 50\,\Omega$



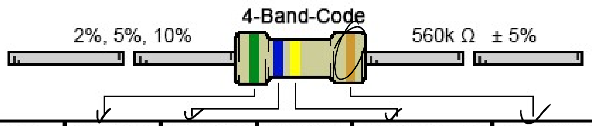
$\Rightarrow 33\,\Omega$

Auch in Kombination

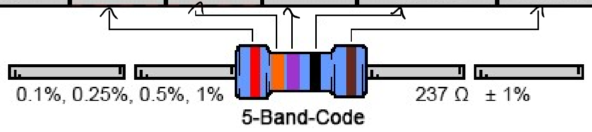


Reihe $\Rightarrow 150\,\Omega$

3.3.1.b Widerstands-Codierung



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)



6. Ring : Temperatur-Koeffizient

100 Ω : 1,0 x 100

braun schwarz rot

Warum Widerstände?

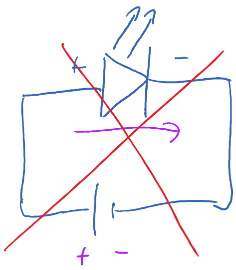
z.B. LED — Light Emitting Diode

sehr effiziente Lichtquelle

Kathode (-)

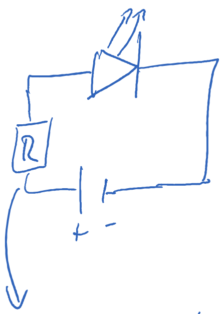
Anode (+) länger

 ← Kathoden seite



geht so nicht!

Raucht! → †



Vorwiderstand

begrenzt Strom

↳ LED "überlebt"

typ LED: 2.2V Betriebsspannung

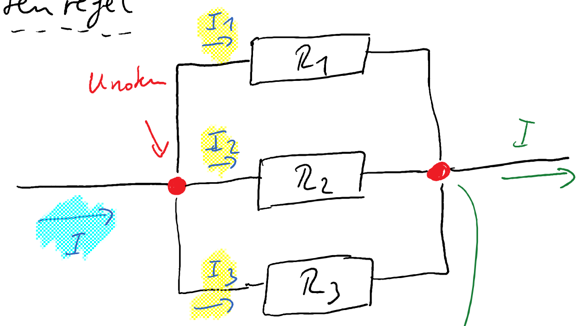
15mA max Strom

$$R = \frac{U}{I} = 150\,\Omega$$

mit 5V → 34 mA <u>zu viel</u>

3.3.2 KIRCHHOFF'SCHE REGELN

<u>Knotenregel</u>

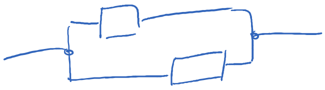


$\underset{\text{„rein"}}{I} = \underbrace{I_1 + I_2 + I_3}_{\text{„raus"}}$

↳ $I - I_1 - I_2 - I_3 = 0$

Die Summe aller Ströme in einem Knoten ist stets 0!

(Grund: Ladungserhaltung)



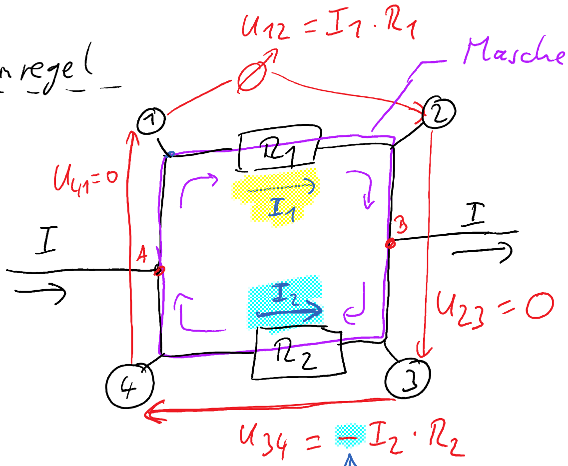
$I_1 + I_2 + I_3 - I = 0$

$$\boxed{\sum_{i=1}^{N} I_k = 0}$$

Konvention:

einlaufend: positiv
auslaufend: negativ

<u>Maschenregel</u>



Strom-Richtung vs. „Maschenrichtung"

$U_{12} = U_{AB} = -U_{BA} = -U_{34}$

↳ $U_{12} + \underbrace{\cancel{U_{23}}}_{=0} + U_{34} + \underbrace{\cancel{U_{41}}}_{=0} = 0$

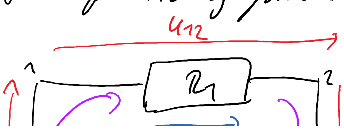
Die Summe aller Spannungen in einer Masche ist stets 0!

$$\boxed{\sum_{k=1}^{N} U_k = 0}$$

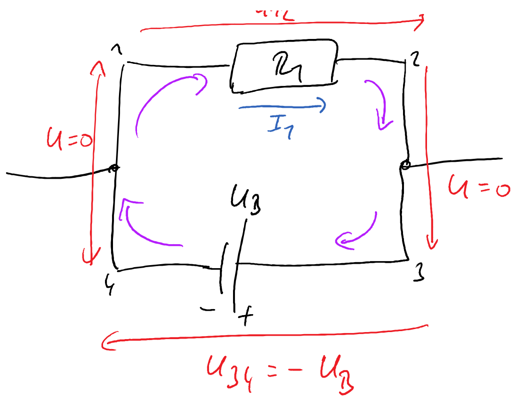
Konvention:

U ist positiv in Stromrichtung
negativ gegen "

z.B. mit Spannungsquelle



$U_{12} + \cancel{U_{23}} + U_{34} + \cancel{U_{41}} = 0$

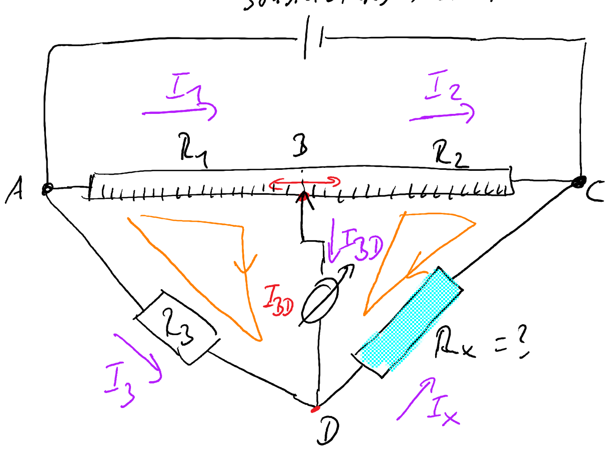


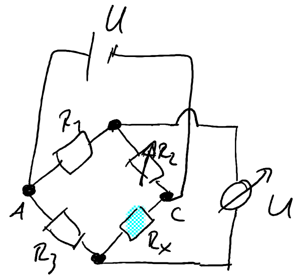
$$U_{12} + \underbrace{\cancel{U_{23}}}_{=0} + \underbrace{U_{34}}_{-U_B} + \underbrace{\cancel{U_{41}}}_{=0} = 0$$

$$U_{12} = +U_B$$

$$\boxed{\sum_{k=1}^{N} U_k = U_B}$$

Anwendung: Wheatstone'sche Meßbrücke





$R_{AC} = R_1 + R_2$

Verhältnis $\frac{R_1}{R_2}$ einstellbar

Ziel: Bestimmung von R_x

Methode: Wähle B so, daß $I_{BD} = 0$