

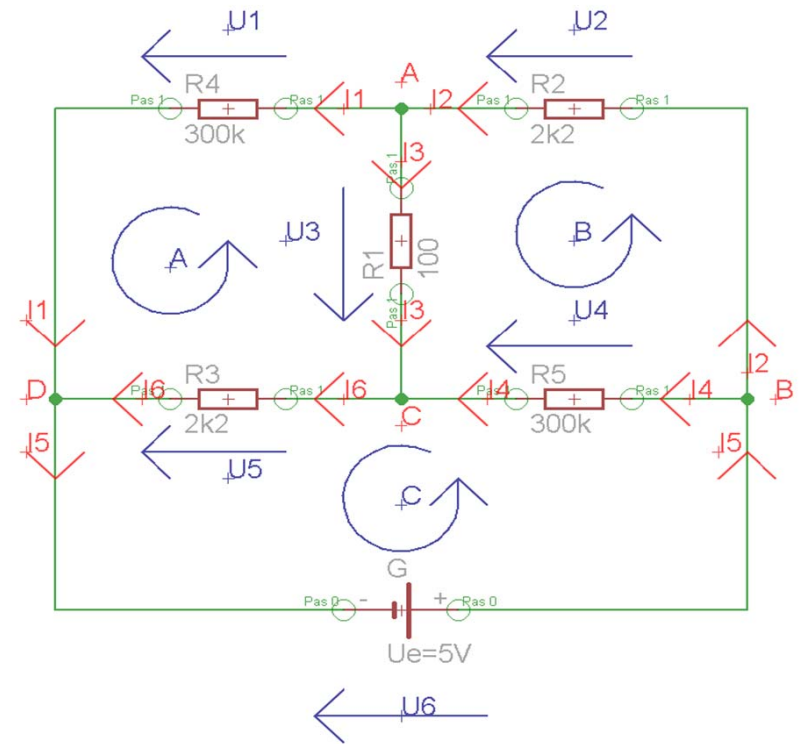
Anwendung der I. und II. Kirchhoffschen Regel

$R1 = 100 \, \Omega$
 $R2 = 2.200 \, \Omega$
 $R3 = 2.200 \, \Omega$
 $R4 = 300.000 \, \Omega$
 $R5 = 300.000 \, \Omega$
 $U_e = 5 \, V$ >>> $U6 = -5$

Folgende Ströme sind unbekannt: $I1, I2, I3, I4, I5, I6$

Folgende Spannungen sind unbekannt: $U1, U2, U3, U4, U5$

- Schaltung kreuzungsfrei zeichnen.
- Stromknoten erfassen (eingehend = positiv / ausgehend = negativ).
- Maschen erfassen in deren Inneren sich keine weiteren Elemente befinden.
- Aus Knoten und Maschen eine quadratische Matrix erstellen (Anzahl der Gleichungen = Anzahl der Unbekannten).
- Durch Gaußsches Eliminationsverfahren oder Gauß-Jordan-Algorithmus lösen.



Knotengleichungen

Knoten A:	$-I1 + I2 - I3 = 0$	=	-1	$I2$	$-I3$	0	0	0	= 0
Knoten B:	$-I2 - I4 + I5 = 0$	=	0	$-I2$	0	$-I4$	$I5$	0	= 0
Knoten C:	$I3 + I4 - I6 = 0$	=	0	0	$I3$	$I4$	0	$-I6$	= 0
Knoten D:	$I1 - I5 + I6 = 0$	=	$I1$	0	0	0	$-I5$	$I6$	= 0

Maschengleichungen

Masche A:	$U1 - U5 - U3 = 0$	=	$R4 \cdot I1$	0	$-R1 \cdot I3$	0	0	$-R3 \cdot I6$	= 0
Masche B:	$U2 + U3 - U4 = 0$	=	0	$R2 \cdot I2$	$R1 \cdot I3$	$-R5 \cdot I4$	0	0	= 0
Masche C:	$U5 - U6 + U4 = 0$	=	0	0	0	$R5 \cdot I4$	0	$R3 \cdot I6$	= 5

Lineare Gleichung (erweiterte Koeffizientenmatrix)

	$I1$	$I2$	$I3$	$I4$	$I5$	$I6$	=
aus Knoten A	-1	1	-1	0	0	0	0
aus Knoten B	0	-1	0	-1	1	0	0
aus Knoten C	0	0	1	1	0	-1	0
aus Masche A	300000	0	-100	0	0	-2200	0
aus Masche B	0	2200	100	-300000	0	0	0
aus Masche C	0	0	0	300000	0	2200	5

Auflösung nach $I1, I2, I3, I4, I5, I6$

	A	μA
$I1 =$	0,00000851713054168950	8,5
$I2 =$	0,00111130038067870000	1.111,3
$I3 =$	0,00110278325013701000	1.102,8
$I4 =$	0,00000851713054168950	8,5
$I5 =$	0,00111981751122039000	1.119,8
$I6 =$	0,00111130038067870000	1.111,3

-1	1	-1	0	0	0	0	> *	300000
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
300000	0	-100	0	0	-2200	0	< +	
0	2200	100	-300000	0	0	0		
0	0	0	300000	0	2200	5		
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0	> *	2200
0	0	1	1	0	-1	0		
0	300000	-300100	0	0	-2200	0		
0	2200	100	-300000	0	0	0	< +	
0	0	0	300000	0	2200	5		
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	300000	-300100	0	0	-2200	0	<>	Tausch
0	0	100	-302200	2200	0	0		
0	0	0	300000	0	2200	5	<>	Tausch
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0	> *	300000
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5		
0	0	100	-302200	2200	0	0		
0	300000	-300100	0	0	-2200	0	< +	
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0	> *	100
0	0	0	300000	0	2200	5		
0	0	100	-302200	2200	0	0	< -	
0	0	-300100	-300000	300000	-2200	0		
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0	> *	300100
0	0	0	300000	0	2200	5		
0	0	0	-302300	2200	100	0		
0	0	-300100	-300000	300000	-2200	0	< +	
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5		
0	0	0	-302300	2200	100	0	< -	
0	0	0	100	300000	-302300	0	> *	3000
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5		
0	0	0	-602300	-899997800	906900100	0	< +	
0	0	0	100	300000	-302300	0	> *	6023
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5	> :	3000
0	0	0	0	906902200	-913852800	0		
0	0	0	100	300000	-302300	0	< -	
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5		
0	0	0	0	906902200	-913852800	0	> :	3023,007333
0	0	0	0	300000	-302300,733333	-0,001667	< -	
-1	1	-1	0	0	0	0		
0	-1	0	-1	1	0	0		
0	0	1	1	0	-1	0		
0	0	0	300000	0	2200	5		
0	0	0	0	906902200	-913852800	0		
0	0	0	0	0	-1,499745	-0,001667		

-1,4997445	*	I6	=	-0,0016667	:	-1,4997445
1	*	I6	=	0,0011113		

906902200	*	I5	+	-913852800	*	I6	=	0		
906902200	*	I5	+	-913852800	*	0,0011113	=	0		
906902200	*	I5	+	-1015564,9645231			=	0	-	-1015564,965
906902200	*	I5	+	0			=	1015564,9645231	:	906902200
1	*	I5					=	0,0011198		

300000	*	I4	+	0	*	I5	+	2200	*	I6	=	5		
300000	*	I4	+	0	*	0,001119818	+	2200	*	0,0011113	=	5		
300000	*	I4	+	0			+	2,4448608			=	5	-	2,4448608
300000	*	I4					+	0	0		=	2,5551392	:	300000
1	*	I4									=	0,0000085		

1	*	I3	+	1	*	I4	+	0	*	I5	+	-1	*	I6	=	0		
1	*	I3	+	1	*	0,0000085	+	0	*	0,0011198	+	-1	*	0,0011113	=	0		
1	*	I3	+	0,0000085			+	0			+	-0,0011113			=	0		
1	*	I3	+	-0,0011028											=	0	-	-0,0011028
1	*	I3	+	0											=	0,0011028		
1	*	I3													=	0,0011028		

-1	*	I2	+	0	*	I3	+	-1	*	I4	+	1	*	I5	+	0	*	I6	=	0		
-1	*	I2	+	0	*	0,0011028	+	-1	*	0,0000085	+	1	*	0,0011198	+	0	*	0,0011113	=	0		
-1	*	I2	+	0			+	-0,0000085			+	0,0011198			+	0			=	0		
-1	*	I2	+	0,0011113															=	0	-	0,0011113
-1	*	I2	+	0															=	-0,0011113	*	-1
1	*	I2																	=	0,0011113		

-1	*	I1	+	1	*	I2	+	-1	*	I3	+	0	*	I4	+	0	*	I5	+	0	*	I6	=	0		
-1	*	I1	+	1	*	0,0011113	+	-1	*	0,0011028	+	0	*	0,0000085	+	0	*	0,0011198	+	0	*	0,0011113	=	0		
-1	*	I1	+	0,0011113			+	-0,0011028			+	0			+	0			+	0			=	0		
-1	*	I1	+	0,0000085																		=	0,0000000	-	0,0000085	
-1	*	I1	+	0																		=	-0,0000085	*	-1	
1	*	I1																				=	0,0000085			

	A	mA	µA
I1	= 0,0000085 =	0,009 =	8,5
I2	= 0,0011113 =	1,111 =	1.111,3
I3	= 0,0011028 =	1,103 =	1.102,8
I4	= 0,0000085 =	0,009 =	8,5
I5	= 0,0011198 =	1,120 =	1.119,8
I6	= 0,0011113 =	1,111 =	1.111,3

Ω				A		V		mV		
U1	=	300.000	(R4)	*	0,000009	(I1)	=	2,56	=	2.555
U2	=	2.200	(R2)	*	0,001111	(I2)	=	2,44	=	2.445
U3	=	100	(R1)	*	0,001103	(I3)	=	0,11	=	110
U4	=	300.000	(R5)	*	0,000009	(I4)	=	2,56	=	2.555
U5	=	2.200	(R3)	*	0,001111	(I6)	=	2,44	=	2.445
U6	=	4.465	(Re)	*	0,001120	(I5)	=	5,00	=	5.000