Maschenstromverfahren / Kreisstromverfahren

Ein Beispiel

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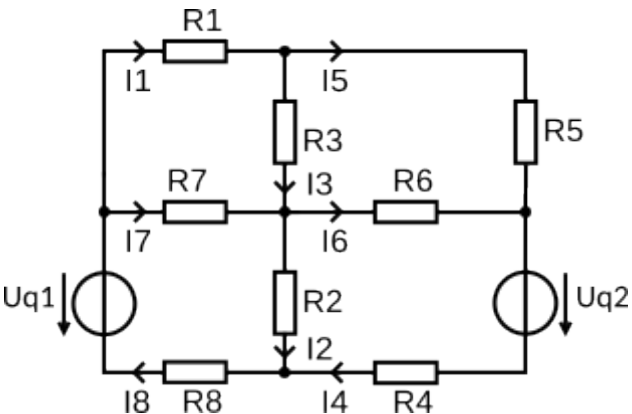
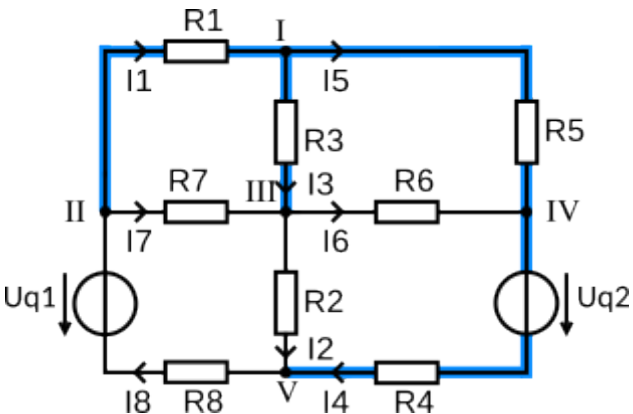
20. Januar 2026

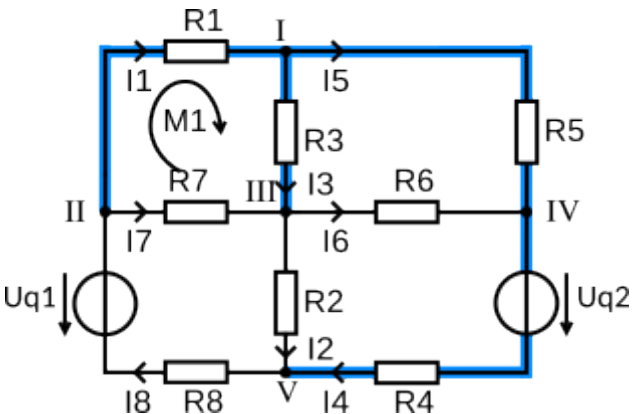
Aufgabenstellung



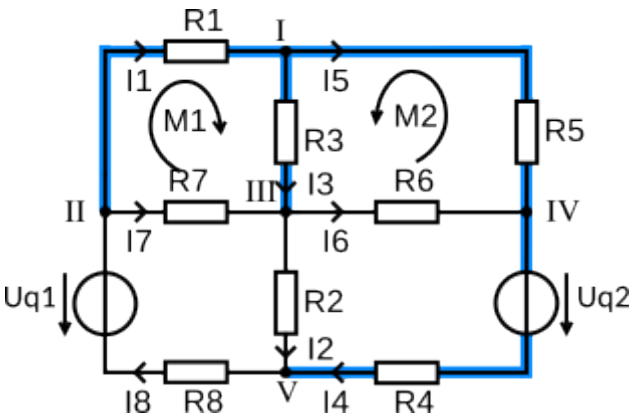
Baum



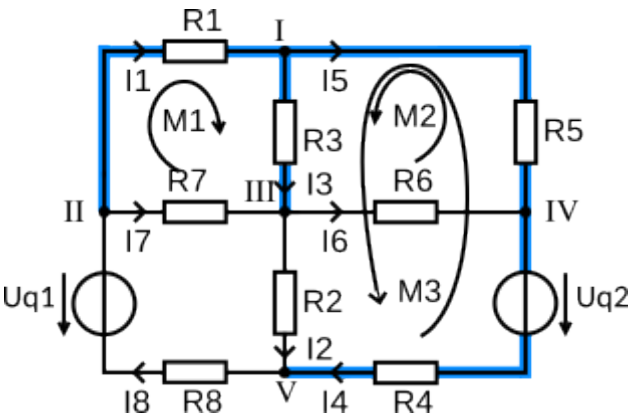
Baum und Masche 1



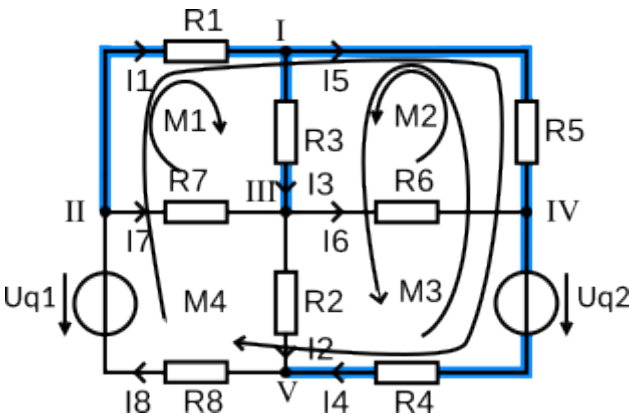
Baum und Maschen 1 und 2



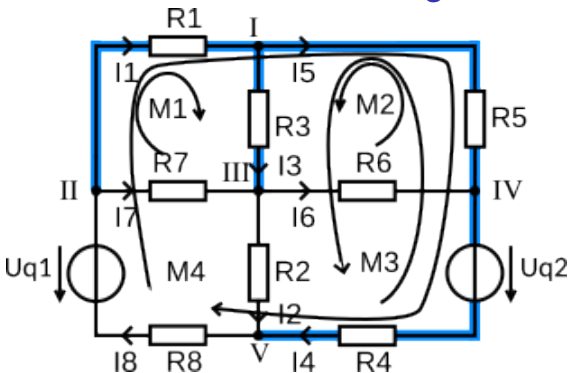
Baum und Maschen 1 bis 3



Baum und Maschen 1 bis 4

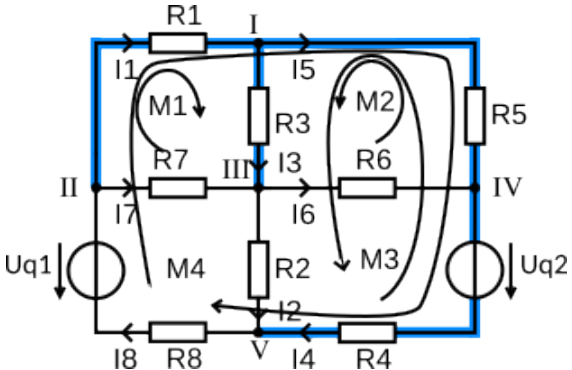


LGS aus Schaltung I



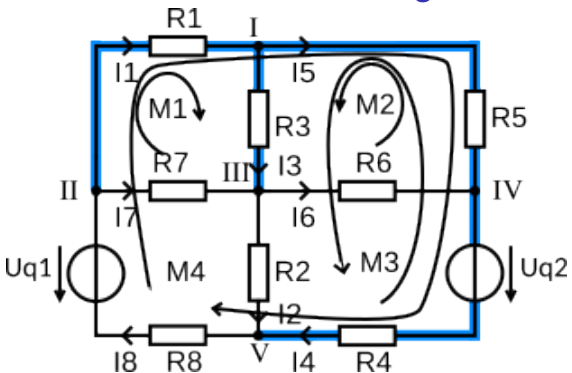
$$\begin{pmatrix} R_1 + R_3 + R_7 & & \\ & R_3 + R_5 + R_6 & \\ & & R_2 + R_3 + R_4 + R_5 \\ & & & R_1 + R_4 + R_5 + R_8 \end{pmatrix}$$

LGS aus Schaltung II



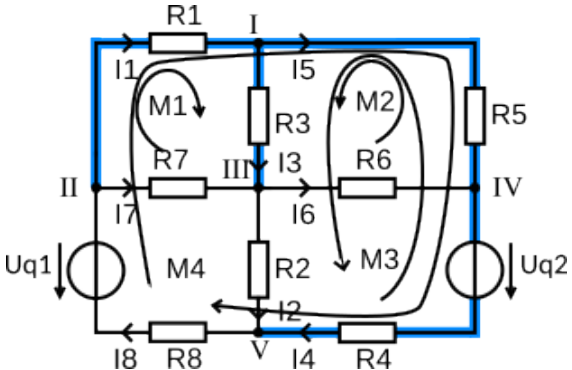
$$\begin{pmatrix} R_1+R_3+R_7 & & & \\ & R_3+R_5+R_6 & & \\ & & R_2+R_3+R_4+R_5 & \\ & & & R_1+R_4+R_5+R_8 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1}-U_{Q2} \end{pmatrix}$$

LGS aus Schaltung III



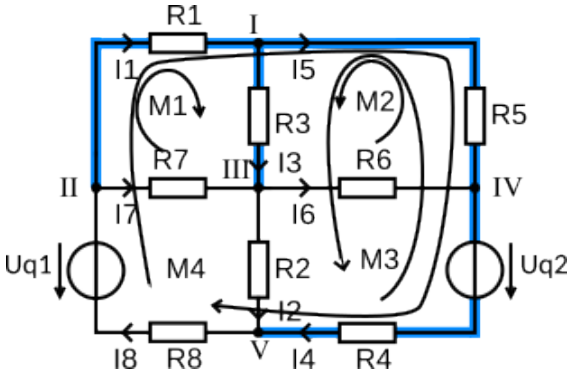
$$\begin{pmatrix} R_1+R_3+R_7 & R_3 & R_3 & R_1 \\ & R_3+R_5+R_6 & & \\ & & R_2+R_3+R_4+R_5 & \\ & & & R_1+R_4+R_5+R_8 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1}-U_{Q2} \end{pmatrix}$$

LGS aus Schaltung IV



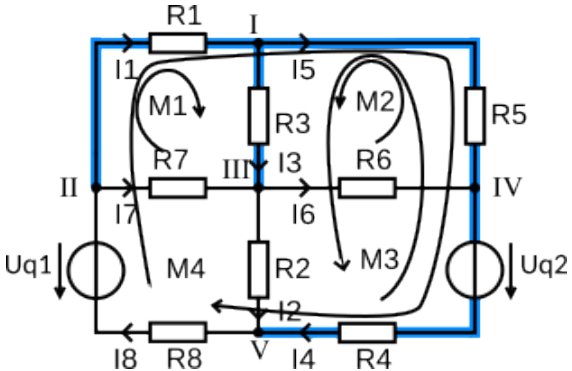
$$\begin{pmatrix} R_1+R_3+R_7 & R_3 & R_3 & R_1 \\ R_3 & R_3+R_5+R_6 & R_3+R_5 & -R_5 \\ & & R_2+R_3+R_4+R_5 & \\ & & & R_1+R_4+R_5+R_8 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1}-U_{Q2} \end{pmatrix}$$

LGS aus Schaltung IV



$$\begin{pmatrix} R_1+R_3+R_7 & R_3 & R_3 & R_1 \\ R_3 & R_3+R_5+R_6 & R_3+R_5 & -R_5 \\ R_3 & R_3+R_5 & R_2+R_3+R_4+R_5 & -R_4-R_5 \\ & & & R_1+R_4+R_5+R_8 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1}-U_{Q2} \end{pmatrix}$$

LGS aus Schaltung V



$$\begin{pmatrix} R_1+R_3+R_7 & R_3 & R_3 & R_1 \\ R_3 & R_3+R_5+R_6 & R_3+R_5 & -R_5 \\ R_3 & R_3+R_5 & R_2+R_3+R_4+R_5 & -R_4-R_5 \\ R_1 & -R_5 & R_4+R_5 & R_1+R_4+R_5+R_8 \end{pmatrix} \cdot \begin{pmatrix} I_{M1} \\ I_{M2} \\ I_{M3} \\ I_{M4} \end{pmatrix} = (U$$

LGS aus Schaltung V

$$\begin{pmatrix} R_1 + R_3 + R_7 & R_3 & R_3 & R_1 \\ R_3 & R_3 + R_5 + R_6 & R_3 + R_5 & -R_5 \\ R_3 & R_3 + R_5 & R_2 + R_3 + R_4 + R_5 & -R_4 - R_5 \\ R_1 & -R_5 & -R_4 - R_5 & R_1 + R_4 + R_5 + R_8 \end{pmatrix} \cdot \begin{pmatrix} I_{M1} \\ I_{M2} \\ I_{M3} \\ I_{M4} \end{pmatrix}$$

$$= \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1} - U_{Q2} \end{pmatrix}$$

Werte einsetzen I

$$\mathrm{R}_1 = 120\Omega, \mathrm{R}_2 = 220\Omega, \mathrm{R}_3 = 220\Omega, \mathrm{R}_4 = 560\Omega,$$
$$\mathrm{R}_5 = 470\Omega, \mathrm{R}_6 = 390\Omega, \mathrm{R}_7 = 820\Omega, \mathrm{R}_8 = 390\Omega$$

$$\begin{pmatrix} R_1 + R_3 + R_7 & R_3 & R_3 & R_1 \\ R_3 & R_3 + R_5 + R_6 & R_3 + R_5 & -R_5 \\ R_3 & R_3 + R_5 & R_2 + R_3 + R_4 + R_5 & -R_4 - R_5 \\ R_1 & -R_5 & -R_4 - R_5 & R_1 + R_4 + R_5 + R_8 \end{pmatrix} \cdot \begin{pmatrix} I_{M1} \\ I_{M2} \\ I_{M3} \\ I_{M4} \end{pmatrix}$$
$$= \begin{pmatrix} 0 \\ 0 \\ U_{q2} \\ U_{q1} - U_{Q2} \end{pmatrix}$$

Werte einsetzen II

$$R_1 = 120\Omega, R_2 = 220\Omega, R_3 = 220\Omega, R_4 = 560\Omega,$$
$$R_5 = 470\Omega, R_6 = 390\Omega, R_7 = 820\Omega, R_8 = 390\Omega$$

$$\begin{pmatrix} 1160 & 220 & 220 & 120 \\ 220 & 1080 & 690 & -470 \\ 220 & 690 & 1470 & -1030 \\ 120 & -470 & -1030 & 1540 \end{pmatrix} \cdot \begin{pmatrix} I_{M1} \\ I_{M2} \\ I_{M3} \\ I_{M4} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 15\ V \\ -3\ V \end{pmatrix}$$

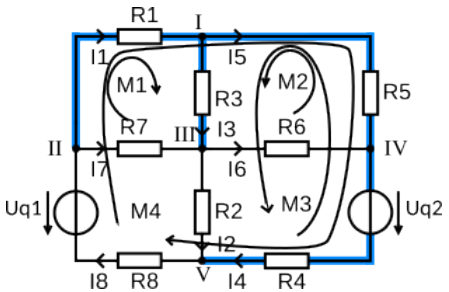
Lösung I

$$R_1 = 120\Omega, R_2 = 220\Omega, R_3 = 220\Omega, R_4 = 560\Omega,$$

$$R_5 = 470\Omega, R_6 = 390\Omega, R_7 = 820\Omega, R_8 = 390\Omega$$

$$\begin{pmatrix} 1160 & 220 & 220 & 120 \\ 220 & 1080 & 690 & -470 \\ 220 & 690 & 1470 & -1030 \\ 120 & -470 & -1030 & 1540 \end{pmatrix} \cdot \begin{pmatrix} -3,6 \cdot 10^{-3} \\ -8,9 \cdot 10^{-3} \\ 22,3 \cdot 10^{-3} \\ 10,5 \cdot 10^{-3} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 15\ V \\ -3\ V \end{pmatrix}$$

Ströme berechnen



$$I_{M1} = -3,6\ mA,\ I_{M2} = 8,9\ mA.I_{M3} = 22,3\ mA,\ I_{M4} = 10,5\ mA$$

$$I_2 = I_{M3} = 22,3\ mA,\ I_6 = I_{M2} = -8,9\ mA,\ I_7 = -I_{M1} = 3,6\ mA,\ I_8 = I_{M4} = 10.5\ mA$$

$$I_1 = I_{M1} + I_{M4} = 6,9\ mA,\ I_3 = I_{M1} + I_{M2} + I_{M3} = 9,8\ mA,\ I_4 = -I_{M3} + I_{M4} = -11,8\ mA,$$

$$I_5 = -I_{M2} - I_{M3} + I_{M4} = -3\ mA$$