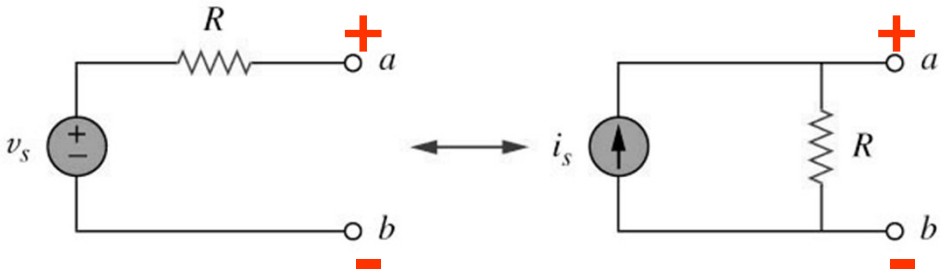
4.4 Source Transformation (1)

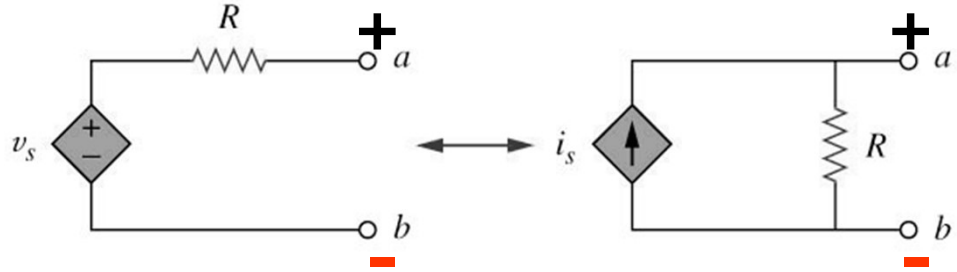
- An equivalent circuit is one whose *v-i* characteristics are identical with the original circuit.

- It is the process of replacing ***a voltage source v_S in series with a resistor R*** **by a** ***current source i_S in parallel with a resistor*** *R*, or vice versa.

4.4 Source Transformation (2)

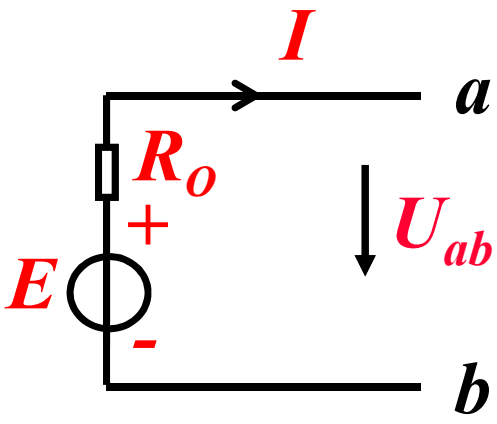


(a) Independent source transform

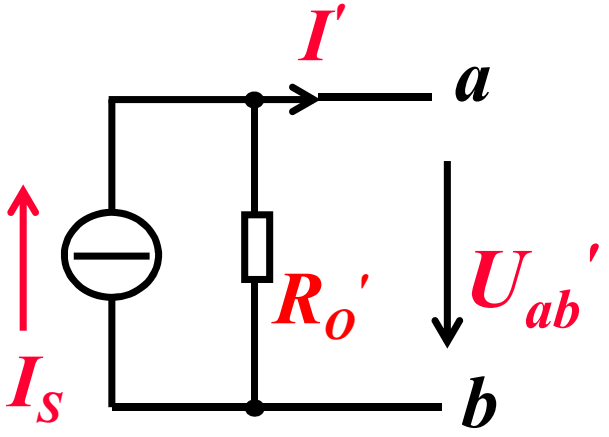


(b) Dependent source transform

- The arrow of the current source is directed toward the positive terminal of the voltage source.
- The source transformation is not possible when R = 0 for voltage source and R = ∞ for current source.



$$U_{ab} = E - I \cdot R_o$$



$$U_{ab}' = (I_s - I') \cdot R_o'$$
$$= I_s \cdot R_o' - I' \cdot R_o'$$

if $I = I'$

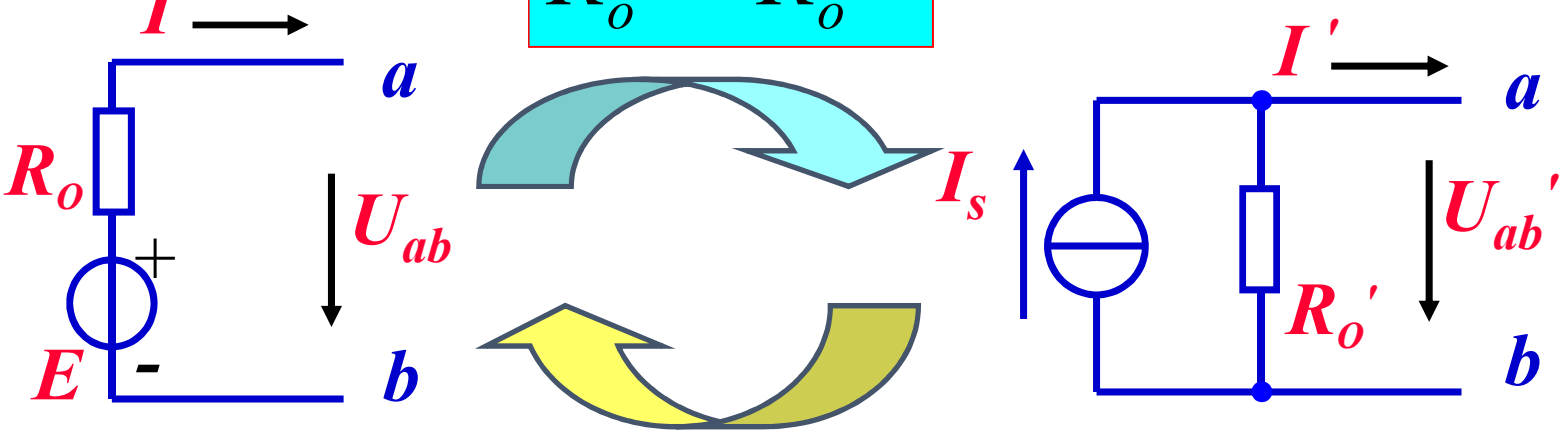
$U_{ab} = U_{ab}'$

then $E - I \cdot R_o = I_s \cdot R_o' - I' \cdot R_o'$

$E = I_s \cdot R_o'$ $\quad R_o = R_o'$

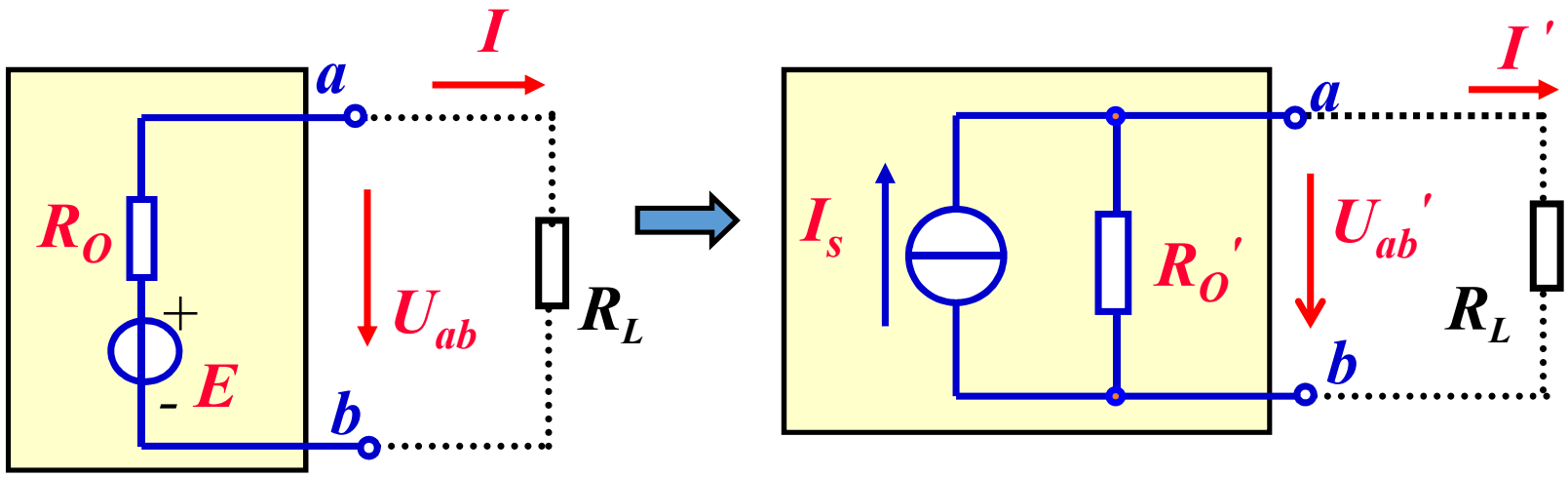
$$I_s = E / R_o$$

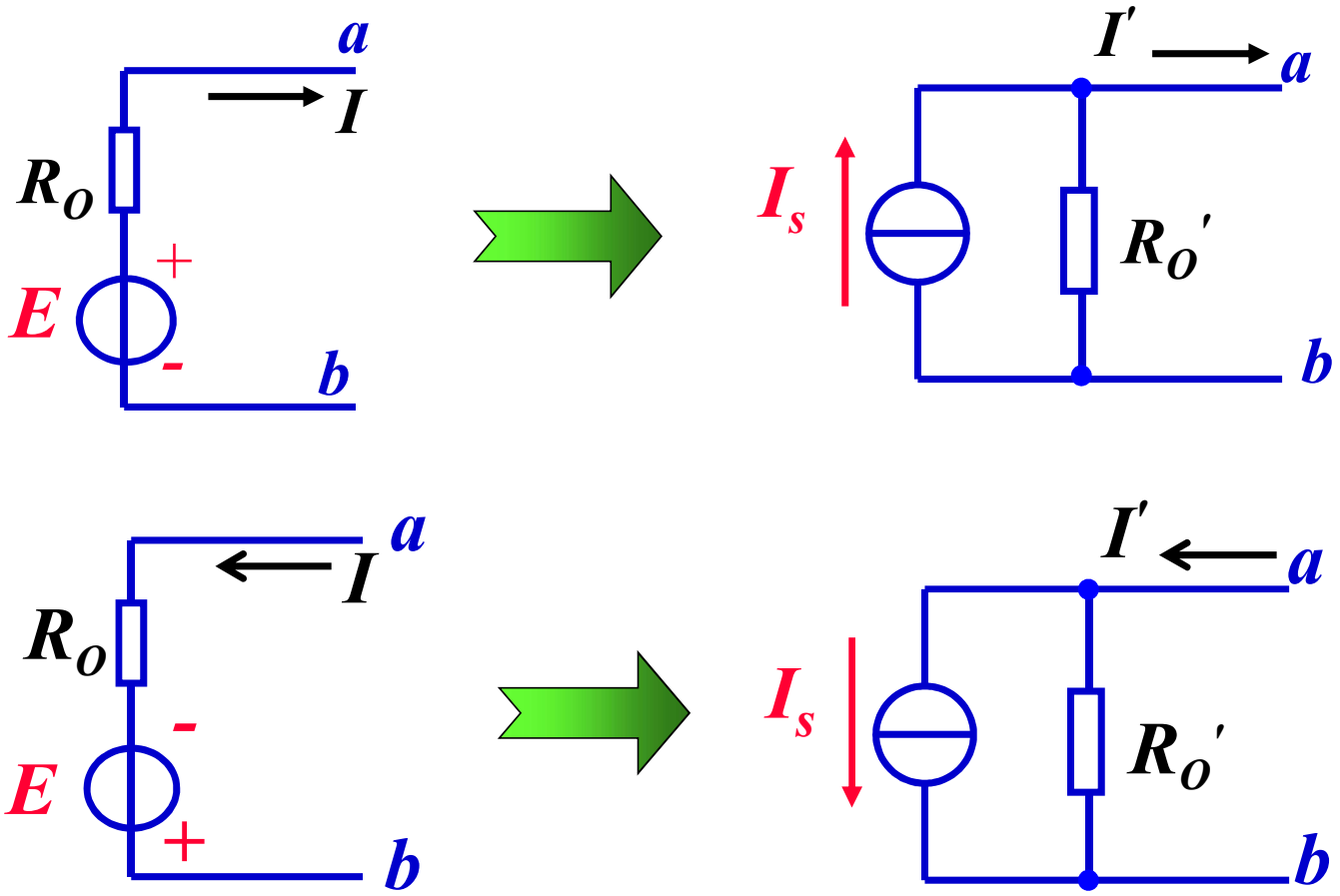
$$R_o' = R_o$$

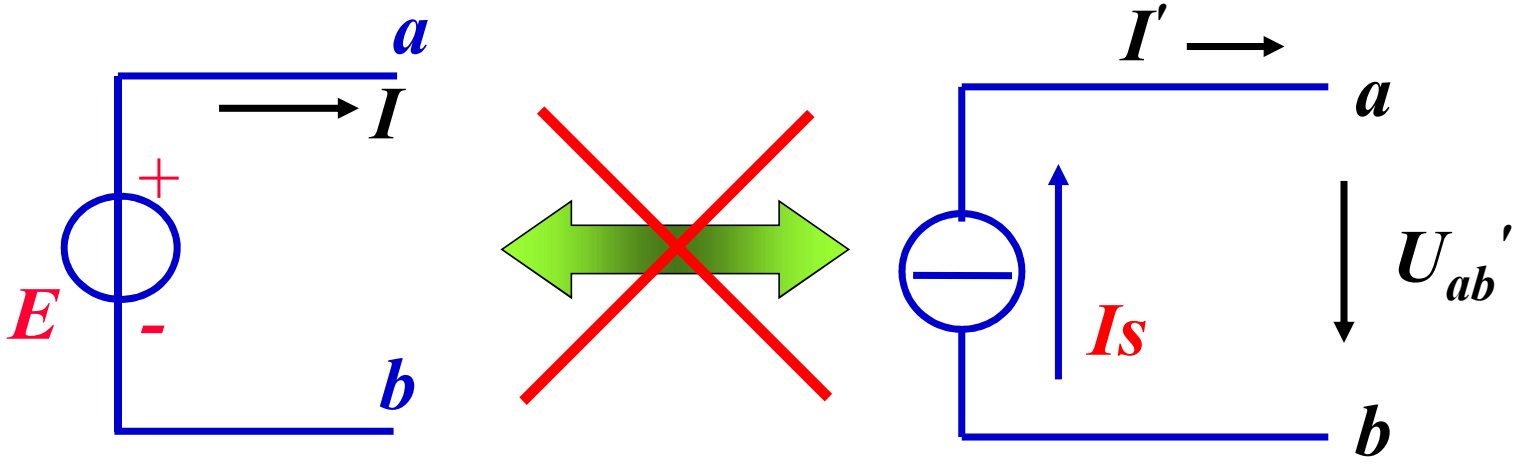


$$E = I_s \cdot R_o'$$

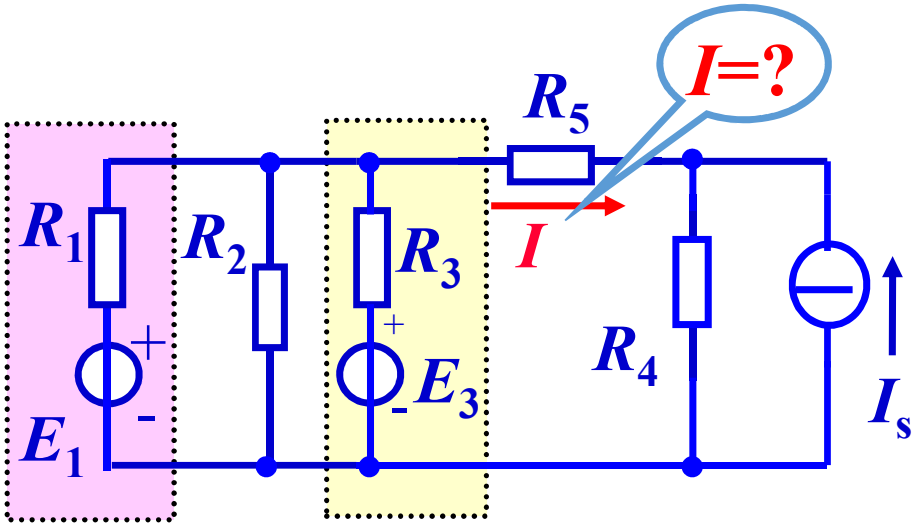
$$R_o = R_o'$$


I
a
R_O
+
E
-
b
U_{ab}
R_L
I_s
R_O'
I'
a
U_{ab}'
b
R_L


a
I
R_O
+
E
-
b
I′
a
I_s
R_O'
b
a
I
R_O
-
E
+
b
I′
a
I_s
R_O'
b

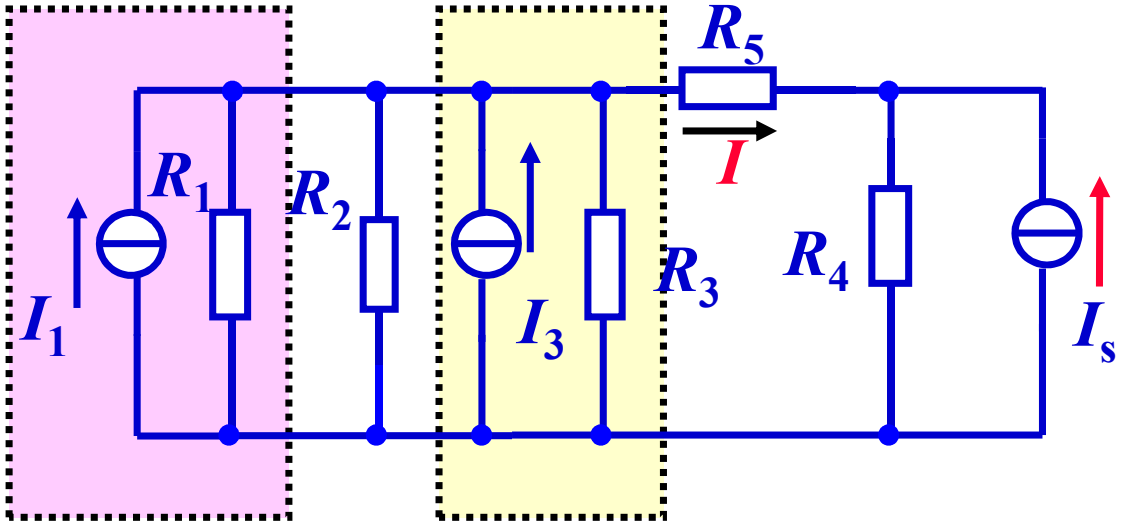


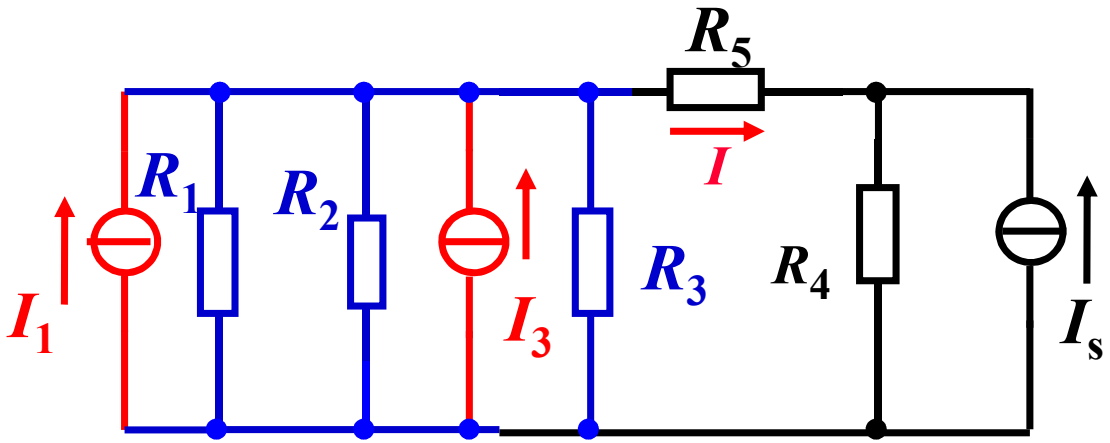
$$I_S = \frac{E}{R_o} = \frac{E}{0} = \infty$$

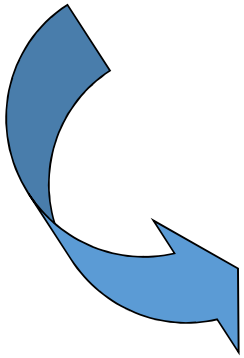


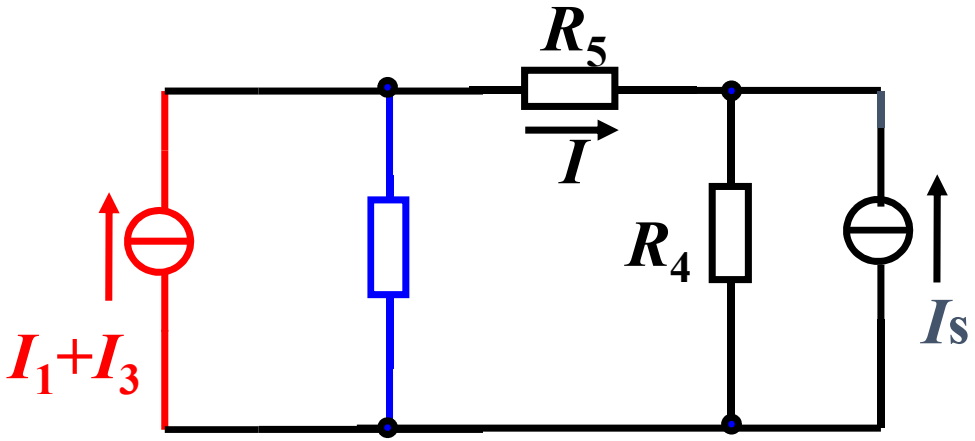
$$I_1 = \frac{E_1}{R_1}$$

$$I_3 = \frac{E_3}{R_3}$$

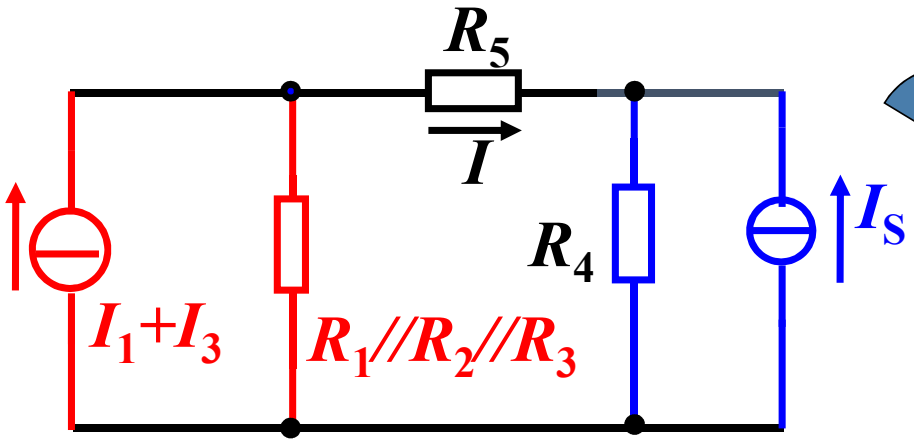


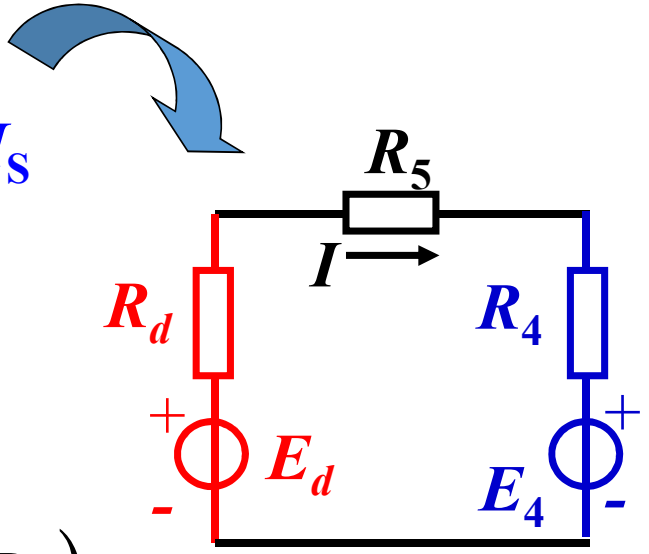






$R_1//R_2//R_3$



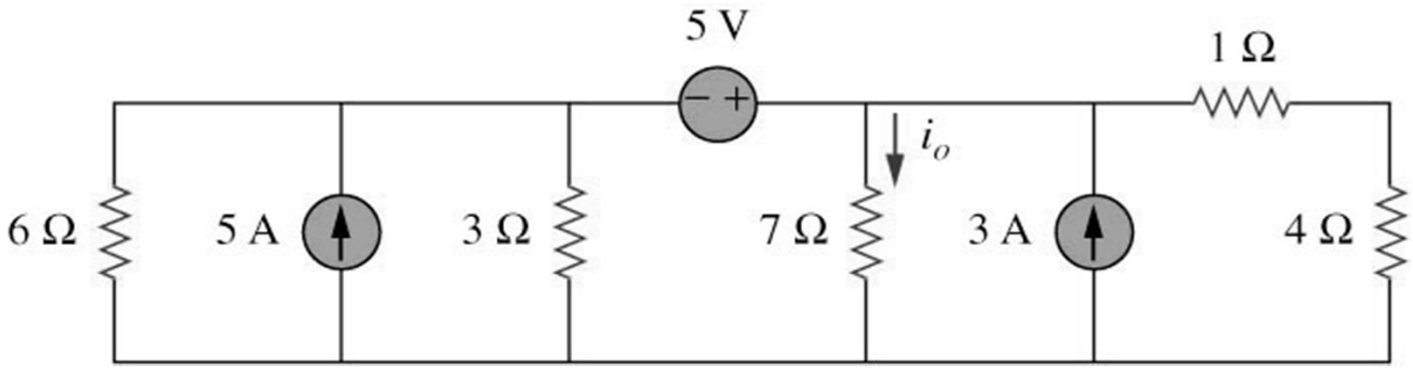


$$\begin{cases} E_d = (I_1 + I_3) \cdot (R_1 // R_2 // R_3) \\ R_d = R_1 // R_2 // R_3 \\ E_4 = I_S \cdot R_4 \end{cases}$$

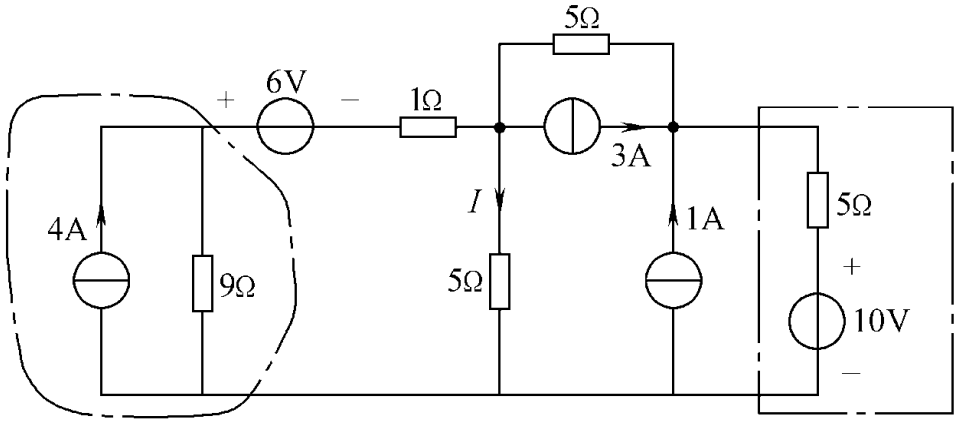
$$I = \frac{E_d - E_4}{R_d + R_5 + R_4}$$

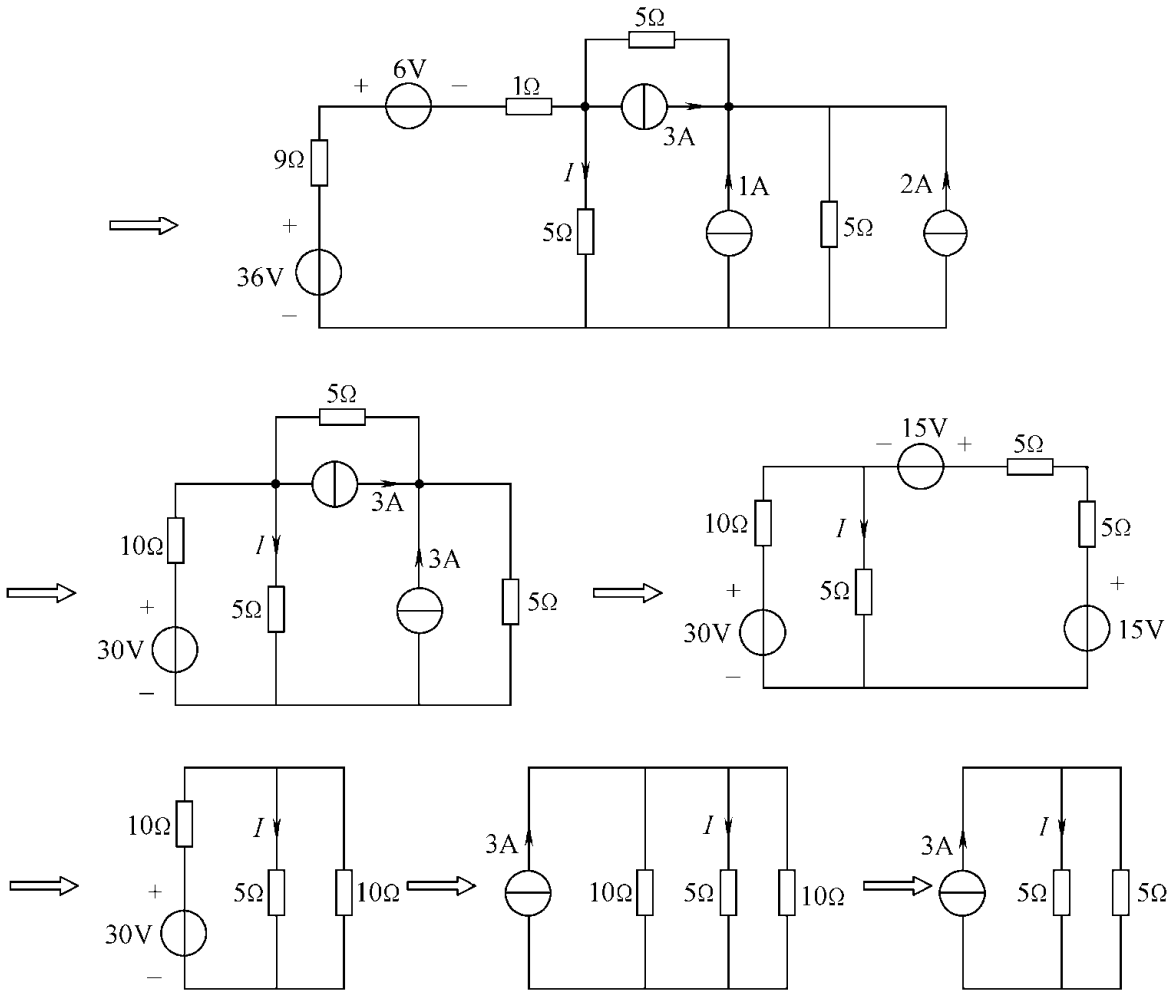
Example 4

Find i_o in the circuit shown below using source transformation.



i_0 = 1.78A

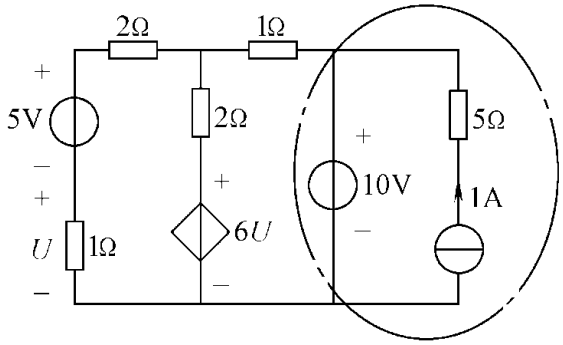

5Ω
6V
+
−
1Ω
3A
I
4A
9Ω
5Ω
1A
5Ω
+
10V
−

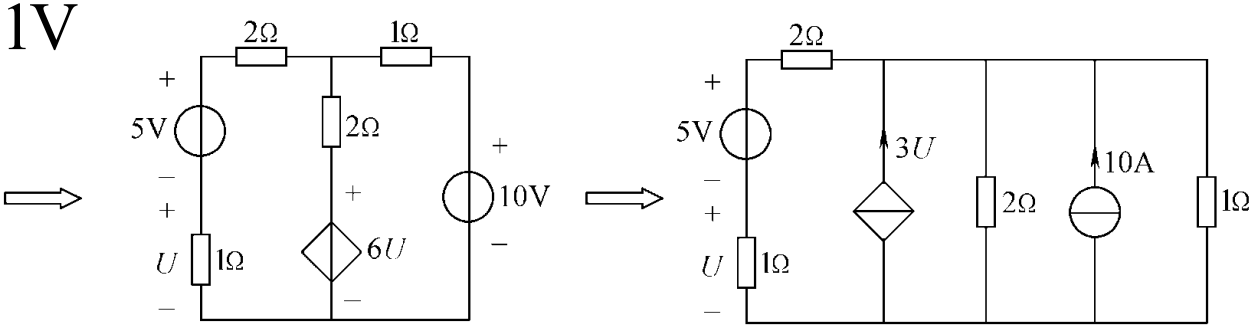

5Ω
6V
1Ω
3A
9Ω
I
1A
2A
5Ω
5Ω
36V
5Ω
3A
10Ω
I
3A
5Ω
5Ω
30V
15V
5Ω
10Ω
I
5Ω
5Ω
30V
15V
10Ω
I
5Ω
10Ω
30V
3A
I
10Ω
5Ω
10Ω
3A
I
5Ω
5Ω

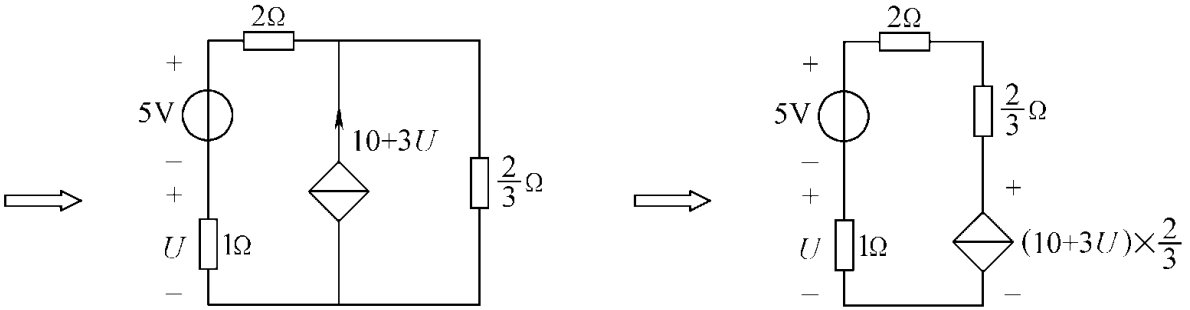
$$I = 1.5\text{A}$$

$$U=\frac{(10+3U)\cdot\frac{2}{3}-5}{3+\frac{2}{3}}\times 1$$

$U=1\mathrm{V}$







§1-7支路电流法

对一个具有*b*条支路和*n*个结点的电路，以**支路电流为独立变量**，**根据KCL列(*n*-1)个独立方程、根据KVL列(*b*-*n*+1)个独立方程**，解得各支路电流。

步骤：

(1)设定各支路*i*的参考方向；

(2)根据KCL对(*n*-1)个独立**结点**列**方程**；

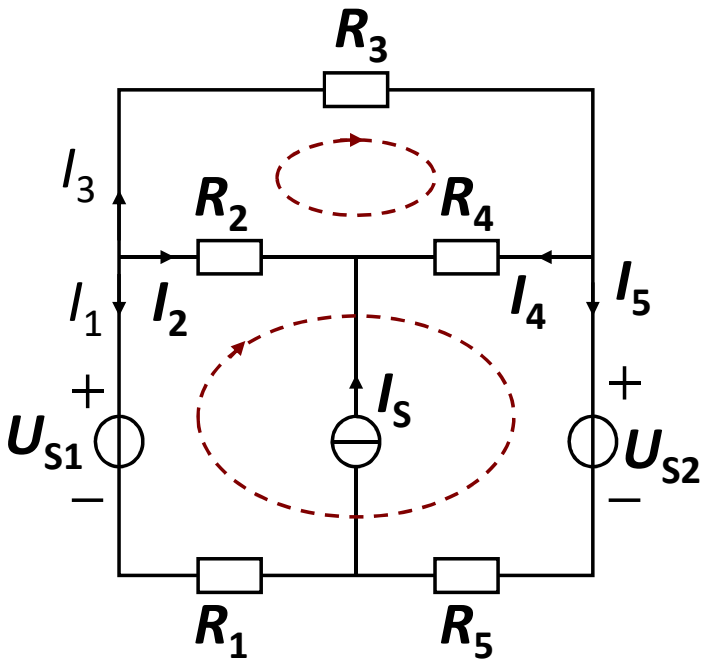
(3)选取 (*b*-*n*+1)个独立回路，指定回路的**绕行方向**，列出KVL**回路方程**。

步骤：

(1)设定各支路*i*的参考方向；

(2)根据KCL对(*n*-1)个独立**结点**列**方程**；

(3)选取 (*b*-*n*+1)个独立回路，指定回路的**绕行方向**，列出KVL**回路方程**。



例：用**支路电流法**求图中各支路电流，并说明U_1、U_2是提供还是吸收功率。