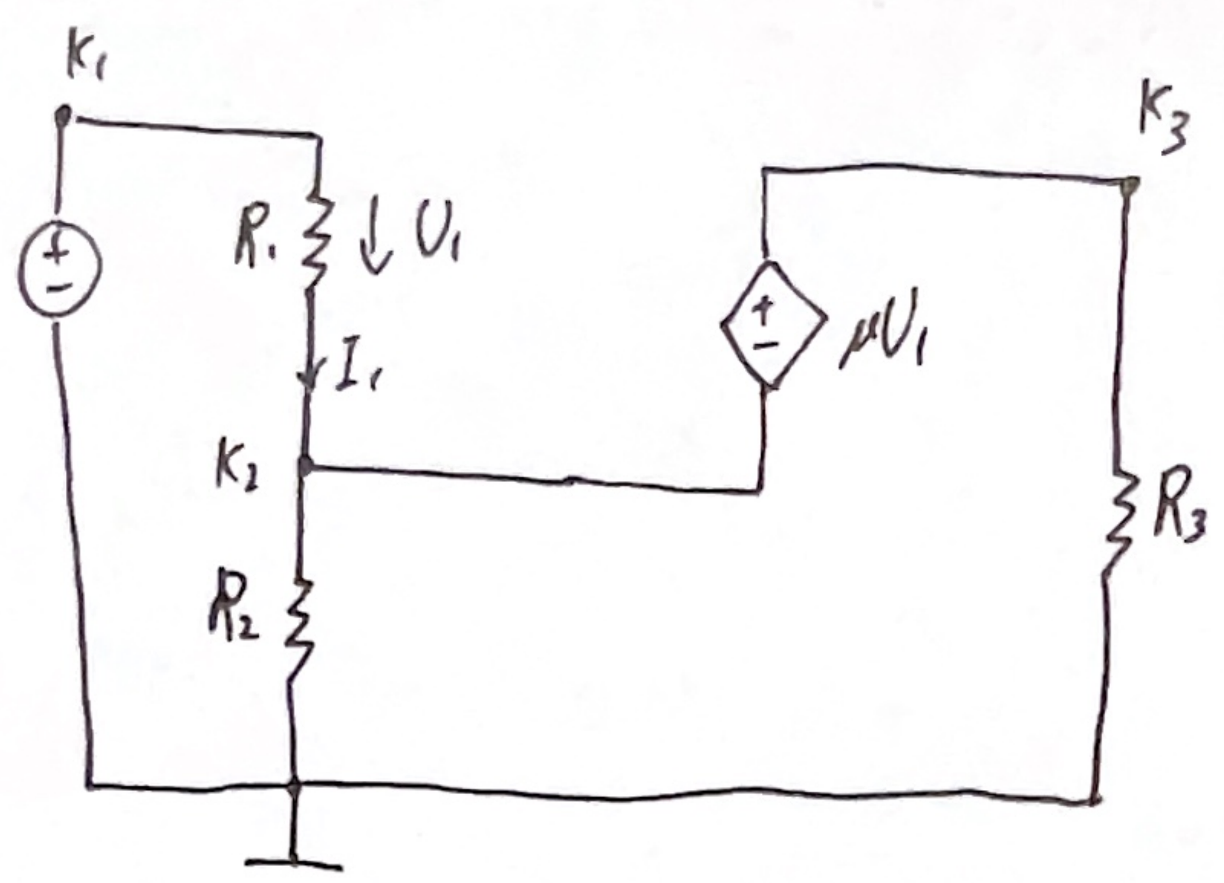
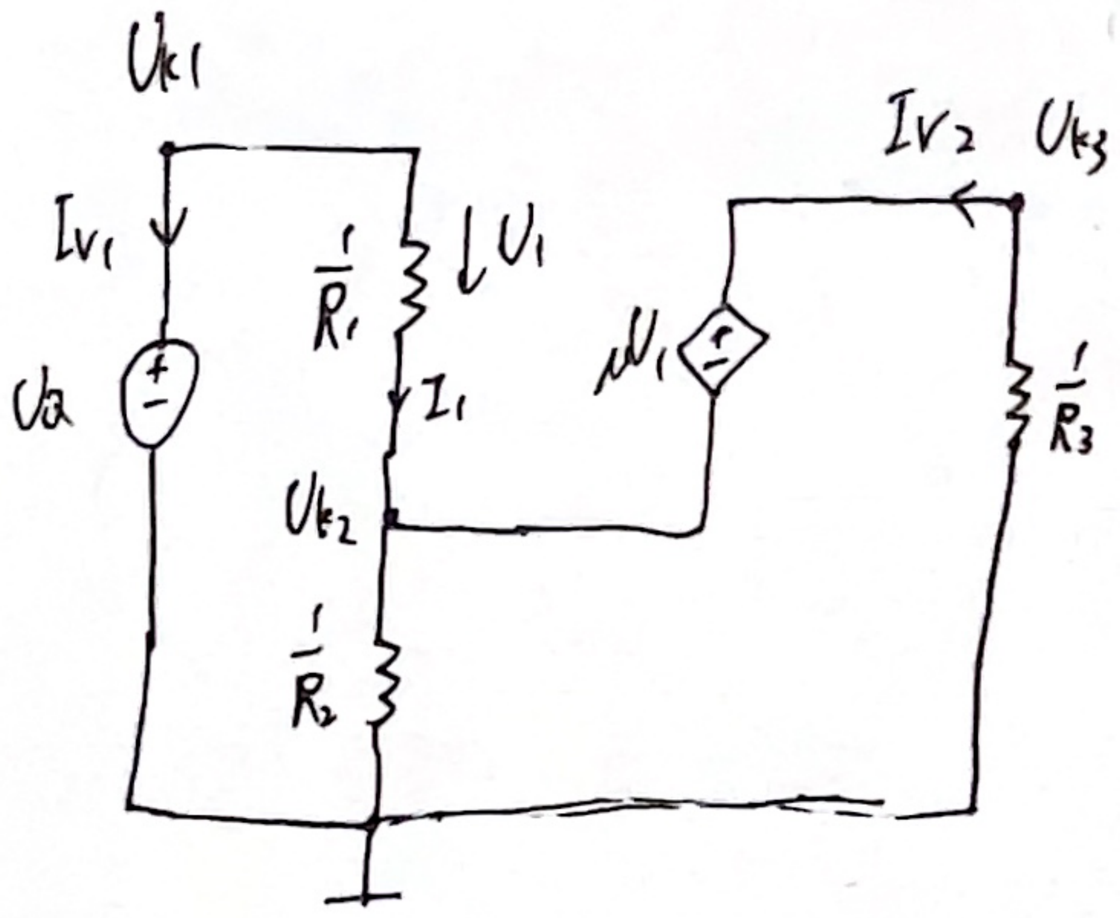
Aufgabe 16

使用 Knotenpotentialverfahren (modifiziert)

a.





$n = 4 - 1 = 3$

$m = 2$

$$
\begin{array}{ccccc}
 & & & & \\
\end{array}
\left(\begin{array}{ccc|cc}
\frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 & 0 \\
-\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0 & -1 \\
0 & 0 & \frac{1}{R_3} & 0 & 1 \\
\hline
1 & 0 & 0 & 0 & 0 \\
0-\mu & -1+\mu & 1 & 0 & 0
\end{array}\right)
\begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_{v1} \\ I_{v2} \end{pmatrix}
=
\begin{pmatrix} 0 \\ 0 \\ 0 \\ U_Q \\ \cancel{\mu U_1}\ 0 \end{pmatrix}
$$

$$\begin{array}{ccccc} \overline{U_{k1}} & \overline{U_{k2}} & \overline{U_{k3}} & \overline{I_{v1}} & \overline{I_{v2}} \end{array}$$

其中

$U_1 = U_{k1} - U_{k2}$

$0 - U_{k2} + U_{k3} = \mu U_1 = \mu (U_{k1} - U_{k2})$

$\Leftrightarrow -\mu U_{k1} - U_{k2} + \mu U_{k2} + U_{k3} = 0$

---

b_1, rI_Q

$$
\begin{pmatrix}
\frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 & 0 \\
-\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0 & -1 \\
0 & 0 & \frac{1}{R_3} & 0 & 1 \\
1 & 0 & 0 & 0 & 0 \\
0 & -1 & 1 & 0-r & 0
\end{pmatrix}
\begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_Q \\ I_g \end{pmatrix}
=
\begin{pmatrix} 0 \\ 0 \\ 0 \\ U_Q \\ \cancel{rI_Q}\ 0 \end{pmatrix}
$$

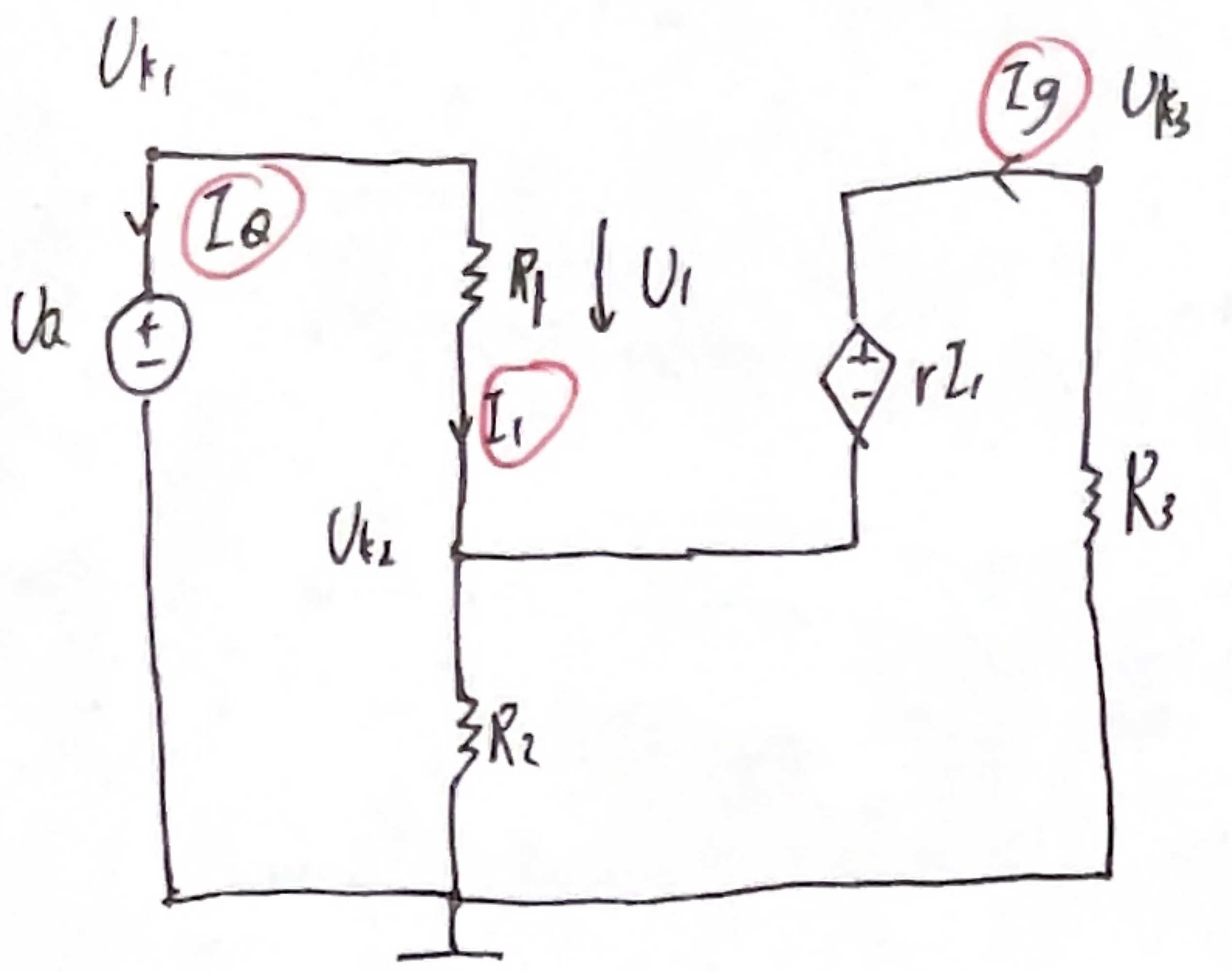
$$\begin{array}{ccccc} \overline{U_{k1}} & \overline{U_{k2}} & \overline{U_{k3}} & \overline{I_Q} & \overline{I_g} \end{array}$$

b_2 $\cancel{rI_1}$

$$
\cancel{
\begin{pmatrix}
\frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 & 0 \\
-\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0 & -1 \\
0 & 0 & \frac{1}{R_3} & 0 & 1 \\
1 & 0 & 0 & 0 & 0 \\
0 & -1 & 1 & 0 & 0
\end{pmatrix}
\begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_Q \\ I_g \end{pmatrix}
=
\begin{pmatrix} 0 \\ 0 \\ 0 \\ U_Q \\ rI_1 \end{pmatrix}
}
$$

$\cancel{I_1 = \frac{U_{k1}}{R_1} \Rightarrow rI_1 = \frac{r}{R_1} U_{k1}}$

b2



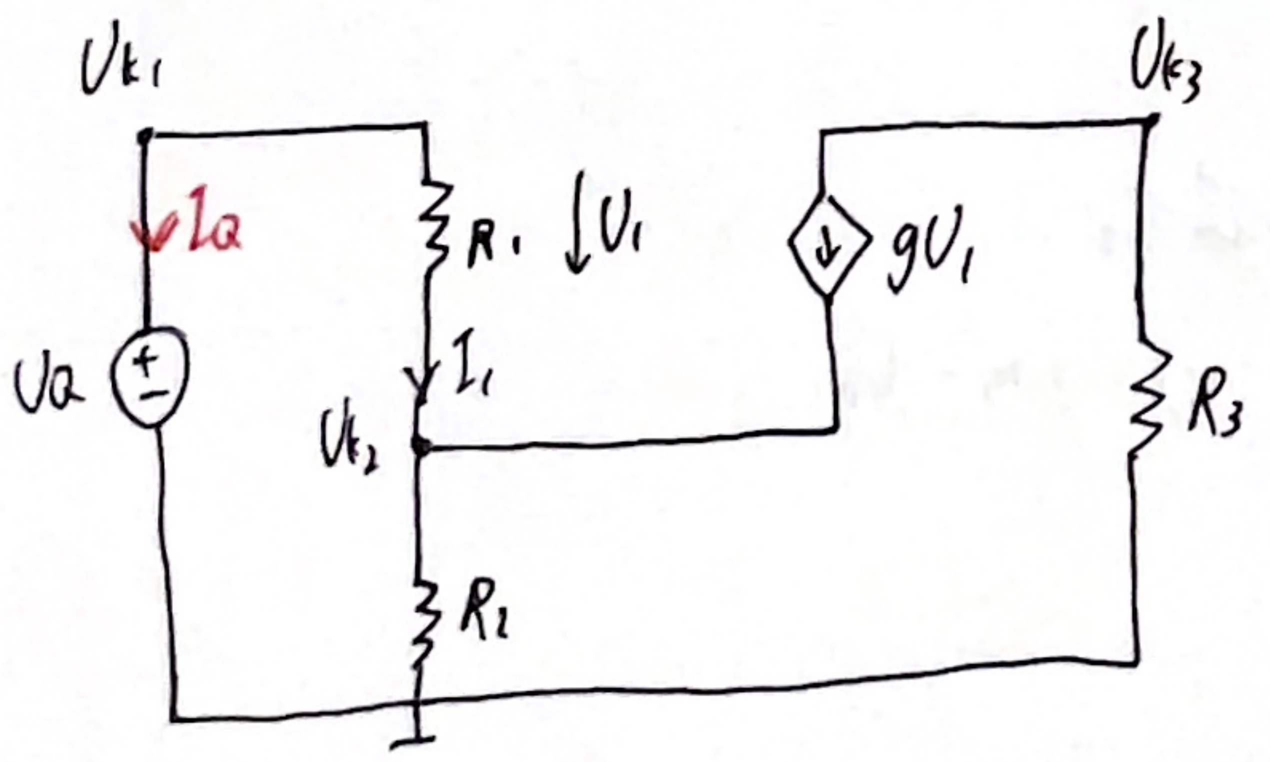
$n = 4-1=3$

$m=3 \longleftarrow$ 额外定义] I_1

$$\begin{pmatrix} \frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 & 0 & 1 \\ -\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0 & -1 & -1 \\ 0 & 0 & \frac{1}{R_3} & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 & \cancel{0}\ -r \\ 1 & -1 & 0 & 0 & 0 & R_1 \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_a \\ I_g \\ I_1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ U_a \\ \cancel{rI_1}\ 0 \\ 0 \end{pmatrix}$$

$\uparrow$ I_1 支路有R_1 $-Z$

c.



$n=4-1=3$

$m=1$

$$\begin{pmatrix} \frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 \\ -\frac{1}{R_1}-g & \frac{1}{R_1}+\frac{1}{R_2}+g & 0 & 0 \\ 0+g & 0-g & \frac{1}{R_3} & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_a \end{pmatrix} = \begin{pmatrix} 0 \\ \cancel{gU_1}\ 0 \\ \cancel{-gU_1}\ 0 \\ U_a \end{pmatrix}, \quad U_1 = U_{k1} - U_{k2}$$

$$-\frac{1}{R_1}U_{k1} + \left(\frac{1}{R_1}+\frac{1}{R_2}\right)U_{k2} = g(U_{k1} - U_{k2})$$

$$\frac{1}{R_3}U_{k3} = -g(U_{k1} - U_{k2})$$

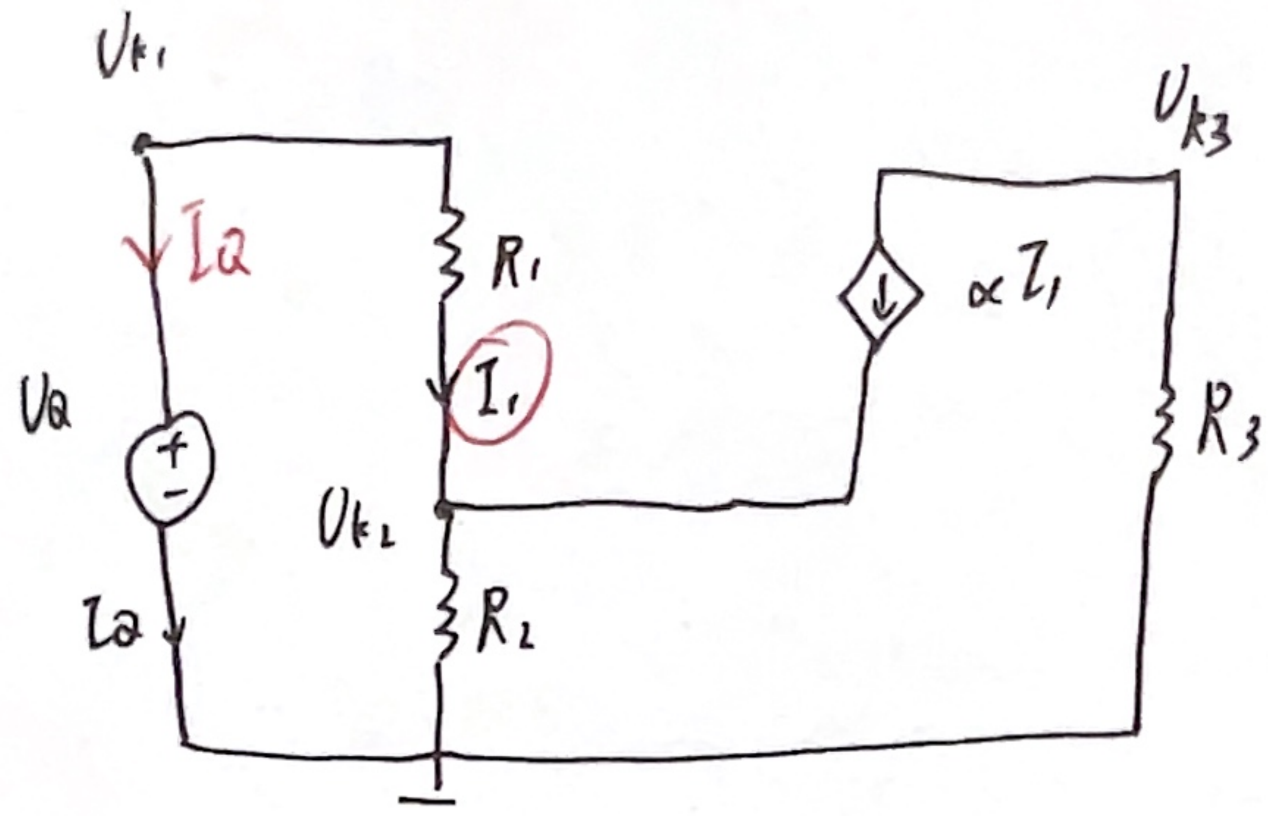
~~d1: αI_a~~

$$\begin{pmatrix} \frac{1}{R_1} & \frac{1}{R_1} & 0 & 1 \\ -\frac{1}{R_1}-g & \frac{1}{R_1}+\frac{1}{R_2}+g & 0 & 0 \\ g & -g & \frac{1}{R_3} & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_a \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

d_1, αI_Q

$$\begin{pmatrix} \frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 \\ -\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0\ -\alpha \\ 0 & 0 & \frac{1}{R_3} & 0\ +\alpha \\ 1 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_Q \end{pmatrix} = \begin{pmatrix} 0 \\ \cancel{\alpha I_Q}\ 0 \\ \cancel{-\alpha I_Q}\ 0 \\ U_Q \end{pmatrix}$$

d_2



$n = 4 - 1 = 3$

$m = 2$ ← 额外多了一个

$$\begin{pmatrix} \frac{1}{R_1} & -\frac{1}{R_1} & 0 & 1 & -1 \\ -\frac{1}{R_1} & \frac{1}{R_1}+\frac{1}{R_2} & 0 & 0 & 1\ -\alpha \\ 0 & 0 & \frac{1}{R_3} & 0 & 0\ +\alpha \\ 1 & 0 & 0 & 0 & 0 \\ -1 & 1 & 0 & 0 & R_1 \end{pmatrix} \begin{pmatrix} U_{k1} \\ U_{k2} \\ U_{k3} \\ I_Q \\ I_1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0\ \cancel{\alpha I_1} \\ 0\ \cancel{-\alpha I_1} \\ U_Q \\ 0 \end{pmatrix}$$