RĪGAS TEHNISKĀ UNIVERSITĀTE
ELEKTRONIKAS UN TELEKOMUNIKĀCIJU FAKULTĀTE
ELEKTRONIKAS PAMATU KATEDRA

ELEKTROTEHNIKAS TEORĒTISKIE PAMATI

STUDIJU DARBS

ETF I REB C02 gr.stud.
Ansis Skadiņš
st.apl.Nr.151REBC02

Rīga - 2018

Contents

1 1.uzdevums - Ķēdes aprēķins stacionārā līdzstrāvas režīmā

151RDB399

$$N - 9; M - 9$$

Shēmas numurs $= 3 \cdot 9 + 9 = 36 - 30 =$ **6** Parametru komplekts $= 4 \cdot 9 + 9 = 45 - 30 =$ **15**

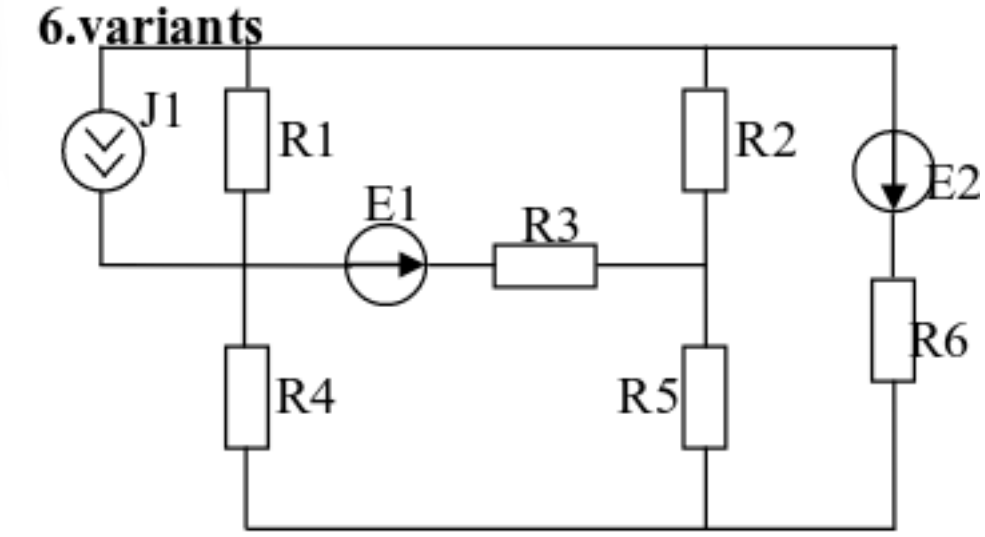
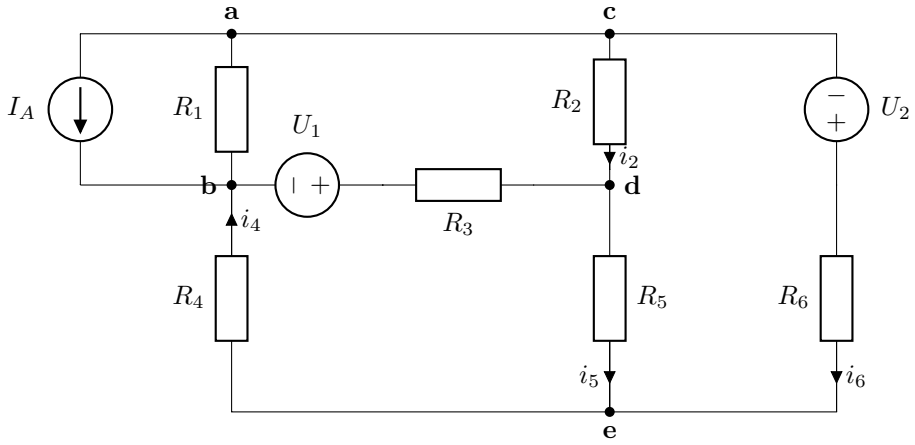


Table 1: 15. variants

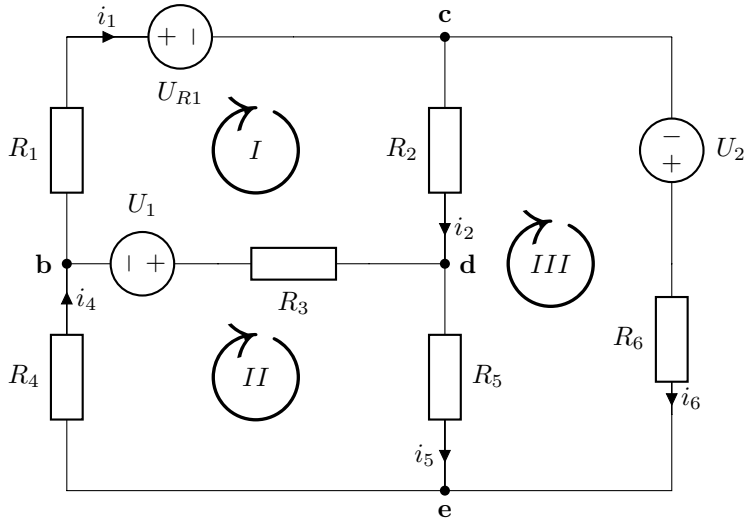
Nr.	R_x	I, mA		U, V		$R, k\Omega$					
		I_{k1}	I_{k2}	U_1	U_2	R_1	R_2	R_3	R_4	R_5	R_6
15	R_5	3	8	10	17	4	2	5	3	6	1

1.1 Ķēdes zaru strāvu aprēķins, izmantojot kontūrstrāvu metodi

Shēma 1



Shēma 2: Ekvivalentā shēma



1.1.1 Vienādojumu skaits

Z - zari, m - mezgli, Z_s - Zari ar strāvas avotiem $n = Z - (m-1) - Z_s$ $n = 6 - (4-1 = 3)$

$$I_{k1} \cdot (R1 + R2 + R3) - I_{k2} \cdot R3, -I_{k3} \cdot R2 = -U_1 - U_{R1}$$
$$-I_{k1} \cdot R3 + I_{k2} \cdot (R4 + R3 + R5) - I_{k3} \cdot R5 = U_1$$
$$-I_{k1} \cdot -R2 - I_{k2} \cdot R5 + I_{k3} \cdot (R5 + R2 + R6) = U_2$$

1.1.2 Matlab

```
In = 3e-3; U1=10; U2=17; R1=4e3; R2=2e3; R3=5e3; R4=3e3; R5=6e3; R6=1e3;
Ux = In*R1;
R = [R1+R2+R3, -R3, -R2
    -R3, R4+R3+R5, -R5
    -R2, -R5, R2+R5+R6];

U = [-U1-Ux;U1;U2];
Ik = R\U;

I1 = -Ik(1)
I2 = Ik(1) - Ik(3)
I3 = Ik(2) - Ik(1)
I4 = Ik(2)
I5 = Ik(2) - Ik(3)
I6 = Ik(3)
```

1.1.3 Kontūrstrāvu vērtības

$$I_{k1} = -7.1986 \cdot 10^{-4} A$$
$$I_{k2} = 1.6774 \cdot 10^{-3} A$$
$$I_{k3} = 2.8472 \cdot 10^{-3} A$$

1.1.4 Strāvas

$$I_1 = -7.1986 \cdot 10^{-4} A$$

$$I_2 = -3.5671 \cdot 10^{-3} A$$

$$I_3 = 2.3973 \cdot 10^{-3} A$$

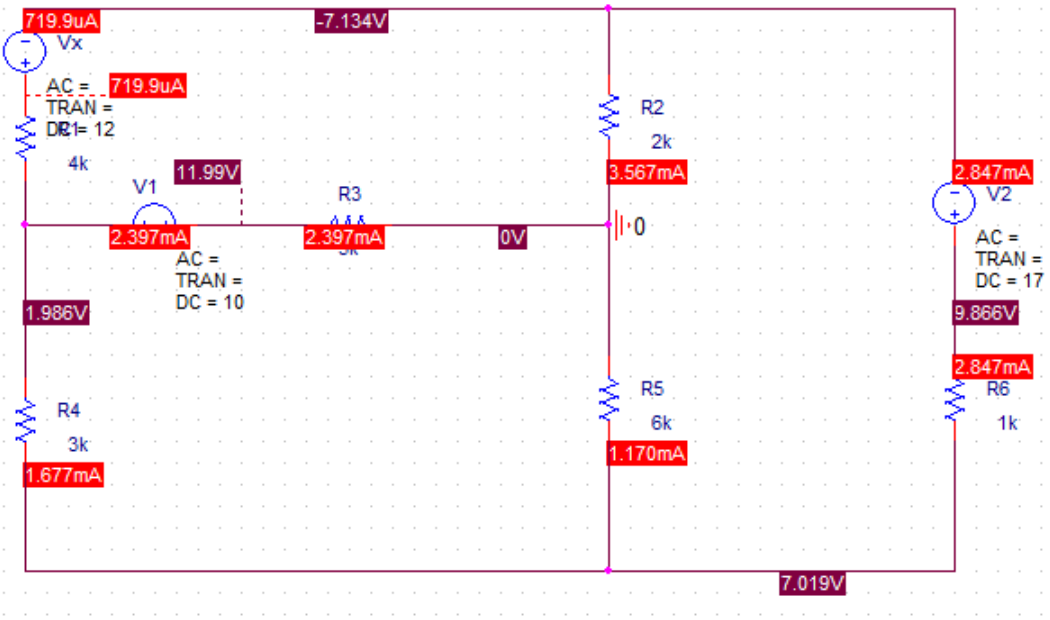
$$I_4 = 1.6774 \cdot 10^{-3} A$$

$$I_5 = -1.1698 \cdot 10^{-3} A$$

$$I_6 = 2.8472 \cdot 10^{-3} A$$

$$I3 + I5 + I2 \approx 0A$$

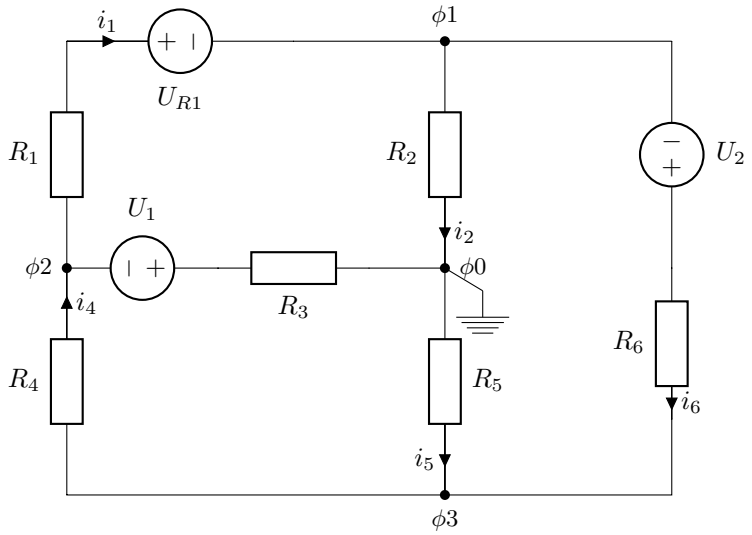
1.1.5 PSPICE



Shēma 3: P-Spice

1.2 Ķēdes zaru strāvas aprēķins, izmantojot mezglu spriegumu metodi

Shēma 4: Shēma ar atzīmētiem potenciāliem



1.2.1 Vienādojumu skaita noteikšana

Z - zari, m - mezgli, Z_s - Zari tikai ar sprieguma avotiem $n = m - 1 - Zs$ $n = 4 - 1 = 3$

$$\phi_1 \cdot (g1 + g2 + g6) - \phi_2 \cdot g1 - \phi_3 \cdot g6 = -g1 * U_{R1} - g6 * U_2$$
$$\phi_1 \cdot (-g1) + \phi_2 \cdot (g1 + g4 + g3) - \phi_3 \cdot g4 = g1 * U_{R1} - g3 * U_1$$
$$\phi_1 \cdot (-g6) - \phi_2 \cdot (-g4) + \phi_3 \cdot (g5 + g4 + g6) = g6 * U_2$$

1.2.2 Matlab

```
In = 3e-3; U1=10; U2=17;
R1=4e3; R2=2e3; R3=5e3; R4=3e3; R5=6e3; R6=1e3;
g1=1/R1; g2=1/R2; g3=1/R3; g4 = 1/R4; g5=1/R5; g6=1/R6;
Ux = In*R1;


g = [g1+g2+g6, -g1, -g6; -g1, g1+g4+g3, -g4; -g6, -g4, g4+g5+g6];

I = [-g1*Ux-g6*U2;g1*Ux-g3*U1;U2*g6];

fi = g\I;

I1 = (fi(2) - fi(1) - Ux)*g1
I2 = (fi(1))*g2
I3 = (fi(2)+U1)*g3
I4 = (fi(3) - fi(2))*g4
I5 = fi(3)*g5
I6 = (fi(1) - fi(3) + U2)*g6
```

1.2.3 Potenciāls

$$\phi_1 = -7.1341V$$
$$\phi_2 = 1.9864V$$
$$\phi_3 = 7.0187V$$

1.2.4 Strāvas

$$I_1 = -7.1986 \cdot 10^{-4} A$$

$$I_2 = -3.5671 \cdot 10^{-3} A$$

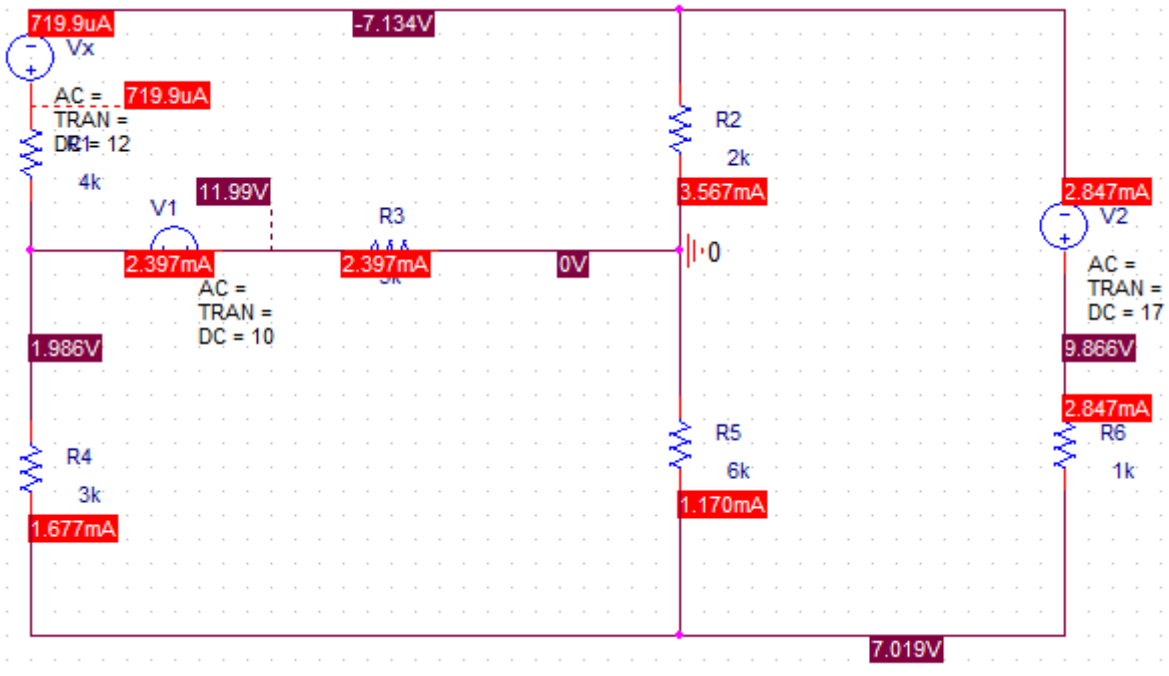
$$I_3 = 2.3973 \cdot 10^{-3} A$$

$$I_4 = 1.6774 \cdot 10^{-3} A$$

$$I_5 = -1.1697 \cdot 10^{-3} A$$

$$I_6 = 2.8472 \cdot 10^{-3} A$$

1.2.5 PSPICE



Shēma 5: P-Spice

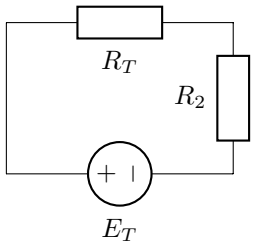
1.3 Zaru strāvas I_5 aprēķins izmantojot Tevenena teorēmu

Table 2: 15. variants

Nr.	R_x	I, mA		U, V		$R, k\Omega$					
		I_{k1}	I_{k2}	U_1	U_2	R_1	R_2	R_3	R_4	R_5	R_6
15	R_5	3	8	10	17	4	2	5	3	6	1

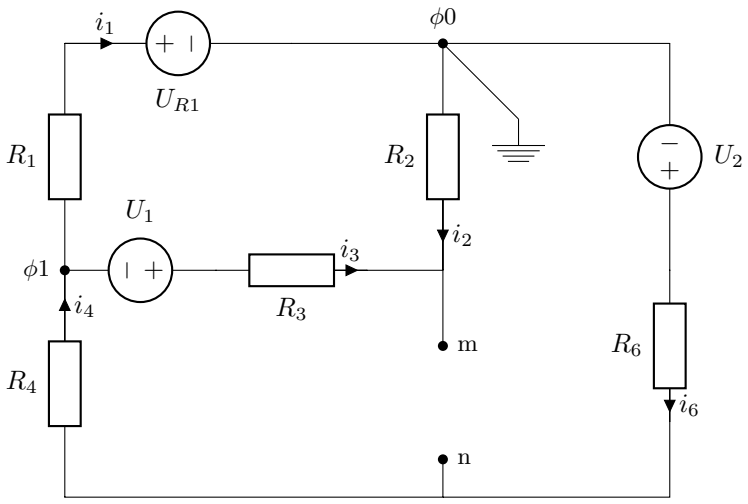
1.3.1 Ekvivalenta shēma

Shēma 6: Ekvivalenta shēma



1.3.2 Shēma U_{mn} aprēķinam

Shēma 7: Shēma ar izslēgto R_5 rezistoru



1.3.3 Vienādojumu skaita noteikšana

Z - zari, m - mezgli, Z_s - Zari tikai ar sprieguma avotiem $n = m - 1 - Zs$ $n = 2 - 1 = 1$

$$\phi_1 \cdot (g1 + g32 + g46) = g1 * U_x - g32 * U_1 + g46 * U2$$

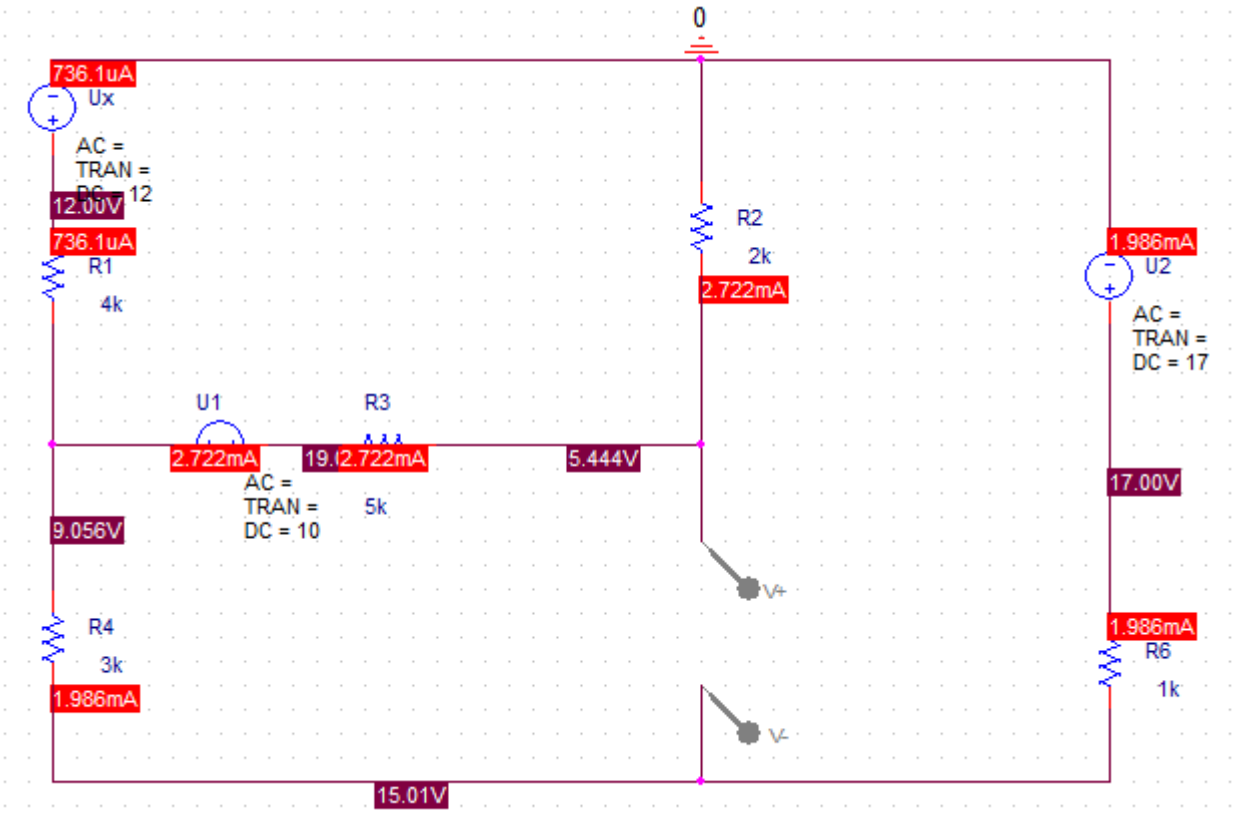
```
In = 3e-3; U1=10; U2=17;
R1=4e3; R2=2e3; R3=5e3; R4=3e3; R5=6e3; R6=1e3;
g1=1/R1; g2=1/R2; g3=1/R3; g4 = 1/R4; g5=1/R5; g6=1/R6;
Ux = In*R1;
g32=1/(R2+R3);
g46=1/(R4+R6);
```

```
g = [g1+g32+g46];
I = [g1*Ux-g32*U1+g46*U2];

fi = g\I;

I4 = (-fi+U2)*g46;
I3 = (fi+U1)*g32;
fim = I3*R2;
fin = fi + I4*R4;
Umn = -fin + fim;
```

$$\phi_1 = 9.0556V$$

$$U_T = U_{mn} = \phi n - \phi m = -9.5695V$$

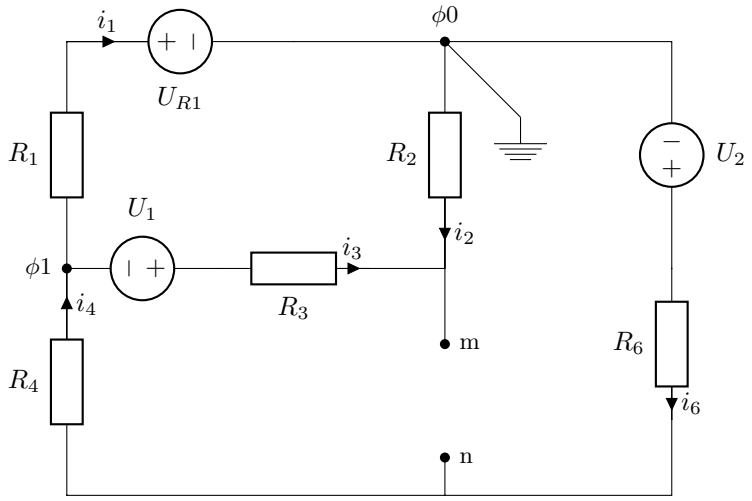
1.3.4 PSPICE



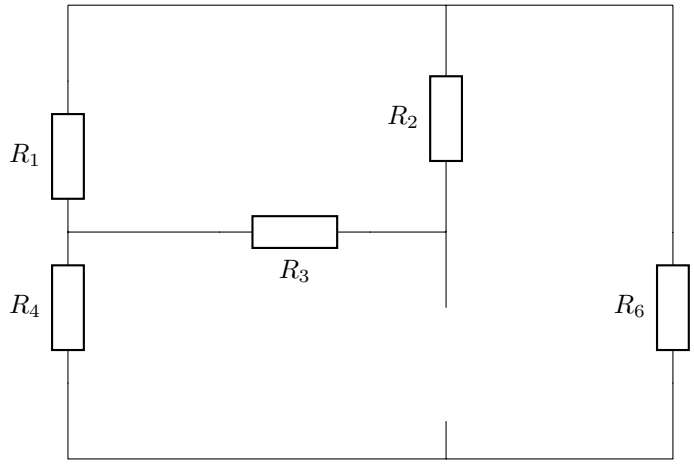
Shēma 8: P-Spice

1.3.5 Shēma R_T aprēķinam

Shēma 9: Shēma ar izslēgto R_5 rezistoru



Shēma 10: Shēma bez sprieguma avotiem



1.3.6 R_T aprēķins

```
In = 3e-3; U1=10; U2=17;
R1=4e3; R2=2e3; R3=5e3; R4=3e3; R5=6e3; R6=1e3;
g1=1/R1; g2=1/R2; g3=1/R3; g4 = 1/R4; g5=1/R5; g6=1/R6;
Ux = In*R1;
g32=1/(R2+R3);
g46=1/(R4+R6);

g = [g1+g32+g46];
I = [g1*Ux-g32*U1+g46*U2];

fi = g\I;

I4 = (-fi+U2)*g46;
I3 = (fi+U1)*g32;
fim = I3*R2;
```

```
fin = fi + I4*R4;
Umn = -fin + fim;
R1p = R1*R3/(R1+R2+R3);
R2p = R1*R2/(R1+R2+R3);
R3p = R2*R3/(R1+R2+R3);
R14p = R1p+R4;
R26p = R2p+R6;
R46p = R14p*R26p/(R14p+R26p);
Req = R46p+R3p;
I5 = Umn/(R5+Req);
```

$$R_T = 2.1806 \cdot 10^3 \Omega$$

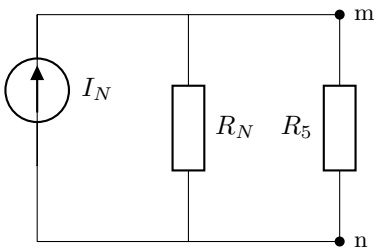
1.3.7 I_5 aprēķins

$$I_5 = \frac{U_T}{R5 + R_T} = -1.1698 \cdot 10^{-3}$$

1.4 Zaru strāvas I_5 aprēķins izmantojot Nortona teorēmu

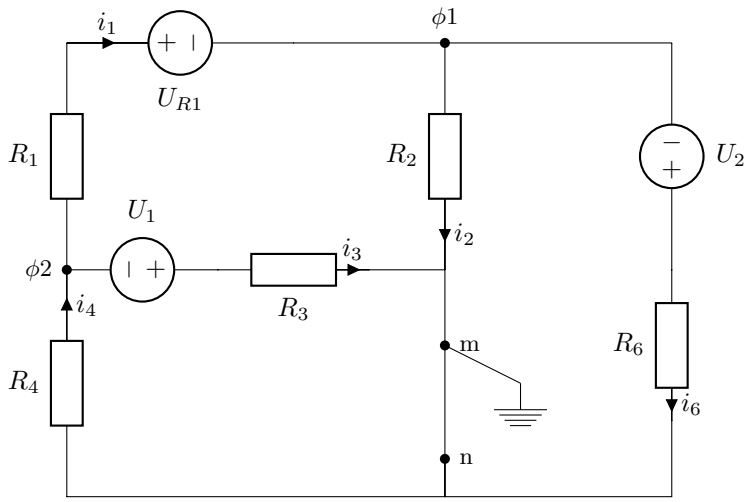
1.4.1 Ekvivalentā Nortona shēma

Shēma 11: Ekvivalenta shēma



1.4.2 Shēma Nortona strāvas atrašanai

Shēma 12: Shēma ar izslēgto R_5 rezistoru



1.4.3 Nortona strāvas atrašana

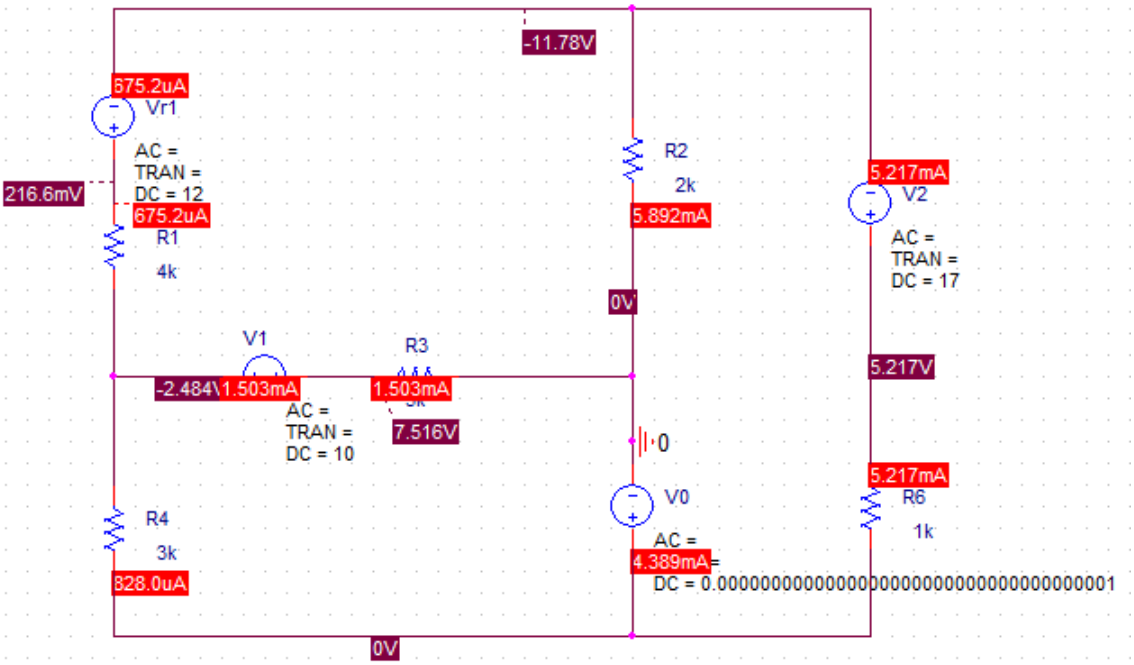
```
In = 3e-3; U1=10; U2=17;
R1=4e3; R2=2e3; R3=5e3; R4=3e3; R5=6e3; R6=1e3;
g1=1/R1; g2=1/R2; g3=1/R3; g4 = 1/R4; g5=1/R5; g6=1/R6;
Ux = In*R1;


g = [g1+g2+g6,-g1;-g1,g1+g3+g4];

I = [-g1*Ux-g6*U2;g1*Ux-g3*U1];

fi = g\I;
I3 = (fi(2) + U1)*g3;
I2 = fi(1)*g2;
In = I2+I3;
```

$$\phi_1 = -1.1783 \cdot 10^1 V$$

$$\phi_2 = -2.4841V$$
$$I_N = -4.3885 \cdot 10^{-3} A$$

$$I_x = I_5 = I_N \cdot \frac{R_{eq}}{R_5 + R_N} = -1.1698 \cdot 10^{-3} A$$

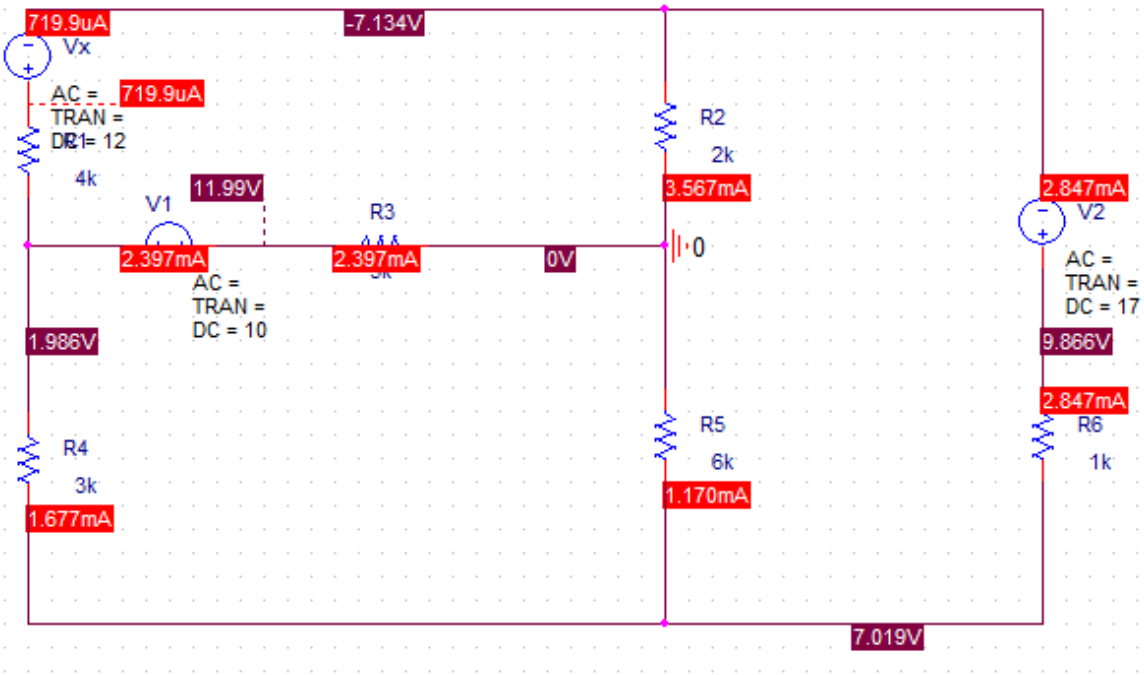
1.4.4 PSPICe



Shēma 13: P-Spice

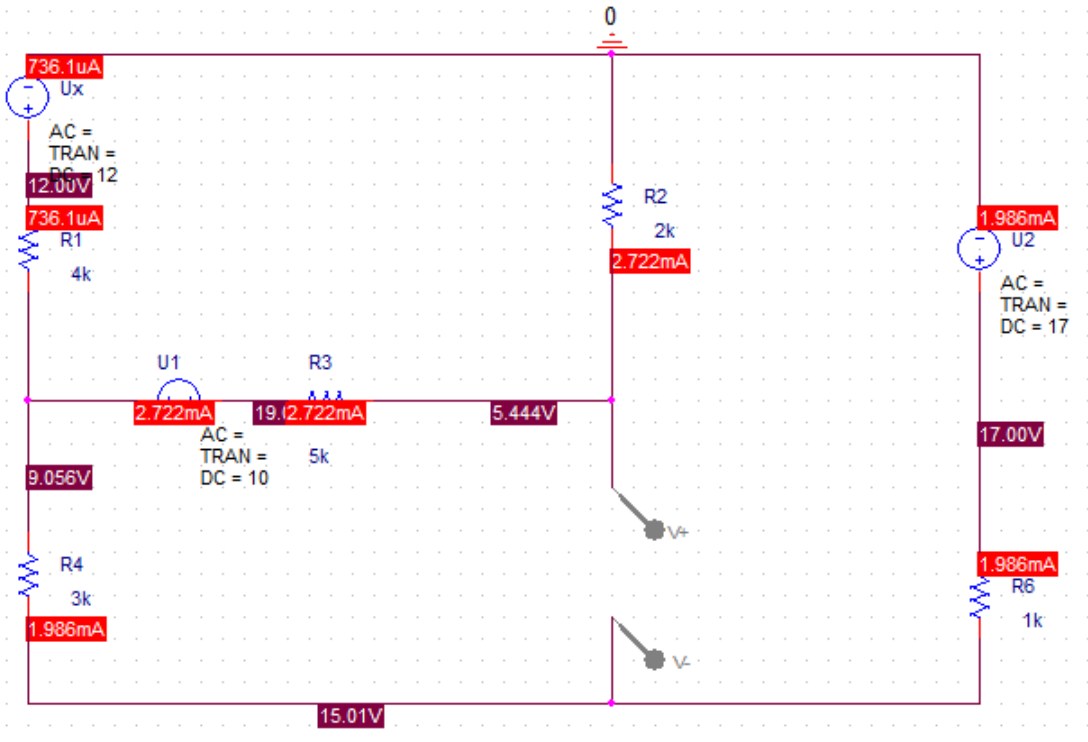
1.5 Zaru strāvu aprēķins izmantojot PSpice modelēšanu

1.5.1 PSpice shēmas



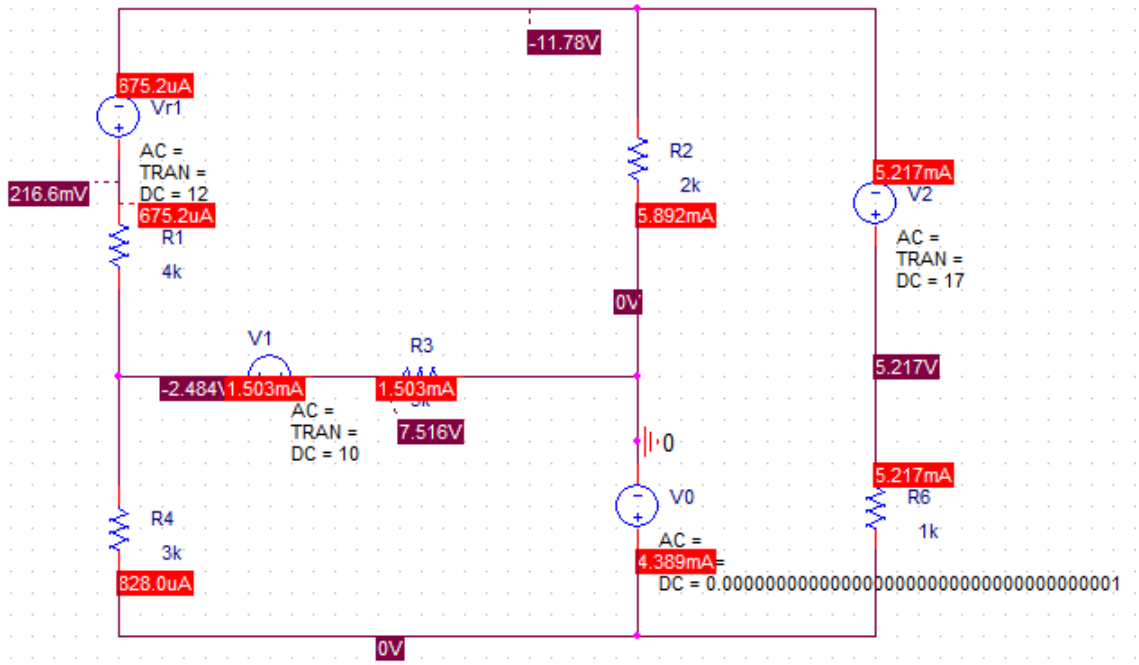
Shēma 14: P-Spice

1.5.2 Tevenena PSPICE shēmas



Shēma 15: P-Spice

1.5.3 Nortona PSPICE shēmas



Shēma 16: P-Spice

1.6 Rezultātu apkopojums

I, mA	KSM mA	MSM mA	TT mA	NTmA	PSpice mA
I_1	-7.1986 $\cdot 10^{-1}$	-7.1986 $\cdot 10^{-1}$			
I_2	-3.5671	-3.5671			
I_3	2.3973	2.3973			
I_4	1.6774	1.6774			
I_5	-1.1698	-1.1698	-1.1698	-1.1698	(-) 1.170
I_6	2.8472	2.8472			

1.7 Ķēdes jaudas bilances aprēķins

$$\sum_{k=1}^{2} E_k \cdot I_k - \sum_{i=1}^{2} J_i \cdot U_i = \sum_{s=1}^{6} I_s^2 \cdot R_s$$

$$I_1 \cdot UR1 + I_3 \cdot U_1 + I_6 \cdot U2 = I_1 \cdot R1 + I_2 \cdot R2 + I_3 \cdot R3 + I_4 \cdot R4 + I_5 \cdot R5 + I_6 \cdot R6$$

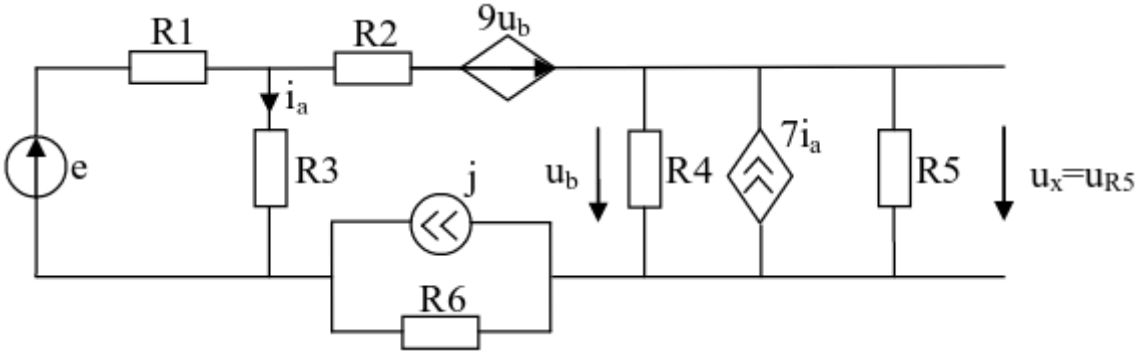
$$0.0637$$

2 uzdevums - Atkarīgos avotus saturošas ķēdes aprēķins

151RDB399

$$N - 9; M - 9$$

Shēmas numurs $= 2 \cdot 9 + 9 = 27 - 20 =$ **7** Parametru komplekts $= 3 \cdot 9 + 9 = 36 - 30 =$ **6**



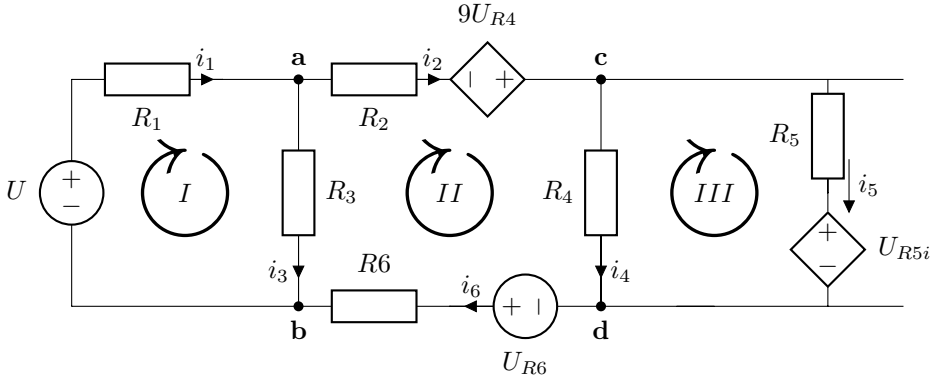
Shēma 17: P-Spice

Table 3: 6.variants

Nr.	e, V	j, mA	$R, k\Omega$					
			R_1	R_2	R_3	R_4	R_5	R_6
6	15	15	8	6	7	5	4	2

2.1 Konturstrāvu metode shēmām ar atkarīgajiem spriegumiem

Shēma 18: Ekvivalenta shēma



2.1.1 Vienādojumu skaits

Z - zari, m - mezgli, Z_s - Zari ar strāvas avotiem $n = Z - (m-1) - Z_s$ $n = 6 - (4-1=3)$

$$I_{k1} \cdot (R1 + R3) + I_{k2} \cdot (-R3) = U$$
$$I_{k1} \cdot (-R3) + I_{k2} \cdot (R2 + R3 + R4 + R6 - 9 \cdot R4) + I_{k3} \cdot 8 \cdot R4 = U_{R6}$$
$$I_{k1} \cdot (7 \cdot R5) + I_{k2} \cdot (-R4 - 7 \cdot R5) + I_{k3} \cdot (R4 + R5) = 0$$

2.1.2 Matlab

```
R1=8e3; R2=6e3; R3=7e3; R4=5e3; R5=4e3; R6=2e3;
U = 15; UR6 = 30;

R = [R1+R3      -R3                        0
     -R3         R2+R3+R4+R6-9*R4          8*R4
     7*R5       -R4-7*R5                  R4+R5];
I = [U;UR6;0];

Ik = R\I;
I1 = Ik(1);
I2 = Ik(2);
I3 = Ik(1) - Ik(2);
I4 = Ik(2) - Ik(3);
I5 = Ik(3);
I6 = Ik(2);
```

2.1.3 Kontūrstrāvas

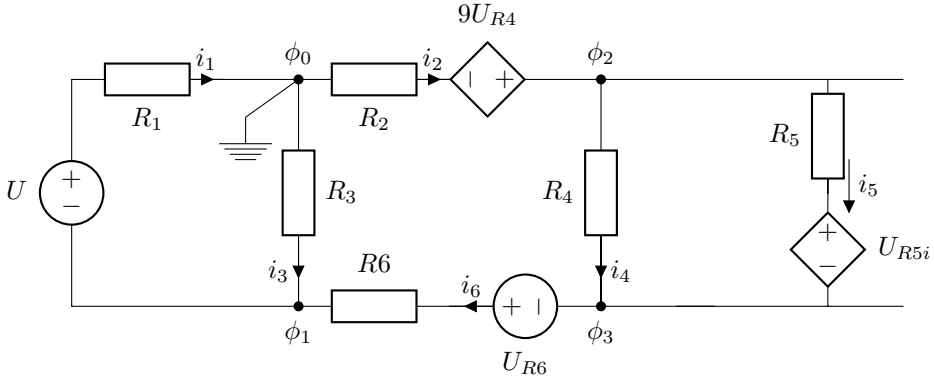
$$I_{k1} = 2.2489 \cdot 10^{-3} A$$
$$I_{k2} = 2.6762 \cdot 10^{-3} A$$
$$I_{k3} = 2.8162 \cdot 10^{-3} A$$

2.1.4 Strāvas

$$I_1 = 2.2489 \cdot 10^{-3} A$$
$$I_2 = 2.6762 \cdot 10^{-3} A$$
$$I_3 = -4.2731 \cdot 10^{-4} A$$
$$I_4 = -1.3998 \cdot 10^{-4} A$$
$$I_5 = 2.8162 \cdot 10^{-3} A$$
$$I_6 = 2.6762 \cdot 10^{-3} A$$

2.2 Mezglu strāvu metode ķēdei ar atkarīgajiem avotiem

Shēma 19: Ekvivalenta shēma



2.2.1 Vienādojumu skaits

Z - zari, m - mezgli, Z_s - Zari tikai ar sprieguma avotiem $n = m - 1 - Z_s$ $n = 4 - 1 = 3$

$$\phi_1 \cdot (g1 + g3 + g6) + 0 + \phi_3 \cdot (-g6) = -g1 \cdot U + g6 * U_{R6}$$
$$\phi_1 \cdot (7 \cdot g5 \cdot g3) + \phi_2 \cdot (g2 + g5 + g4 - 9 \cdot g2) + \phi_3 \cdot (-g4 - g5 + 9 \cdot g2) = 0$$
$$\phi_1 \cdot (-g6 - 7 \cdot g5 \cdot g3) + \phi_2 \cdot (-g4 - g5) + \phi_3 \cdot (g6 + g4 + g5) = -g6 \cdot U_{R6}$$

2.2.2 Matlab

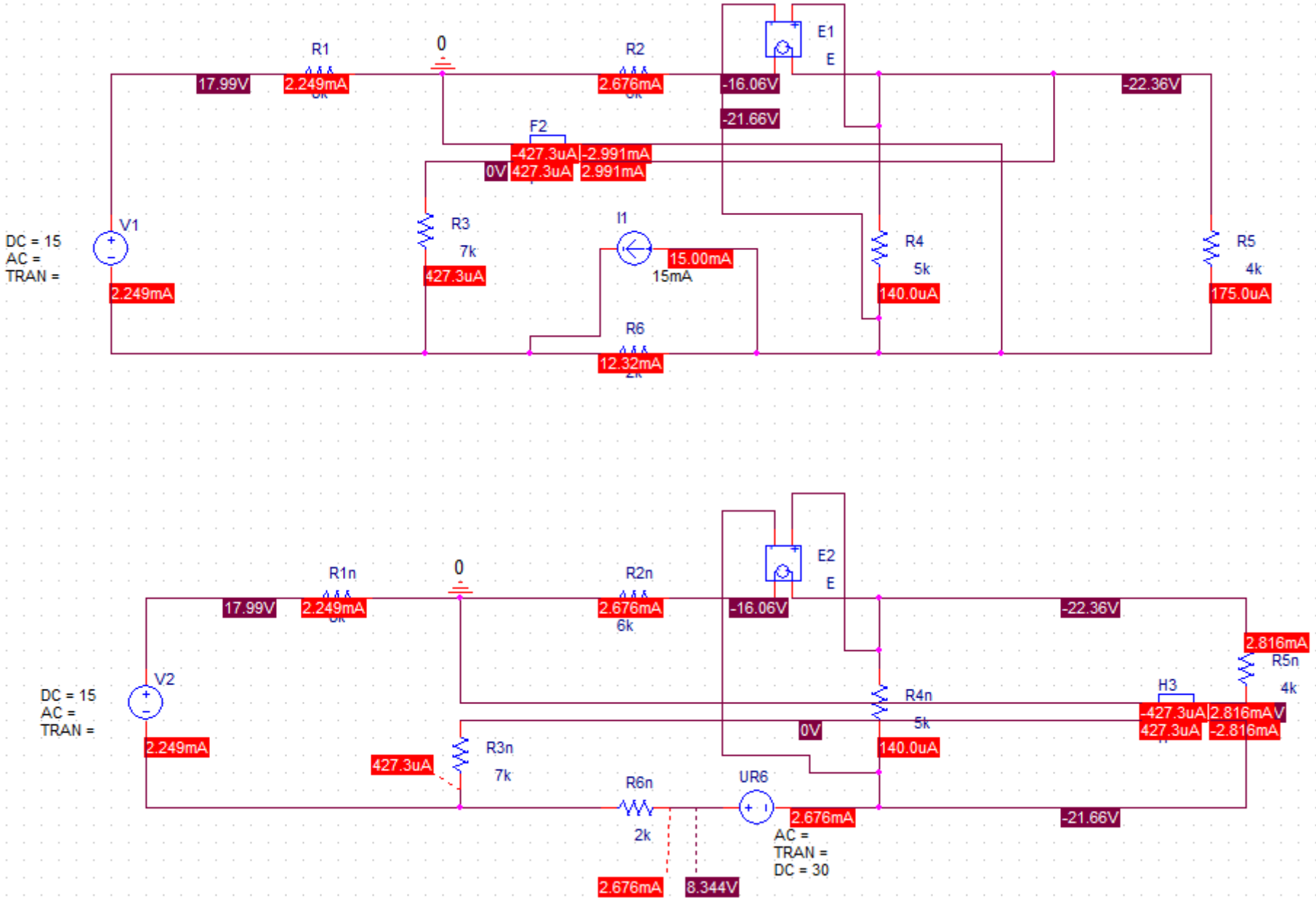
```
R1=8e3; R2=6e3; R3=7e3; R4=5e3; R5=4e3; R6=2e3;
U = 15; UR6 = 30;
g1=1/R1; g2=1/R2; g3=1/R3; g4=1/R4; g5=1/R5; g6=1/R6;

g = [g1+g3+g6        0            -g6
    7*g3          g2+g4+g5-9*g2     -g4-g5+9*g2
    -g6-7*g3     -g4-g5       g4+g6+g5];
I = [-g1*U+g6*UR6;0;-g6*UR6];
fi = g\I;
I1 = ( fi(1) + U )*g1;
I4 = ( fi(2) - fi(3) )*g4;
I2 = (-fi(2) + 9*I4*R4)*g2;
I3 = -fi(1)*g3;
I5 = (fi(2) - fi(3) - 7*I3*R5)*g5;
I6 = (fi(3) - fi(1) + UR6)*g6;
```

2.2.3 Potenciāls

$$\phi_1 = 2.9912V$$
$$\phi_2 = -2.2356V$$
$$\phi_3 = -2.1656V$$

2.2.4 Strāvas

$$I_1 = 2.2489 \cdot 10^{-3} A$$
$$I_2 = 2.6762 \cdot 10^{-3} A$$
$$I_3 = -4.2731 \cdot 10^{-4} A$$
$$I_4 = -1.3998 \cdot 10^{-3} A$$
$$I_5 = 2.8162 \cdot 10^{-3} A$$
$$I_6 = 2.6762 \cdot 10^{-3} A$$



Shēma 20: P-Spice

3 ķēdes aprēķins stacionārā maiņstrāvas režīmā

151RDB399

$$N-9; M-9$$

Shēmas numurs $= 2 \cdot 9 + 9 =$ **27** Parametru komplekts $= 3 \cdot 9 + 9 = 36 - 30 =$ **6**

Shēma 21: 27 variants

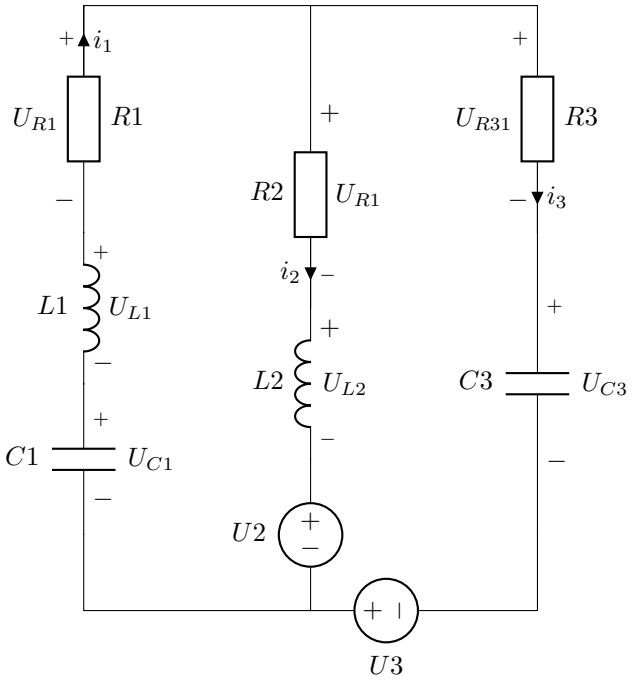


Table 4: 6.variants

Nr	f, kHz	$R, k\Omega$			L, mH			C, nF			E_m, V			$\Psi_e * \pi, rad$		
		R_1	R_2	R_3	L_1	L_2	L_3	C_1	C_2	C_3	U_{m1}	U_{m2}	U_{m3}	Ψ_1	Ψ_2	Ψ_3
6	100	0.5	0.3	0.2	0.8	1	1.2	1.5	2	1.6	15	12	11	0.3	-0.4	0.5

$U_c = \frac{1}{C} \int_0^t i_C(t)dt$

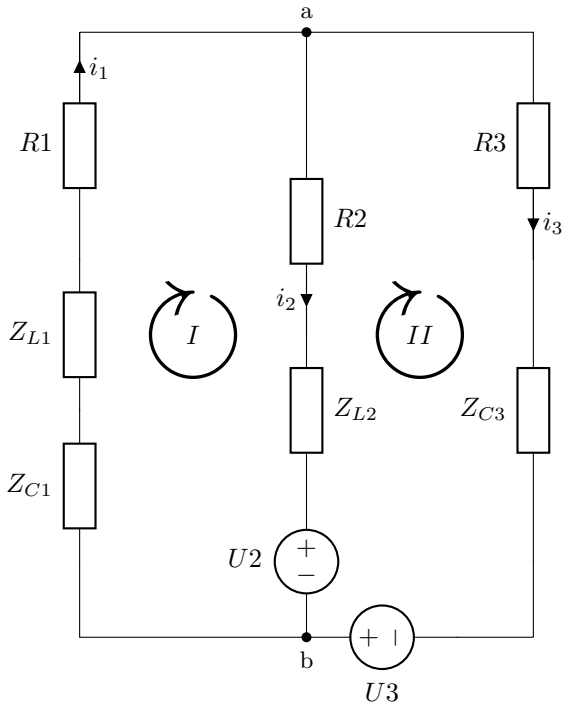
$$-i_1(t) + i_2(t) + I_3(t) = 0$$

$$i_1(t)R1 + L1\frac{di_1(t)}{dt} + U_{C1} - i_2(t)R2 - L2\frac{di_2(t)}{dt} = U2$$

$$i_3(t)R3 + U_{C3} - i_2(t)R2 - L2\frac{di_2(t)}{dt} = U3$$

3.1 Aprēķins izmantojot kontūrstrāvu metodi

Shēma 22: Ekvivalenta shēma



$\omega = 2\pi f = 100000 * 2\pi = 10^5 \cdot 2\pi$
$U_2(t) = 15 \cdot cos(2\pi \cdot 10^5 + 0.3\pi)$
$U_3(t) = 11 \cdot cos(2\pi \cdot 10^5 + 0.5\pi)$
$Z_{L1} = i \cdot \omega L1 = 1.6i\pi \cdot 10^2$
$Z_{L2} = i \cdot \omega L2 = 2i\pi \cdot 10^2$
$Z_{C1} = i \cdot \omega C1 = \frac{1}{3i\pi \cdot 10^{-4}}$
$Z_{C3} = i \cdot \omega C1 = \frac{1}{3.2i\pi \cdot 10^{-4}}$

3.1.1 Vienādojumu skaits

Z - zari, m - mezgli, Z_s - Zari ar strāvas avotiem $n = Z - (m-1) - Z_s$ $n = 3 - (2-1=2)$

$$I_{k1} \cdot (ZC1 + Z_{L1} + R1 + R2 + Z_{L2}) - I_{k2} \cdot (R2 + Z_{L2}) = -12e^{-0.4\pi i}$$
$$I_{k1} \cdot (ZL2 + Z_{C3} + R1 + R2) - I_{k2} \cdot (R2 + Z_{L2}) = 12e^{j0.3\pi} + 11e^{i0.5\pi}$$

3.1.2 Matlab

```
R1=0.5e3; R2=0.3e3; R3=0.2e3; L1=0.8e-3; L2=1e-3; C1=1.5e-9; C3=1.6e-9;
omega=10^5*2*pi;
Zl1=L1*i*omega; Zl2=L2*i*omega;
Zc1=1/(C1*i*omega); Zc3=1/(C3*i*omega);
 fa2 = -0.4*pi; fa3 = 0.5*pi;
 U2=12*exp(i*fa2); U3=11*exp(i*fa3);

Z = [Zc1+Zl1+R1+R2+Zl2 -R2-Zl2
    Zl2+R2+R3+Zc3 -R2-Zl2];
U = [-U2;U2+U3];
```

```
Ik = Z\U;

I1 = Ik(1);
I2 = Ik(1) - Ik(2);
I3 = Ik(2);

UR1 = R1*I1;
UL1 = Zl1*I1;
UC1 = Zc1*I1;
UR2 = R2*I2;
UL2 = Zl2*I2;
UR3 = R3*I3;
UC3 = Zc3*I3;

Uv = [UR1 UR2 UR3 UL1 UL2 UC1 UC3];
modulis = abs(Uv);
faze = angle(Uv);

Iv = [I1 I2 I3];
modulisi = abs(Iv);
gradii = radtodeg(angle(Iv));
```

3.1.3 Kontūrstrāvas

$$I_{k1} = 0.010467 + 0.024193i = 2.6361 \cdot 10^{-2} \underline{/66.6043^\circ} A$$

$$I_{k2} = 0.017672 - 0.0080983i = 1.9439 \cdot 10^{-2} \underline{/-24.6198^\circ} A$$

3.1.4 Strāvas

$$I_1 = 0.010467 + 0.024193i = 2.6361 \cdot 10^{-2} \underline{/66.6043^\circ} A$$
$$I_2 = -0.0072048 + 0.032292i = 3.3086 \cdot 10^{-2} \underline{/102.5775^\circ} A$$
$$I_3 = 0.017672 - 0.0080983i = 1.9439 \cdot 10^{-2} \underline{/-24.6198^\circ} A$$

3.1.5 Kompleksie spriegumi

$$U_{R1} = 5.2337 + 12.0968i = 1.3181 \cdot 10^{1} \underline{/66.6043^\circ} V$$

$$U_{R2} = -2.1614 + 9.6875i = 9.9257 \underline{/102.5775^\circ} V$$

$$U_{R3} = 3.5344 - 1.6197i = 3.8879 \underline{/-24.6198} V$$

$$U_{L1} = -12.1610 + 5.2614i = 1.3251 \cdot 10^{1} \underline{/156.6043} V$$

$$U_{L2} = -20.2895 - 4.5269i = 2.0788 \cdot 10^{1} \underline{/-167.4225} V$$

$$U_{C1} = 25.6701 - 11.1062i = 2.7970 \cdot 10^{1} \underline{/-23.3957} V$$

$$U_{C3} = -8.0555 - 17.5788i = 1.9337 \cdot 10^{1} \underline{/-114.6198} V$$

3.1.6 Momentānās strāvas

$$I_1 = 2.6361 \cdot 10^{-2} cos(\omega + 1.1625) A$$
$$I_2 = 3.3086 \cdot 10^{-2} cos(\omega + 1.7903) A$$
$$I_3 = 1.9439 \cdot 10^{-2} cos(\omega - 42.9697) A$$

3.1.7 Momentānie spriegumi

$\omega = 2\pi f = 100000 * 2\pi = 10^5 \cdot 2\pi$

$$U_{R1}(t) = 13.1804 cos(\omega + 1.1625), V$$

$$U_{R2}(t) = 9.9257 cos(\omega + 1.7903), V$$

$$U_{R3}(t) = 3.8879 cos(\omega - 0.4297), V$$

$$U_{L1}(t) = 13.2504 cos(\omega + 2.7333), V$$

$$U_{L2}(t) = 20.7884 cos(\omega - 2.9221), V$$

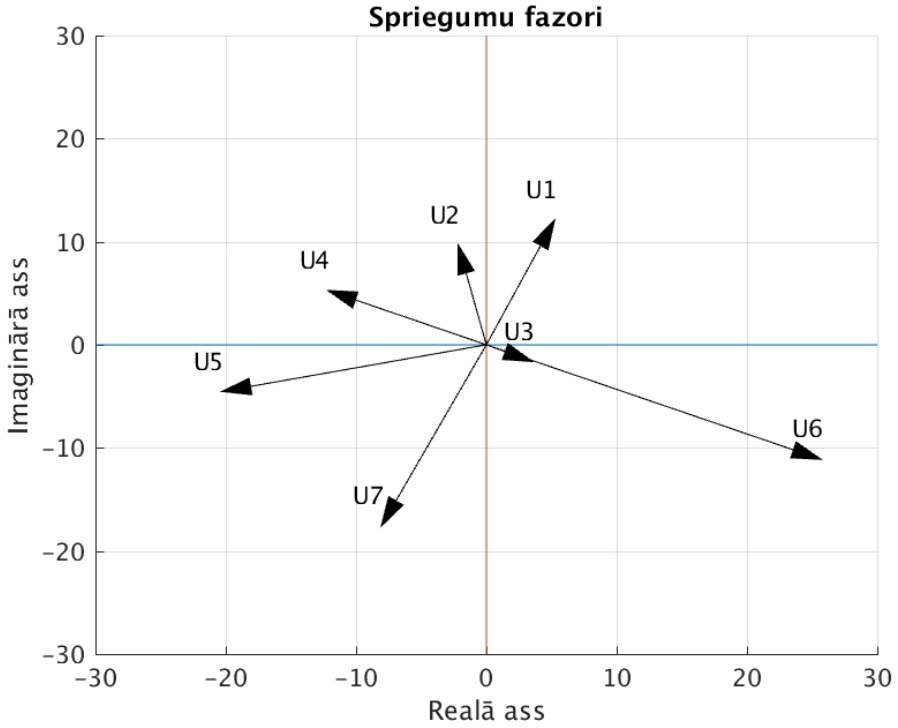
$$U_{C1}(t) = 27.9696 cos(\omega - 0.4083), V$$

$$U_{C3}(t) = 19.3366 cos(\omega - 2.0005), V$$

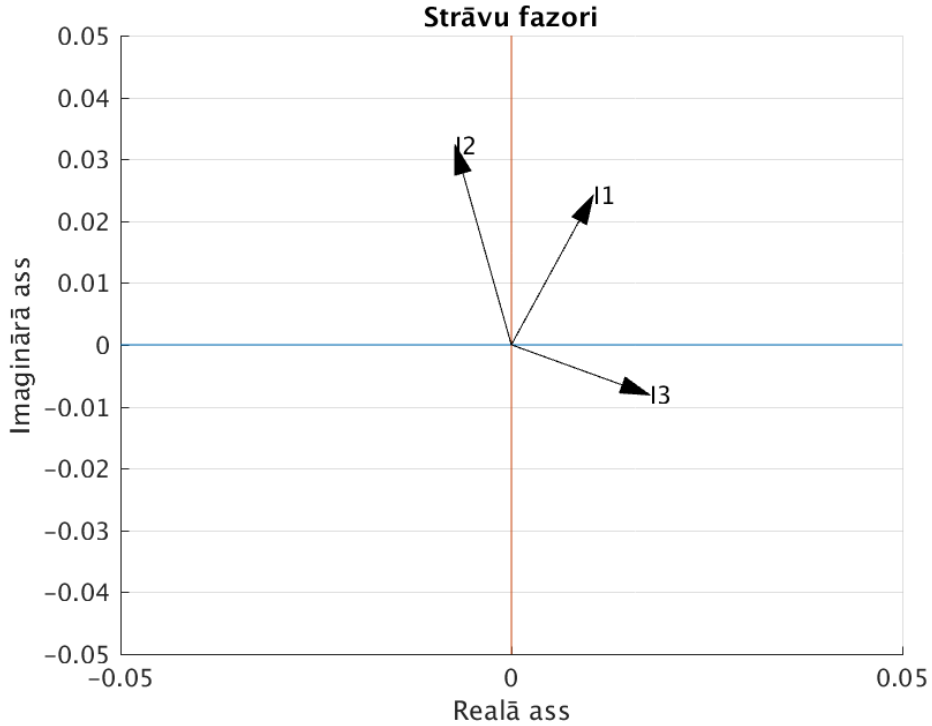
3.1.8 Avotu atdotās kompleksās jaudas

$$\dot{S}_2 = \frac{1}{2} \dot{E_{m2}} \dot{I}^*_{m2} = 1.7091 \cdot 10^{-1} W + 1.0099i \cdot 10^{-1} VAr$$
$$\dot{S}_3 = \frac{1}{2} \dot{E_{m3}} \dot{-I}^*_{m3} = -4.4541 \cdot 10^{-2} W - 9.7197i \cdot 10^{-2} VAr$$

3.1.9 Fazoru grafika



Shēma 23: P-Spice



Shēma 24: P-Spice