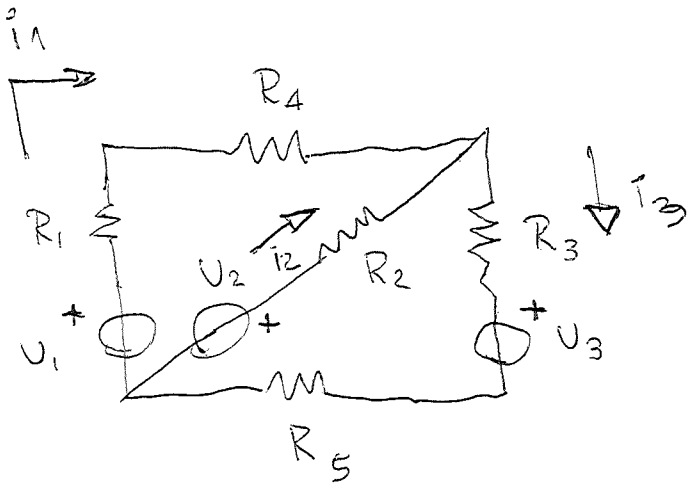


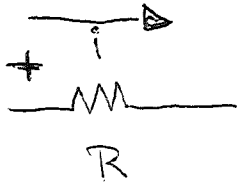
~~COMPONENTS IN SERIES GET~~
~~THE SAME CURRENT~~

COMPONENTS IN SERIES GET
⚠ THE SAME CURRENT (don't add unnecessary currents)

Steps:

1. Assign currents to branches (i_1, i_2, i_3)

2. Assign polarity to resistances



3. Write kirchhoff laws

4. Solve system of equations ("n" equations for "n" variables)

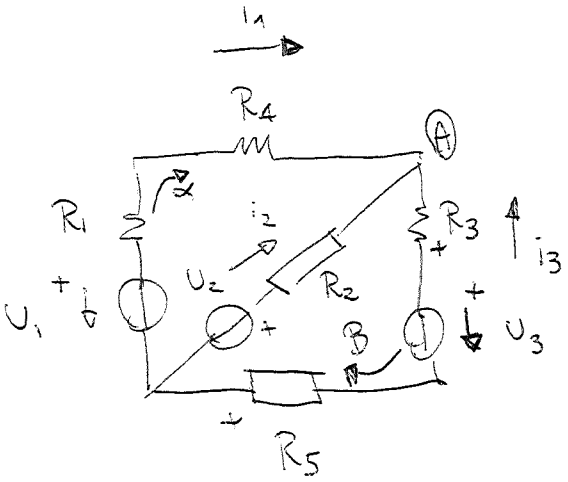
Ex. 3.2

$U_1 = U_2 = U_3 = 10\ V$

$R_1 = R_2 = R_3 = 2\ \Omega$

$R_4 = 50\ \Omega$

$R_5 = 100\ \Omega$



(A) $\quad i_1 + i_2 + i_3 = 0$

(A)' $\quad i_3 = -(i_1 + i_2)$

(α) : $\quad -U_1 + i_1 R_1 + i_1 R_4 - i_2 R_2 + U_2 = 0$

(B) : $\quad -i_3 R_3 + U_3 - i_3 R_5 - U_2 + i_2 R_2 = 0$

(A)' into (B) : $\quad (i_1 + i_2) R_3 + U_3 + (i_1 + i_2) R_5 - U_2 + i_2 R_2 = 0$

$$i_1 (R_3 + R_5) + i_2 (R_3 + R_5 + R_2) + U_3 - U_2 = 0$$

(B)' : $\quad i_2 = \dfrac{U_2 - U_3 - i_1 (R_3 + R_5)}{R_3 + R_5 + R_2}$

(B)' into (A):

$$-U_1 + i_1R_1 + i_1R_4 + U_2 - \frac{R_2}{R_3+R_5+R_2}\left(U_2 - U_3 - i_1(R_3+R_5)\right) = 0$$

$$-U_1 + i_1R_1 + i_1R_4 + U_2 - \frac{1}{R_T}\left(U_2 - U_3 - i_1(R_3+R_5)\right) = 0$$

$$-U_1R_T + i_1R_1R_T + i_1R_4R_T + U_2R_T - U_2 + U_3 + i_1(R_3+R_5) = 0$$

$$i_1\left(R_1R_T + R_4R_T + R_3 + R_5\right) = U_1R_T - U_2R_T + U_2 - U_3$$

$$i_1 = \frac{U_1R_T - U_2R_T + U_2 - U_3}{R_1R_T + R_4R_T + R_3 + R_5} = \frac{0+0}{-} = 0 \quad \boxed{i_1}.$$

$\boxed{i_1}$ into (B)': $i_2 = \frac{0-0}{-} = 0$. $\boxed{i_1}$ and $\boxed{i_2}$ into (C): $i_3 = -0$.

Ex 3.2 VARIATION

Consider 3.2 but with $U_3 = 15\ V$.

i_1 $$i_1 = \frac{U_1 R_T - U_2 R_T + U_2 - U_3}{R_1 R_T + R_4 R_T + R_3 + R_5} = \frac{0 + 10 - 15}{R_T(R_1 + R_4) + R_3 + R_5} = -\frac{5}{52.52 + 2 + 100} = -\frac{5}{2806} =$$

$$= i_1 = -1.7\ mA.$$

i_1 into (3):

$$i_2 = \frac{U_2 - U_3 + 1.7\,mA\,(R_3 + R_5)}{R_3 + R_5 + R_2} = \frac{-5 + 1.7mA \cdot 102\,\Omega}{104\,\Omega} = -0.0464\ A.$$

i_1 and i_2 into A: $i_3 = -(i_1 + i_2) = -(-1.8\,mA - 0.0464A) = 0.0482\ A.$

Ex. 3.2

MATRIX WAY

(A) $i_1 + i_2 + i_3 = 0$

(α) $i_1(R_1 + R_4) - i_2 R_2 = U_1 - U_2$

(B) $i_2 R_2 + i_3(-R_3 - R_5) = U_2 - U_3$

$$\begin{bmatrix} 1 & 1 & 1 \\ R_1+R_4 & -R_2 & 0 \\ 0 & R_2 & -R_3-R_5 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ U_1-U_2 \\ U_2-U_3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & 1 \\ 52 & -2 & 0 \\ 0 & 2 & -102 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \quad \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = A^{-1} \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$