第1章　电路元件和电路定律

1. 电压、电流的参考方向

2. 电路元件特性（元件约束）

3. 基尔霍夫定律（拓扑约束）
   (基本形式+推广形式)

4. 电路元件的功率

第2章 电阻电路的等效变换

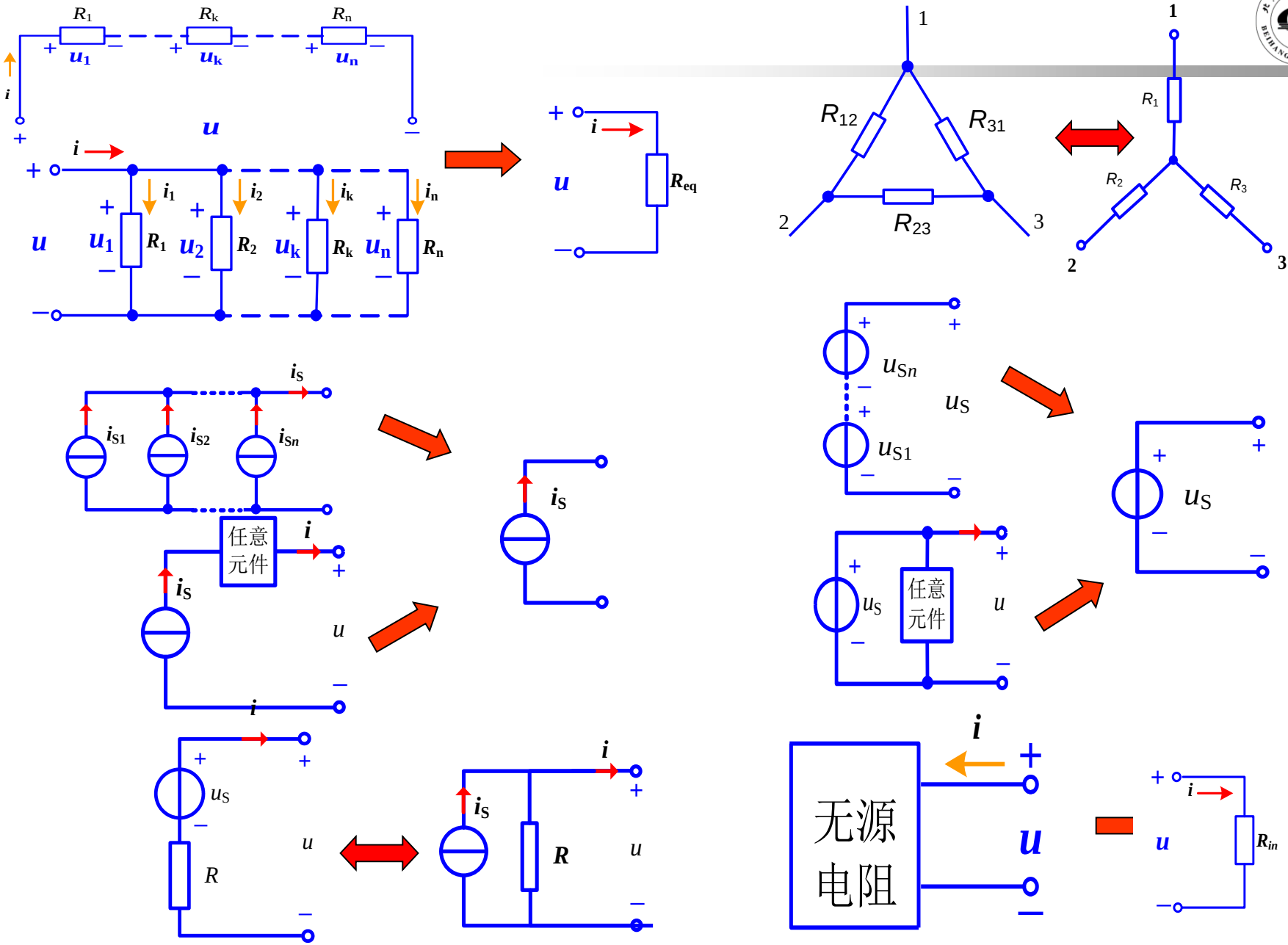
1. 电路等效的概念；

2. 电阻的串、并联；

3. Y—Δ 变换；

4. 电压源和电流源的等效变换；

5. 一端口（两端网络）输入电阻的计算。


R1
Rk
Rn
u1
uk
un
i
u
i
i1
i2
ik
in
u
u1
R1
u2
R2
uk
Rk
un
Rn
i
u
Req
1
R12
R31
2
R23
3
1
R1
R2
R3
2
3
iS
iS1
iS2
iSn
任意
元件
i
iS
u
i
iS
uSn
uS
uS1
uS
uS
任意
元件
u
uS
R
u
i
iS
R
u
i
无源
电阻
u
i
u
Rin

第3章　电阻电路的一般分析

熟练掌握电路方程的列写方法：

2b法

支路电流（电压）法

回路电流法

结点电压法

电阻电路的一般分析方法

分析方法	电路变量	方程数	方程类型	特点适用性	注意问题
支路法（2*b*）	支路电流、支路电压	2*b*	KCL (*n*-1) KVL *b*- (*n*-1) 支路方程*b*	最灵活、任何电路、方程组庞大	
支路电流法	支路电流	*b*	KCL (*n*-1) KVL *b*- (*n*-1)	指定支路电流参考方向，任何电路	电流源在KVL方程
回路法（网孔法）	回路电流（网孔电流）	*l*=*b*-（*n*-1）	KVL	选择回路电流（网孔电流），任何电路，对回路少的电路有优势	电流源在KVL方程
结点法	结点电压	*n*-1	KCL	选择参考结点，任何电路，对结点少的电路有优势	电压源在KCL方程； 电流源串联电阻支路

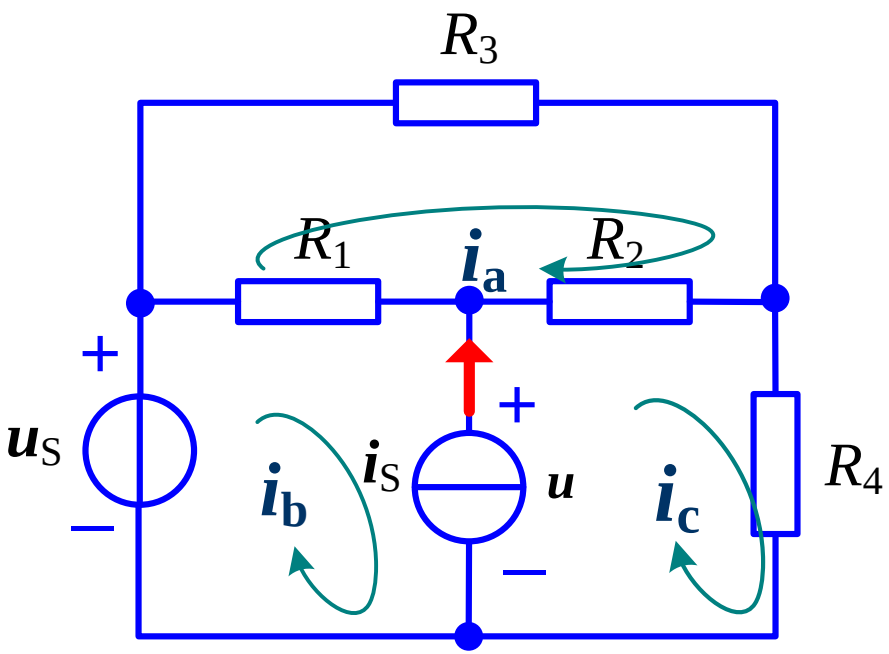
回路法

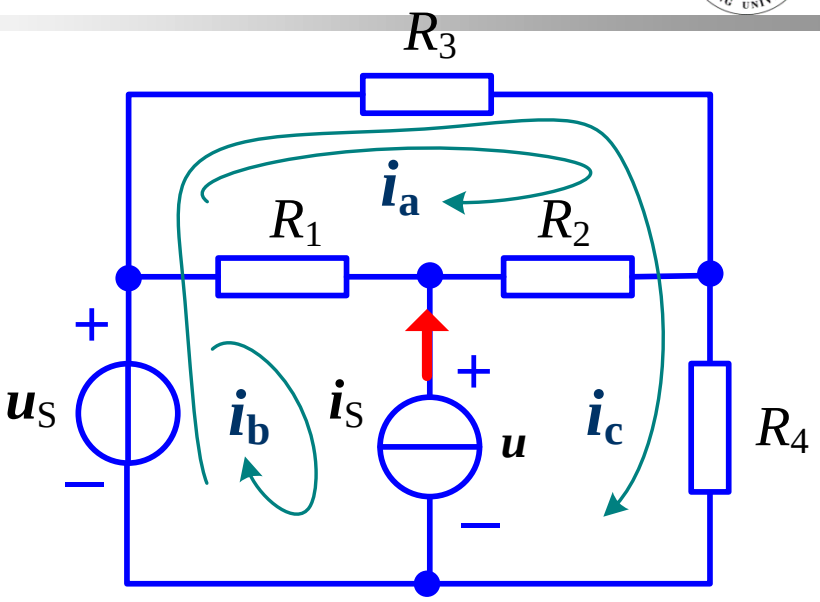
$$\begin{cases} R_{11}i_{l1}+R_{12}i_{l2}+\cdots+R_{1l}i_{ll}=u_{S11} \\ R_{21}i_{l1}+R_{22}i_{l2}+\cdots+R_{2l}i_{ll}=u_{S22} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ R_{l1}i_{l1}+R_{l2}i_{l2}+\cdots+R_{ll}i_{ll}=u_{Sll} \end{cases}$$

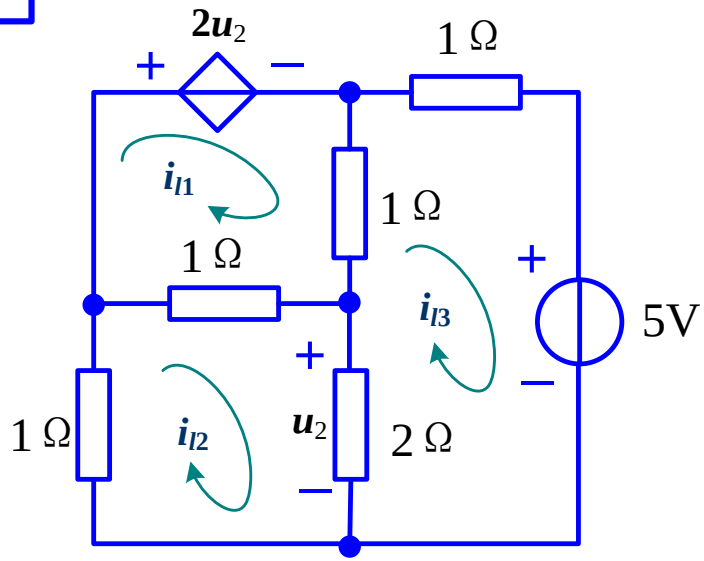
结点法

$$\begin{cases} G_{11}u_{n1}+G_{12}u_{n2}+\ldots+G_{1(n-1)}u_{n(n-1)}=i_{S11} \\ G_{21}u_{n1}+G_{22}u_{n2}+\ldots+G_{2(n-1)}u_{n(n-1)}=i_{S22} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ G_{(n-1)1}u_{n1}+G_{(n-1)2}u_{n2}\ldots+G_{(n-1)(n-1)}u_{n(n-1)}=i_{S(n-1)(n-1)} \end{cases}$$

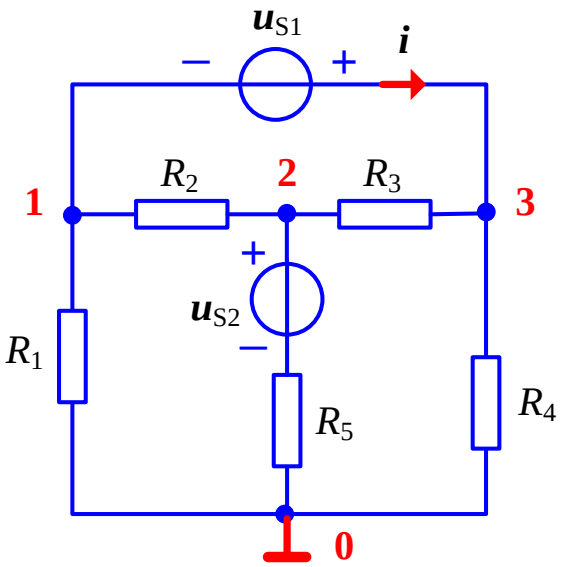
写出回路法方程。

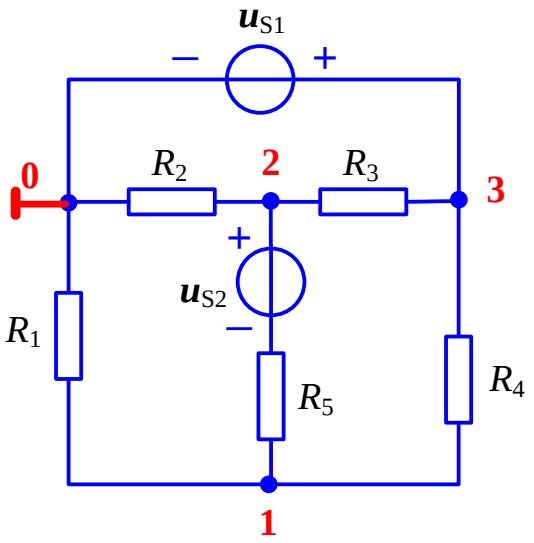

R_3
R_1
i_a
R_2
u_S
i_b
i_S
u
i_c
R_4

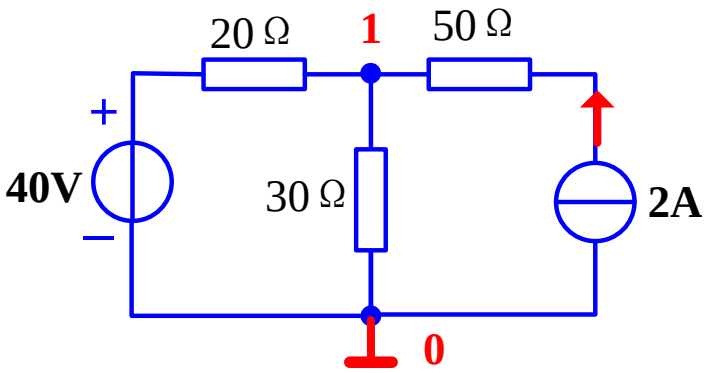

R_3
i_a
R_1
R_2
u_S
i_b
i_S
u
i_c
R_4

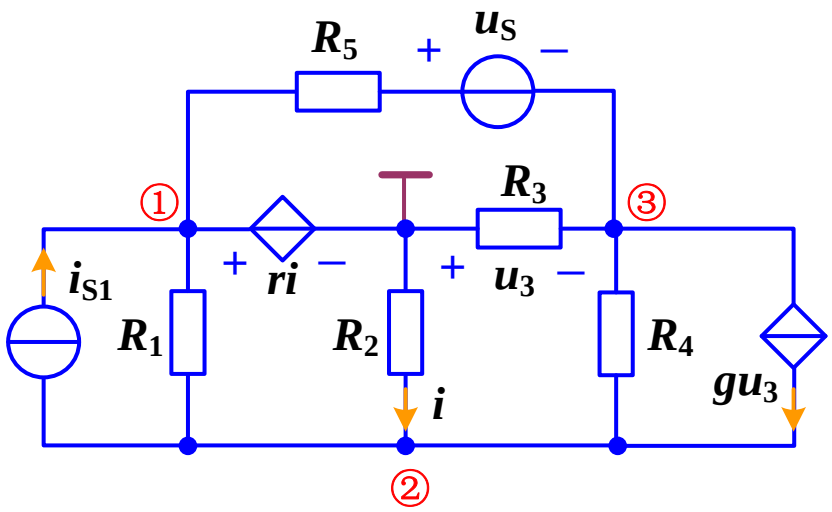

$2u_2$
1 Ω
i_{l1}
1 Ω
1 Ω
i_{l3}
5V
1 Ω
i_{l2}
u_2
2 Ω

列结点法方程

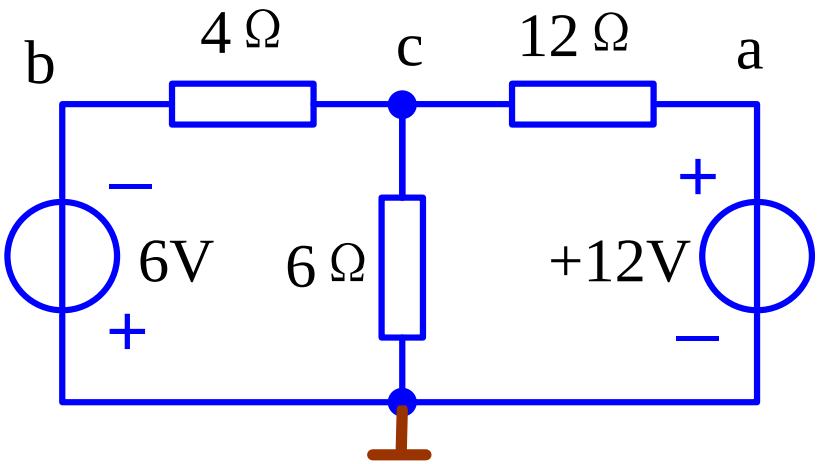

u_{S1}
i
1
R_2
2
R_3
3
u_{S2}
R_1
R_5
R_4
0


u_{S1}
0
R_2
2
R_3
3
u_{S2}
R_1
R_5
R_4
1

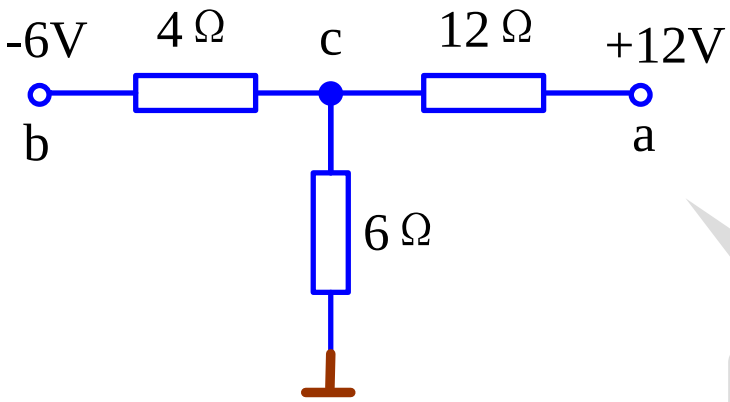

20 Ω
1
50 Ω
40V
30 Ω
2A
0


R_5
u_S
①
R_3
③
i_{S1}
ri
u_3
R_1
R_2
R_4
gu_3
i
②

电子线路的习惯表示方法



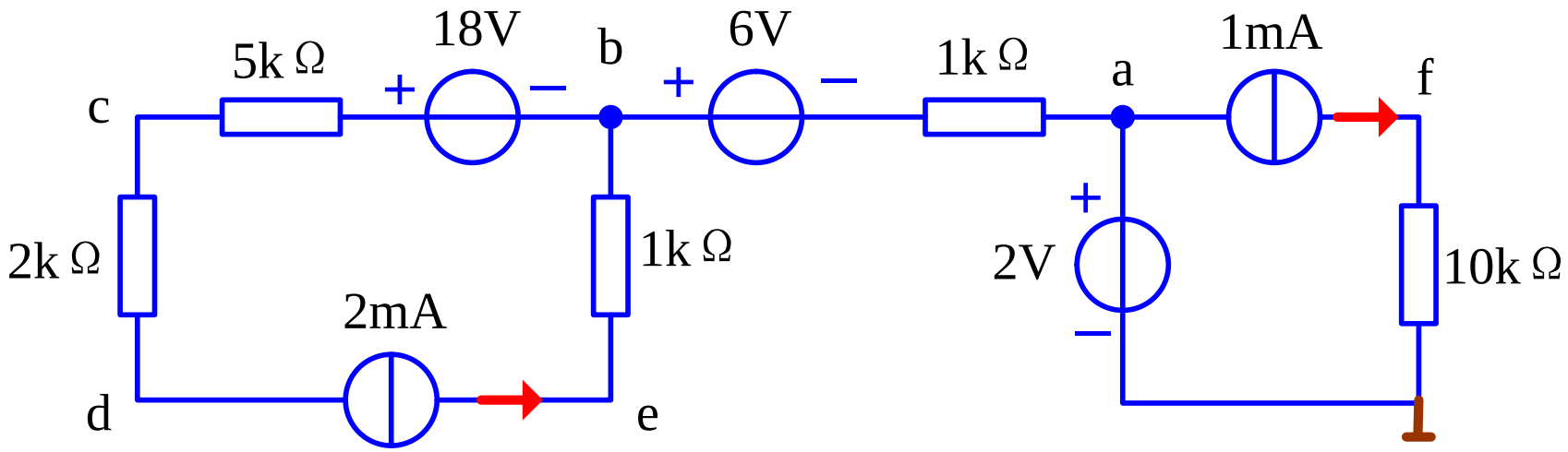
一般性电路



电子习惯线路

【题1】 求：（1）a、b、c、d、e各点电位；

（2）2mA电流源的输出功率。



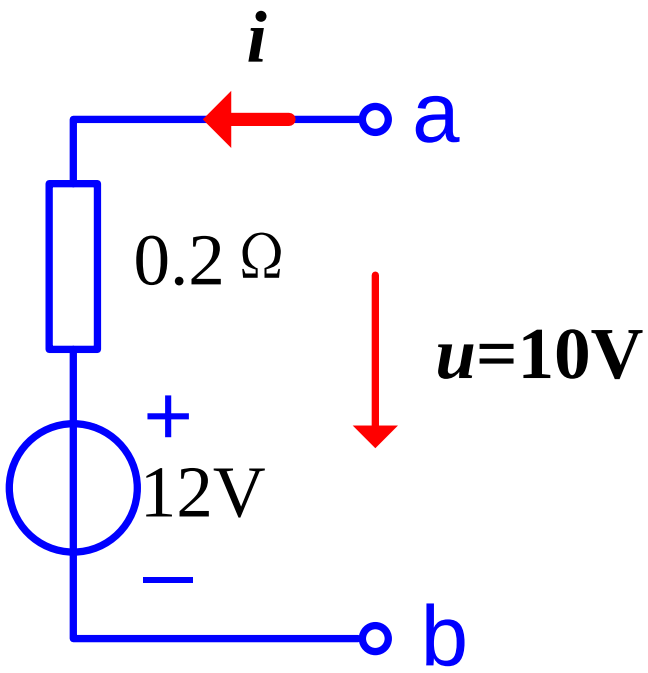
$$u_a = 2\text{V}, u_b = u_a + 6 = 8\text{V}\ , u_c = u_b + 18 - 5\times 2 = 16\text{V}$$

$$, u_d = u_c - 2\times 2 = 12\text{V}\ \ , u_e = u_b + 1\times 2 = 10\text{V}$$

$p_{2mA发} = (u_e - u_d)\times 2 = -4(m\text{w})$， 实际上吸收4mw功率

【题2】

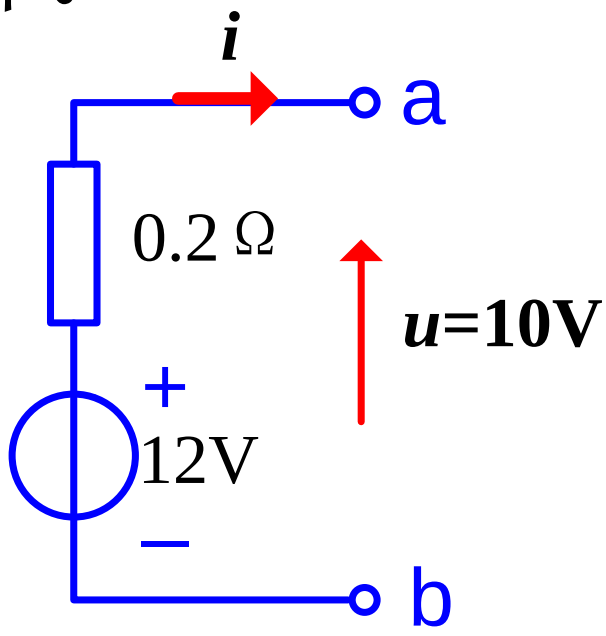
求支路a、b的输入功率并判断吸收功率还是发出功率。



$$i=\frac{u-12}{0.2}=-10\text{A}$$

$$p_{\text{吸}}=u\times i=-100(\text{w})$$

实际上发出100mw功率

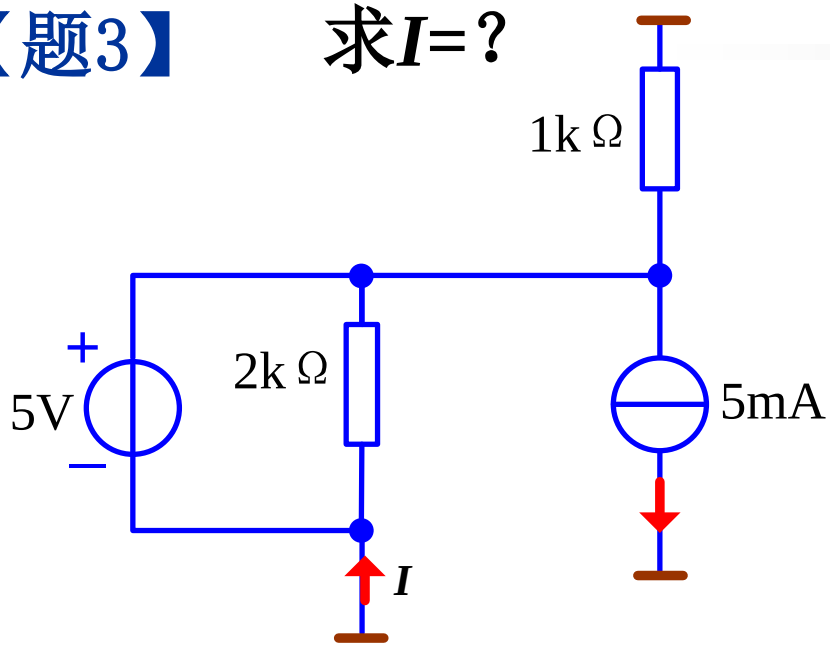


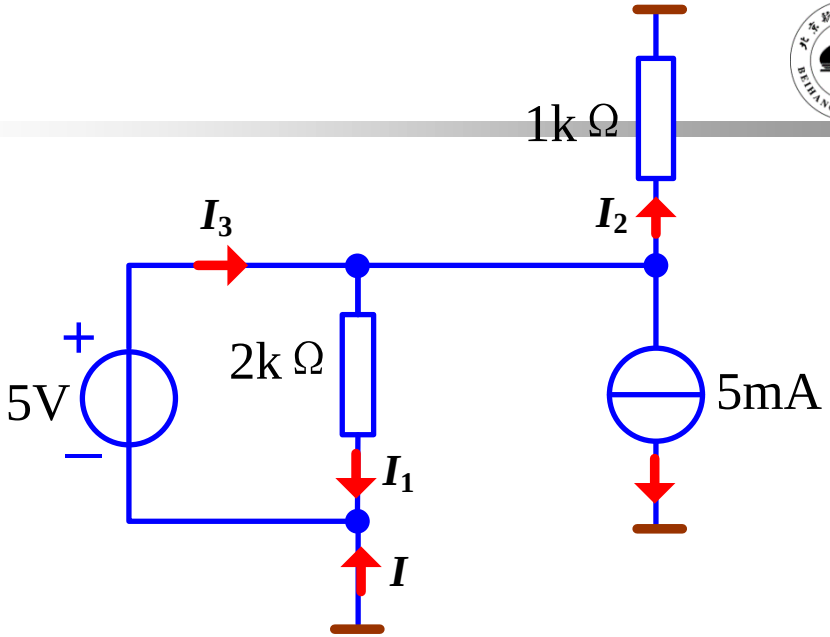
$$i=\frac{12+u}{0.2}=110\text{A}$$

$$p_{\text{吸}}=u\times i=1100(\text{w})$$

实际吸收1100mw功率

【题3】 求I=?

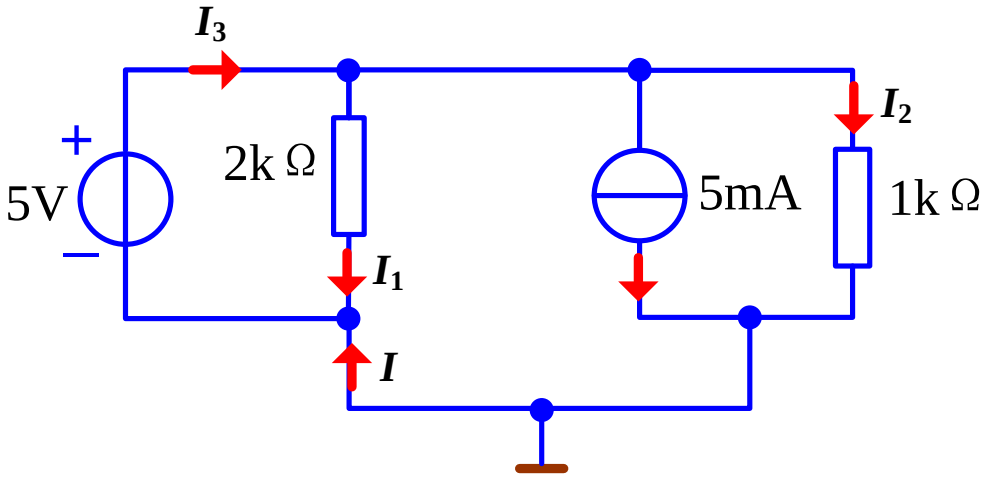




$$I_1=\frac{5}{2}=2.5mA, I_2=\frac{5}{1}=5mA$$

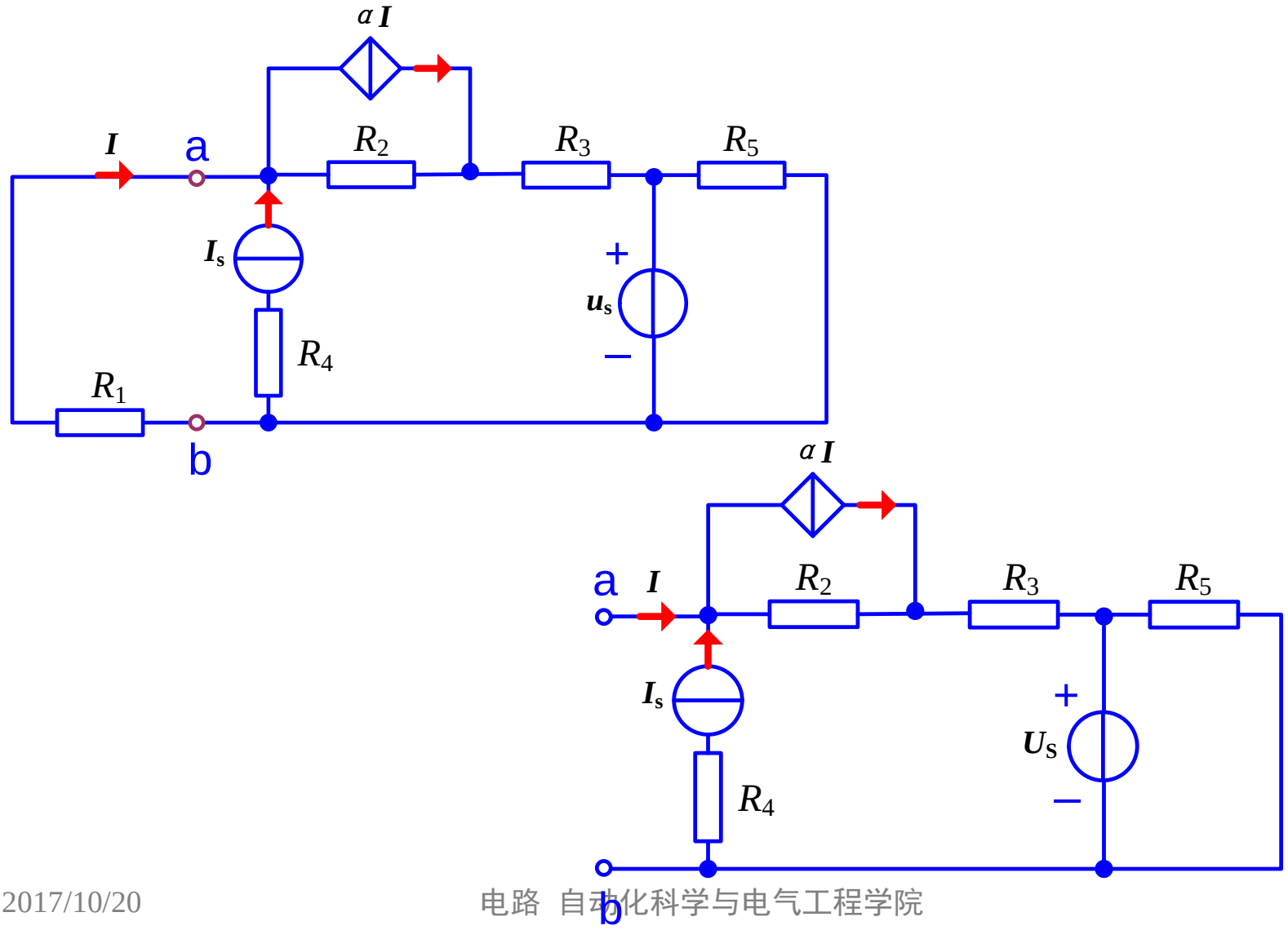
$$I_3=I_1+I_2+5=12.5mA,$$

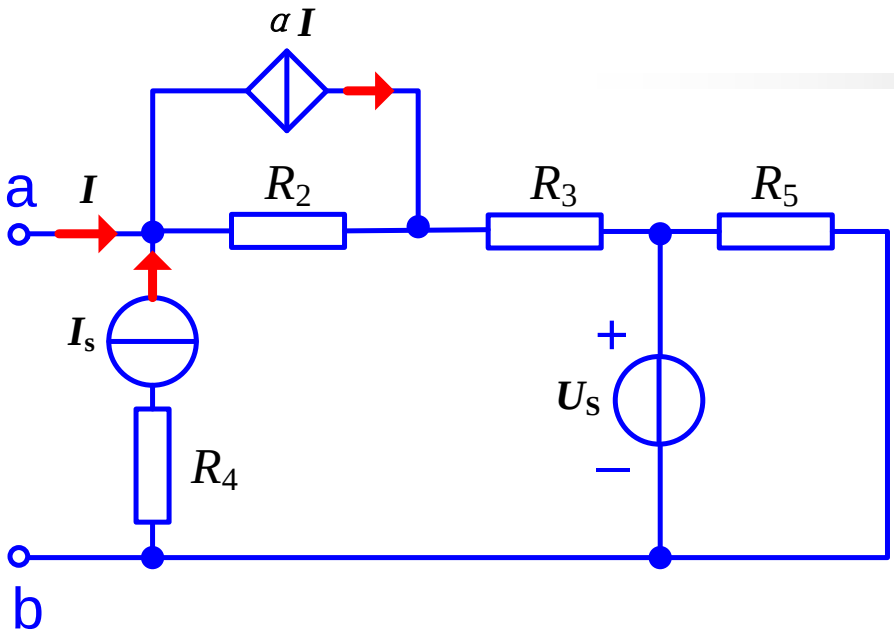
$$I=I_3-I_1=10mA$$

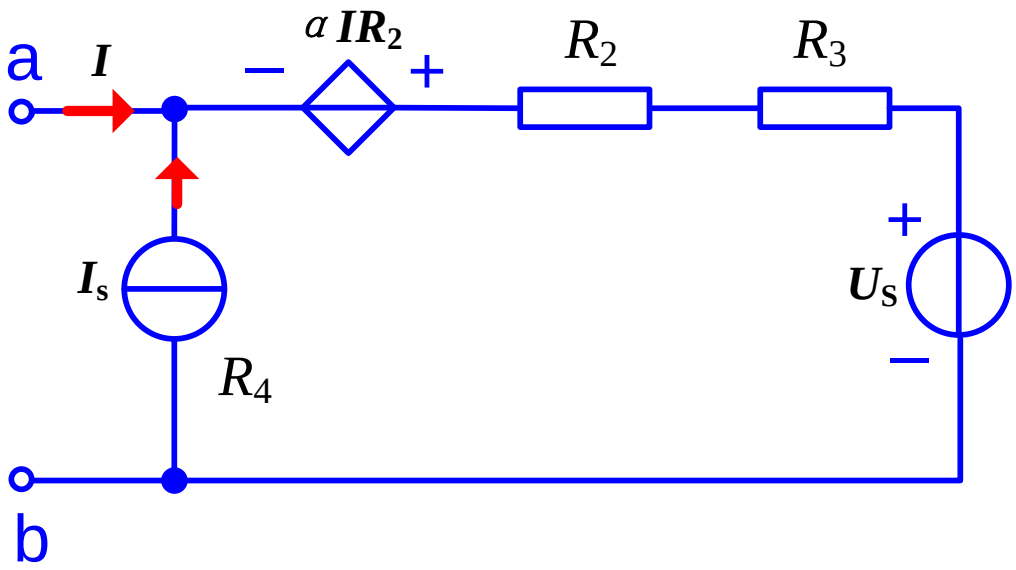


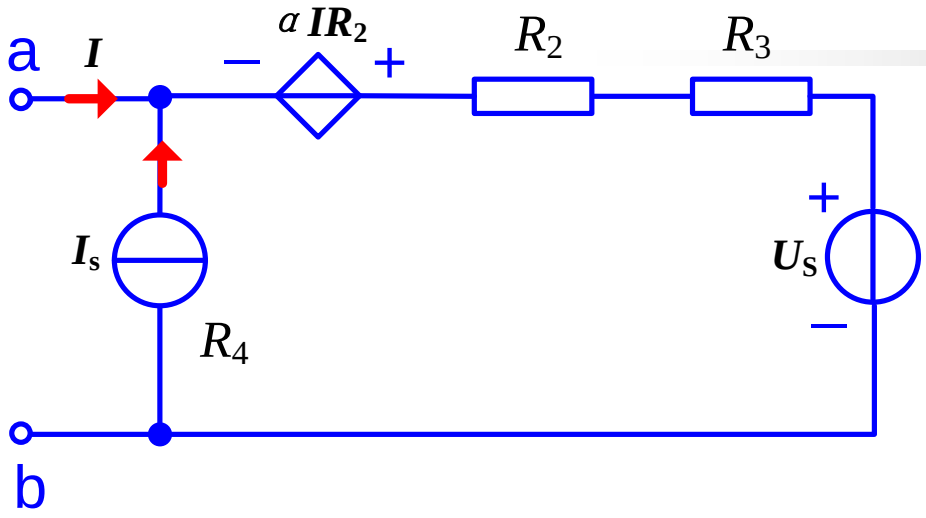
$$I=5+I_2=10mA$$

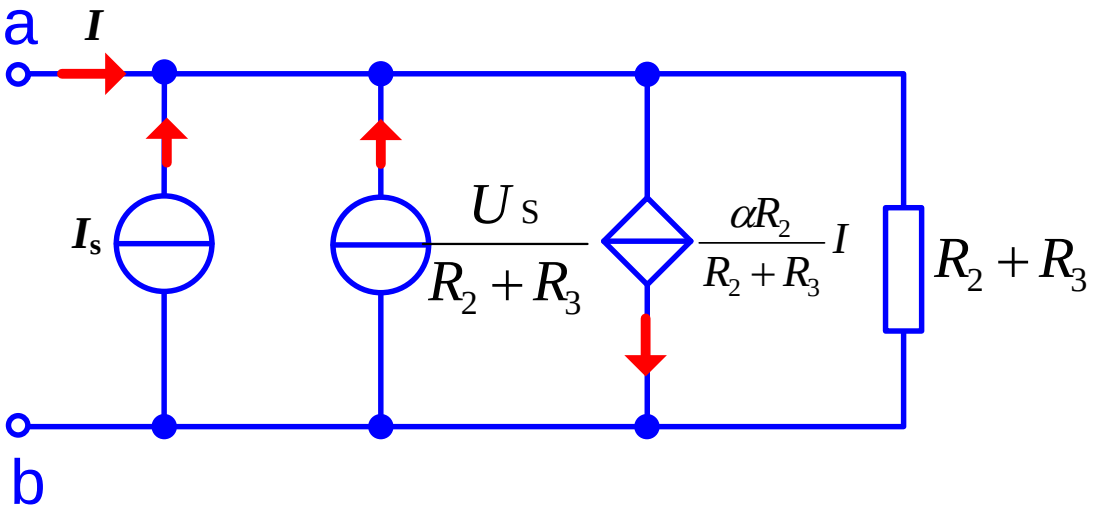
【题4】 将电路化成能求*I*的最简形式（用等效变换的方法）。

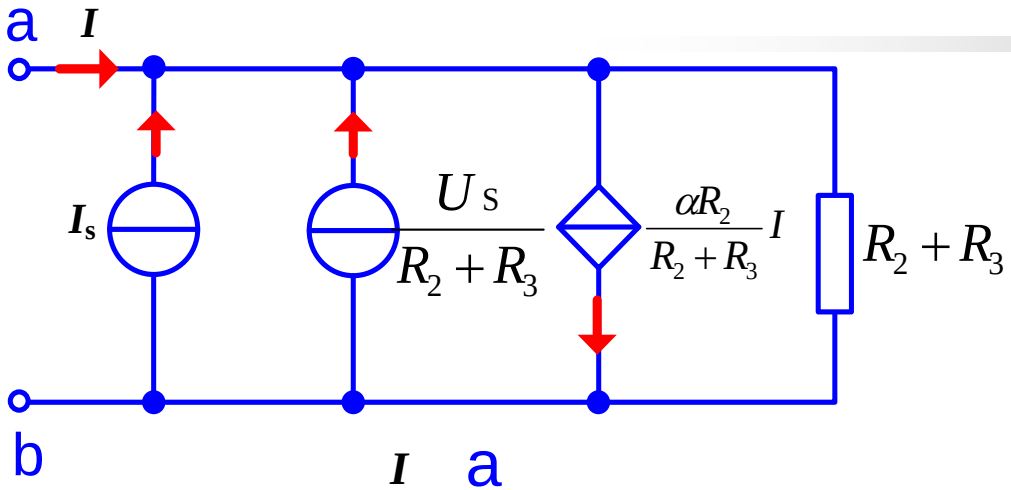


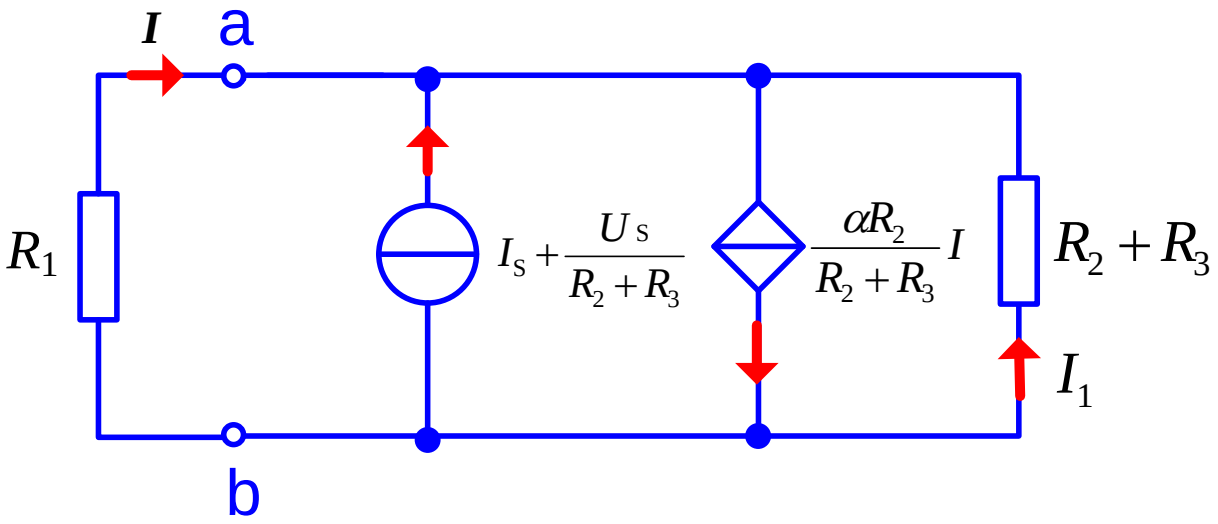

αI
a
I
R2
R3
R5
Is
+
US
−
R4
b


a
I
αIR2
−
+
R2
R3
Is
+
US
−
R4
b


a
I
αIR2
R2
R3
Is
R4
Us
b

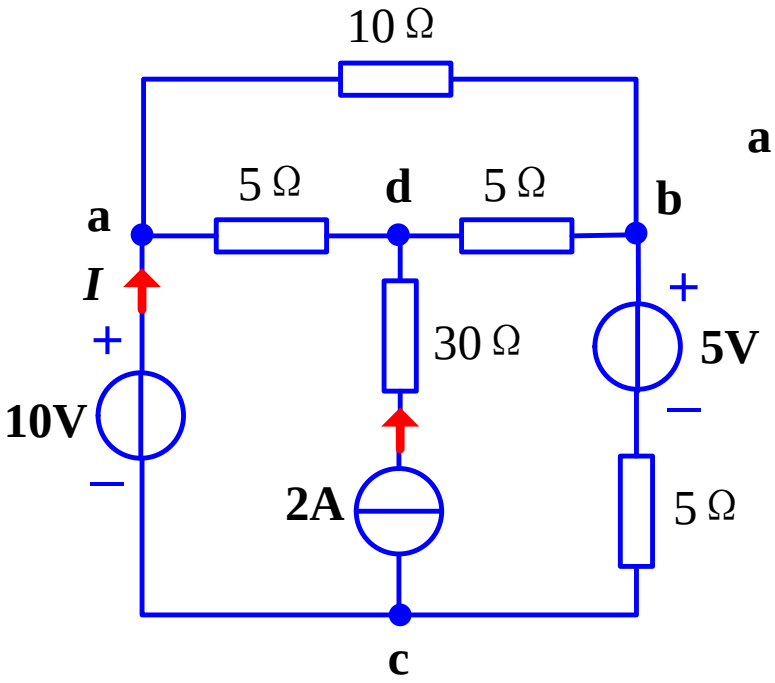

a
I
Is
Us / (R2 + R3)
αR2 / (R2 + R3) I
R2 + R3
b

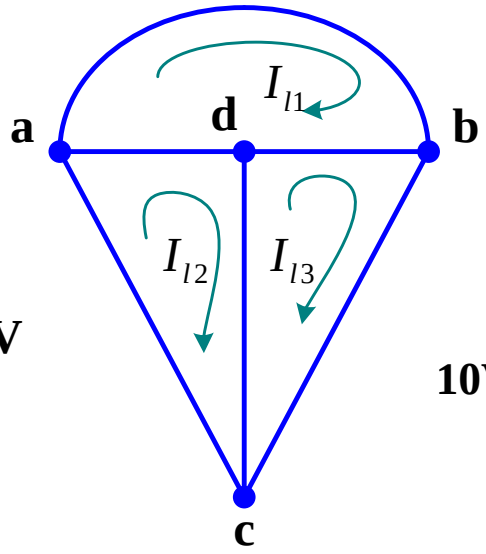


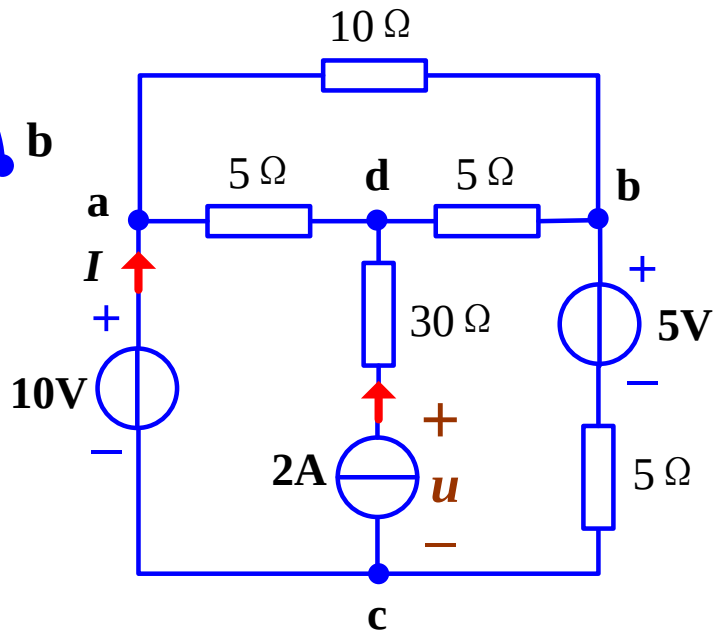


$$I+I_S+\frac{U_S}{R_2+R_3}-\frac{\alpha R_2}{R_2+R_3}I+\frac{R_1}{R_2+R_3}I=0$$

【题5】 用回路法求u_{ab} 、I。







$$\begin{cases} 20I_{l1}-5I_{l2}-5I_{l3}=0 \\ -5I_{l1}+35I_{l2}-30I_{l3}=10-u \\ -5I_{l1}-30I_{l2}+40I_{l3}=-5+u \\ -I_{l2}+I_{l3}=2 \end{cases}$$

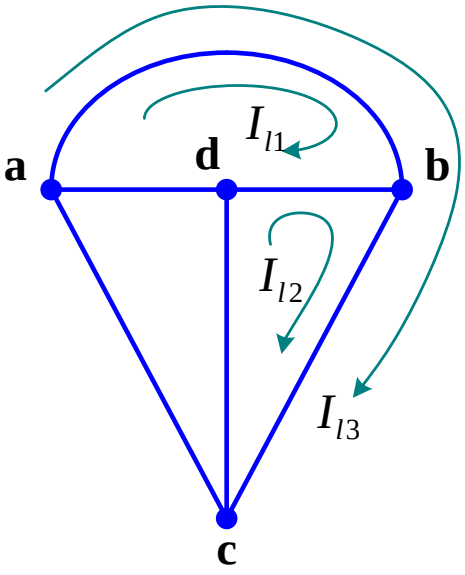
$$I_{l1}=0,$$

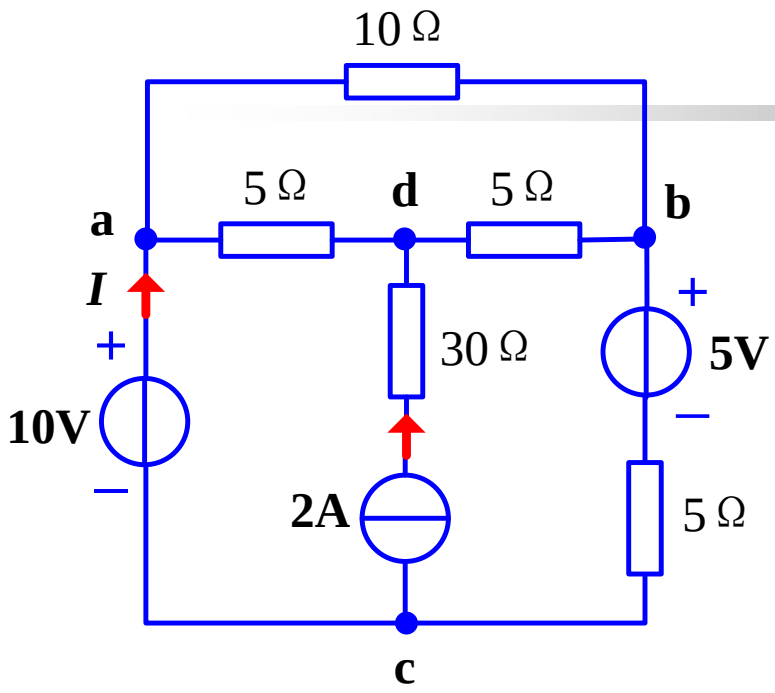
$$I_{l2}=-1\text{A},$$

$$I_{l3}=1\text{A}$$

$$\therefore I=I_{l2}=-1\text{A},$$

$$u_{ab}=10\times I_{l1}=0$$





$$\begin{cases} 20I_{l1}-5I_{l2}+10I_{l3}=0 \\ I_{l2}=2 \\ 10I_{l1}+5I_{l2}+15I_{l3}=-5+10 \end{cases}$$

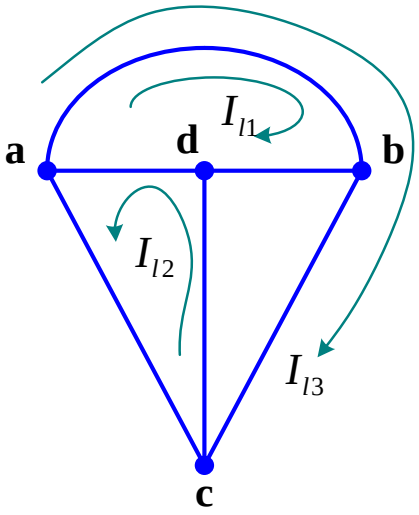
$$I_{l1}=1\text{A},$$

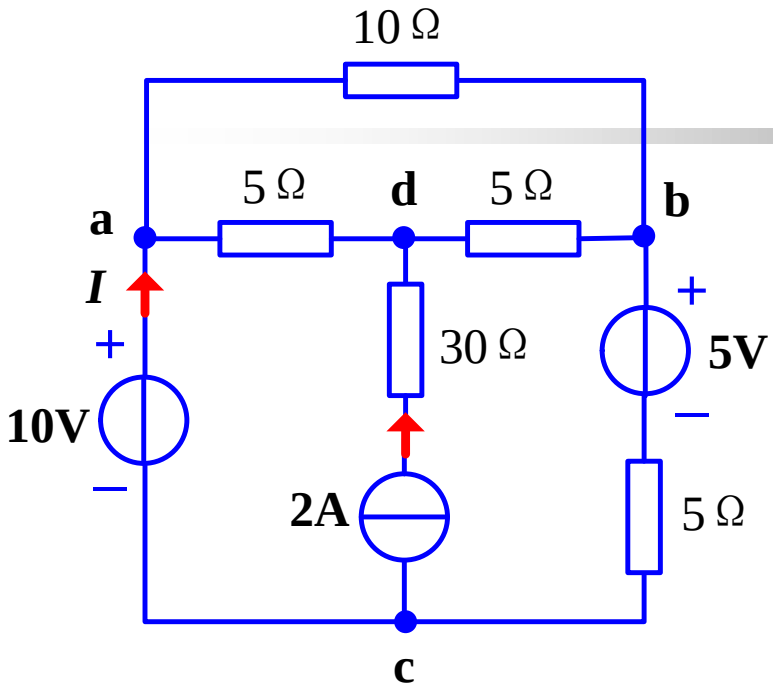
$$I_{l2}=2\text{A},$$

$$I_{l3}=-1\text{A}$$

$$\therefore I=I_{l3}=-1\text{A},$$

$$u_{ab}=10\times(I_{l1}+I_{l3})=0$$





$$\begin{cases} 20I_{l1}+5I_{l2}+10I_{l3}=0 \\ I_{l2}=2 \\ 10I_{l1}+15I_{l3}=-5+10 \end{cases}$$

$$I_{l1}=-1\text{A},$$

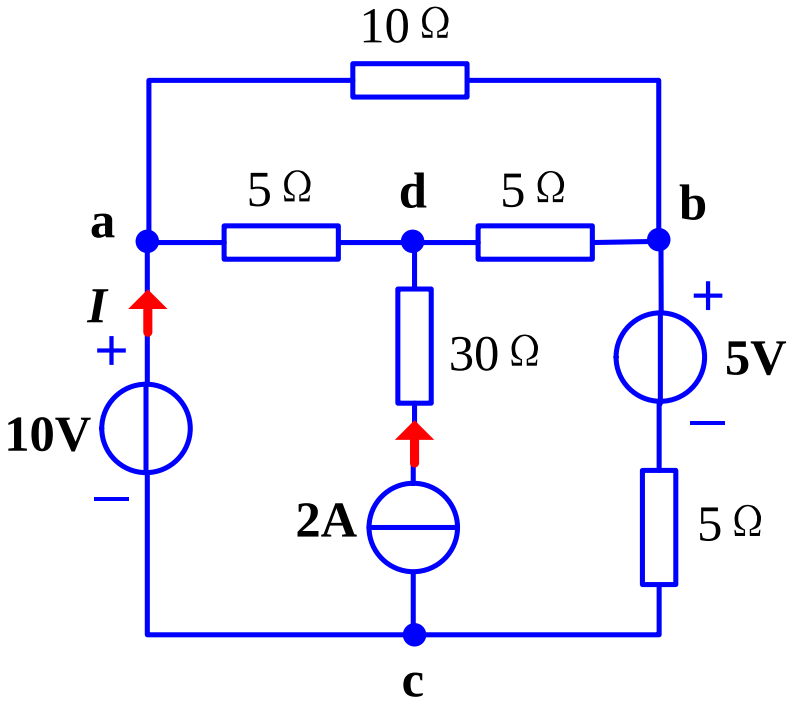
$$I_{l2}=2\text{A},$$

$$I_{l3}=1\text{A}$$

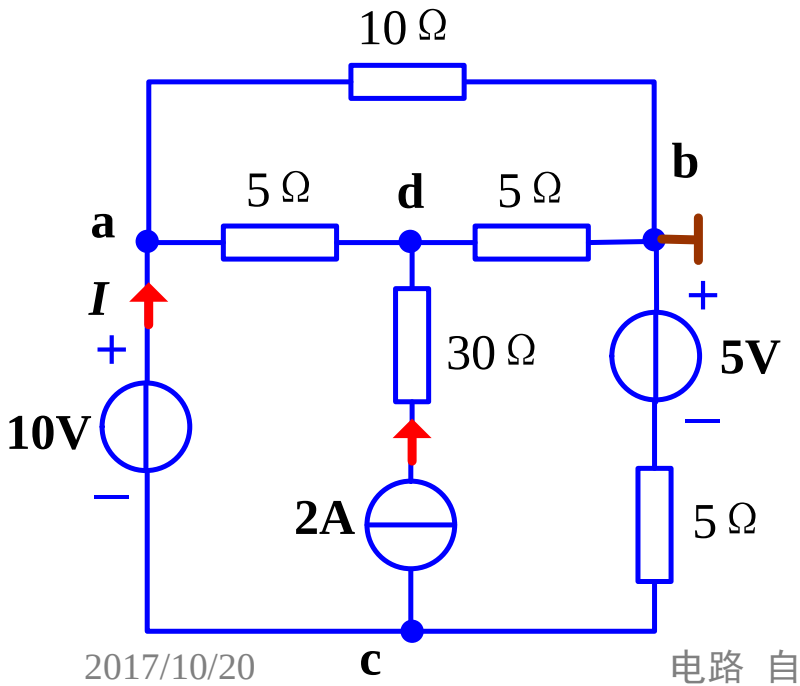
$$\therefore I=I_{l3}-I_{l2}=-1\text{A},$$

$$u_{ab}=10\times(I_{l1}+I_{l3})=0$$

用结点法求 u_{ab}、I。



$$\begin{cases} (\frac{1}{5}+\frac{1}{10})u_a-\frac{1}{5}u_d=I \\ (\frac{1}{5}+\frac{1}{5})u_d-\frac{1}{5}u_a=2 \\ \frac{1}{5}u_c=-2-I-\frac{5}{5} \\ u_a-u_c=10 \end{cases}$$

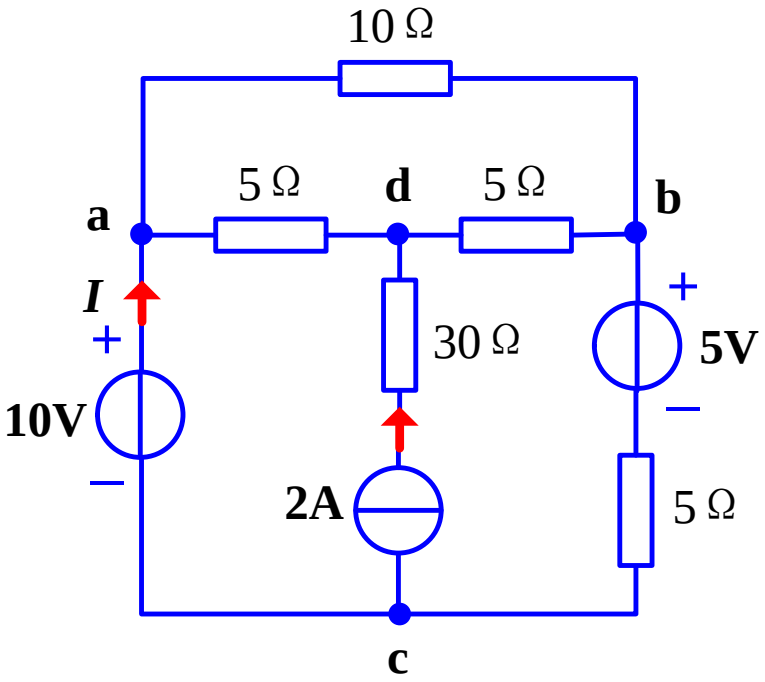


$$I=-1\text{A},$$

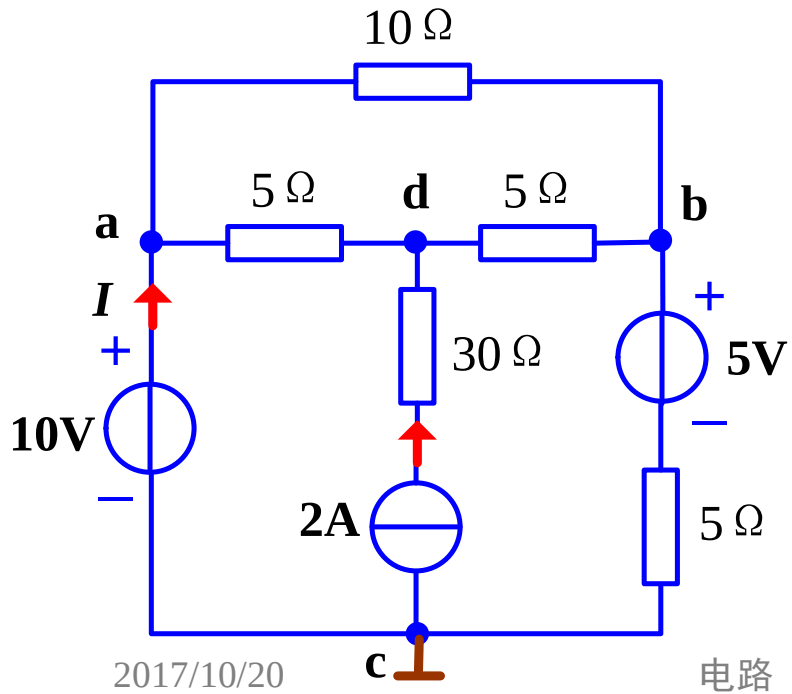
$$u_a=0$$

$$\therefore u_{ab}=0$$

用结点法求 u_{ab} 、I。



$$\begin{cases} u_a = 10 \\ (\frac{1}{5}+\frac{1}{5})u_d - \frac{1}{5}u_a - \frac{1}{5}u_b = 2 \\ (\frac{1}{10}+\frac{1}{5}+\frac{1}{5})u_b - \frac{1}{5}u_d - \frac{1}{10}u_a = 1 \end{cases}$$



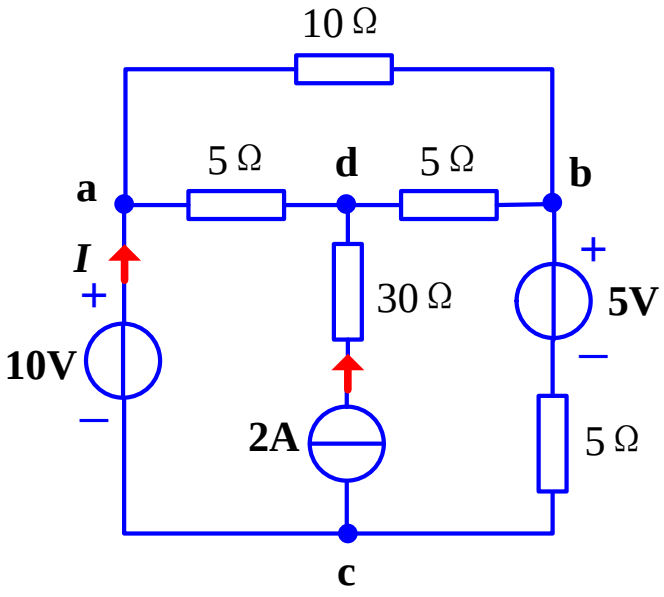
$$u_a = 10\text{V}, u_b = 10\text{V}$$

$$u_d = 15\text{V}$$

$$\therefore u_{ab} = 0$$

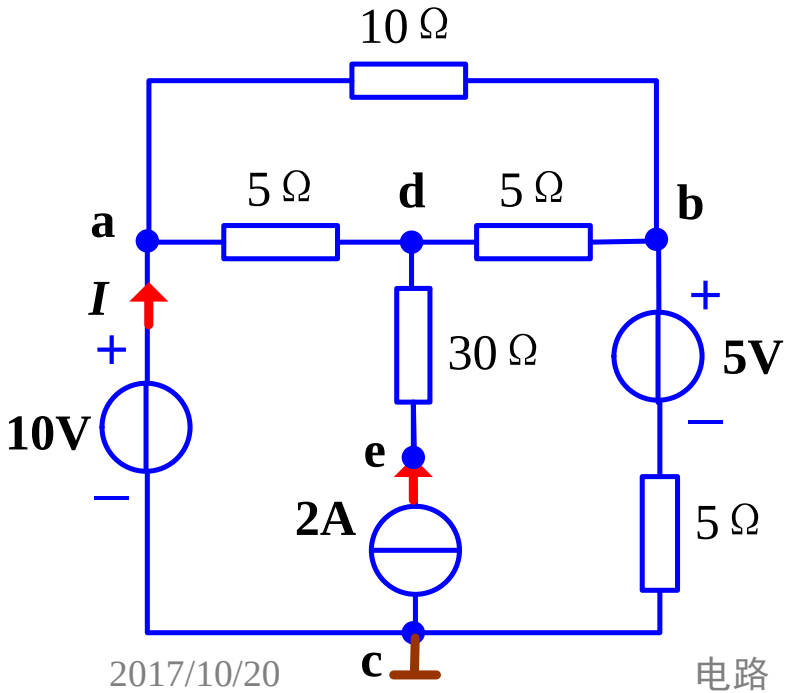
$$I = \frac{u_{ab}}{10} + \frac{u_a - u_d}{5} = -1\text{A}$$

用结点法求 u_{ab}、I。



增设结点在e处

$$\begin{cases} u_a = 10 \\ (\frac{1}{5}+\frac{1}{5}+\frac{1}{30})u_d - \frac{1}{5}u_a - \frac{1}{5}u_b - \frac{1}{30}u_e = 0 \\ (\frac{1}{10}+\frac{1}{5}+\frac{1}{5})u_b - \frac{1}{5}u_d - \frac{1}{10}u_a = 1 \\ \frac{1}{30}u_e - \frac{1}{30}u_d = 2 \end{cases}$$



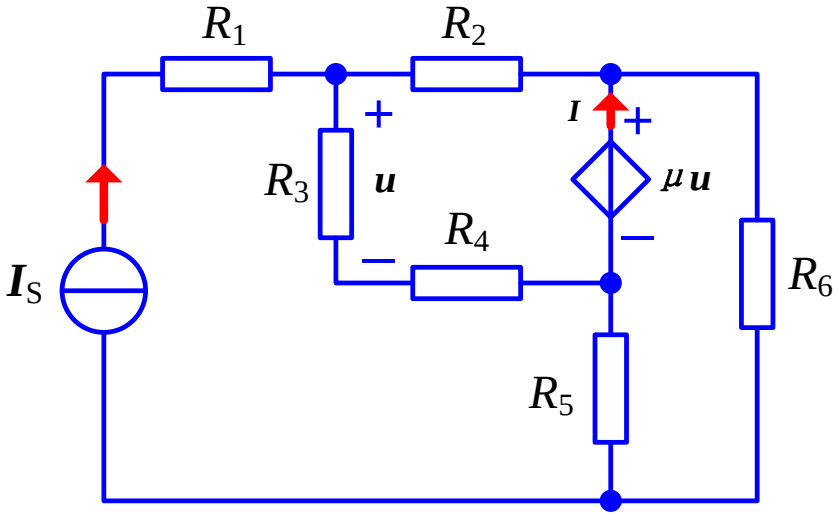
$$u_a = 10\text{V}, u_b = 10\text{V}$$

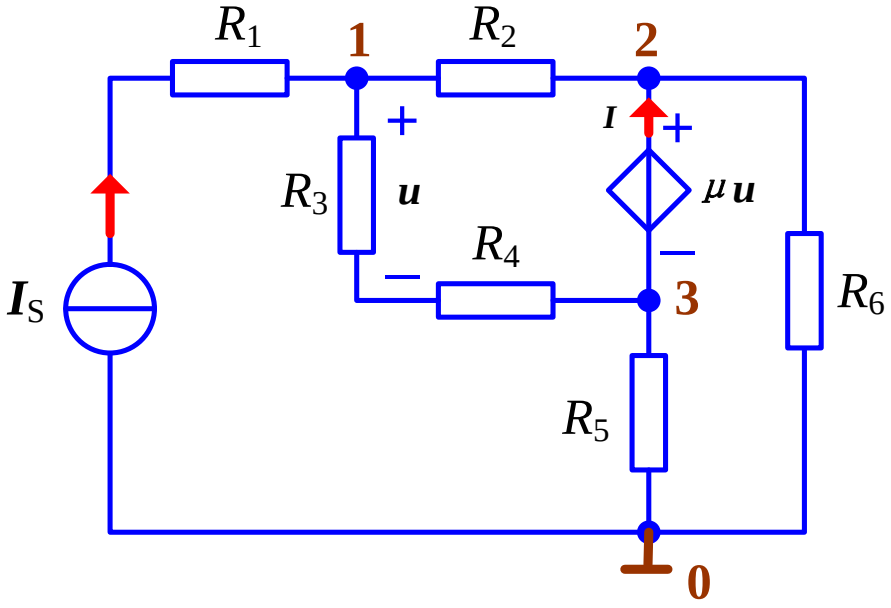
$$u_d = 15\text{V}, u_e = 75\text{V}$$

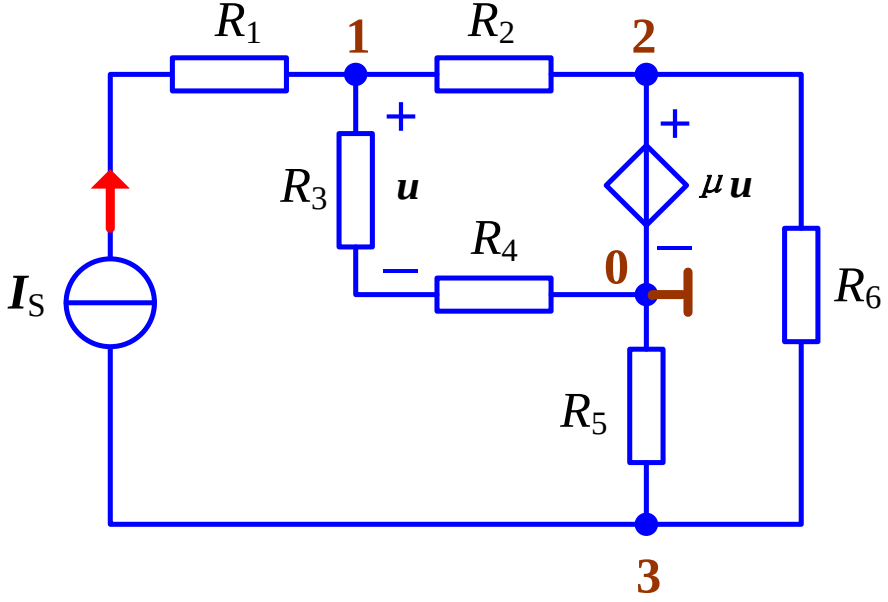
$$\therefore u_{ab} = 0$$

$$I = \frac{u_{ab}}{10} + \frac{u_a - u_d}{5} = -1\text{A}$$

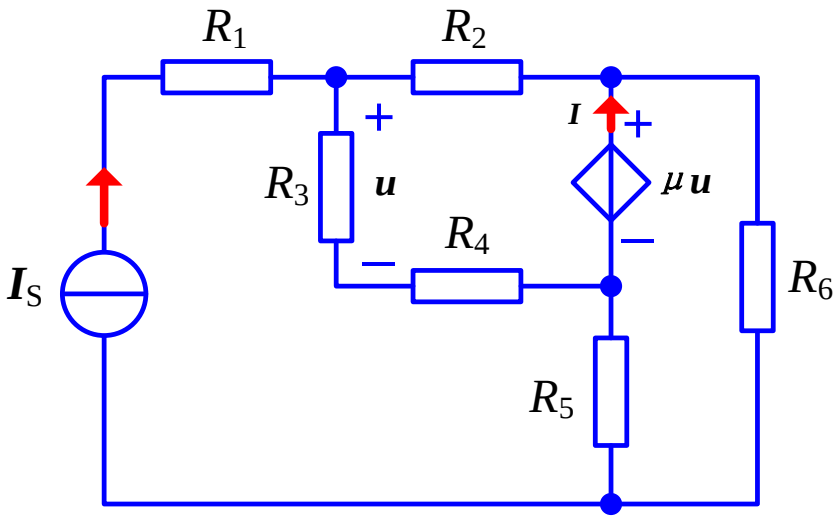
【题6】 用结点法求u=?

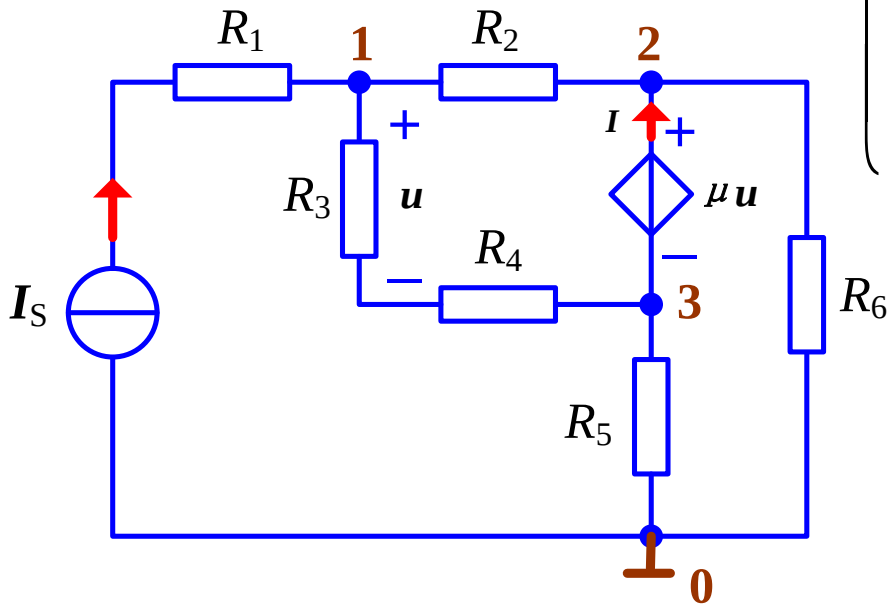

R1
R2
R3
u
I
μu
R4
IS
R6
R5


R1
1
R2
2
R3
u
I
μu
R4
3
IS
R6
R5
0


R1
1
R2
2
R3
u
μu
R4
0
IS
R6
R5
3

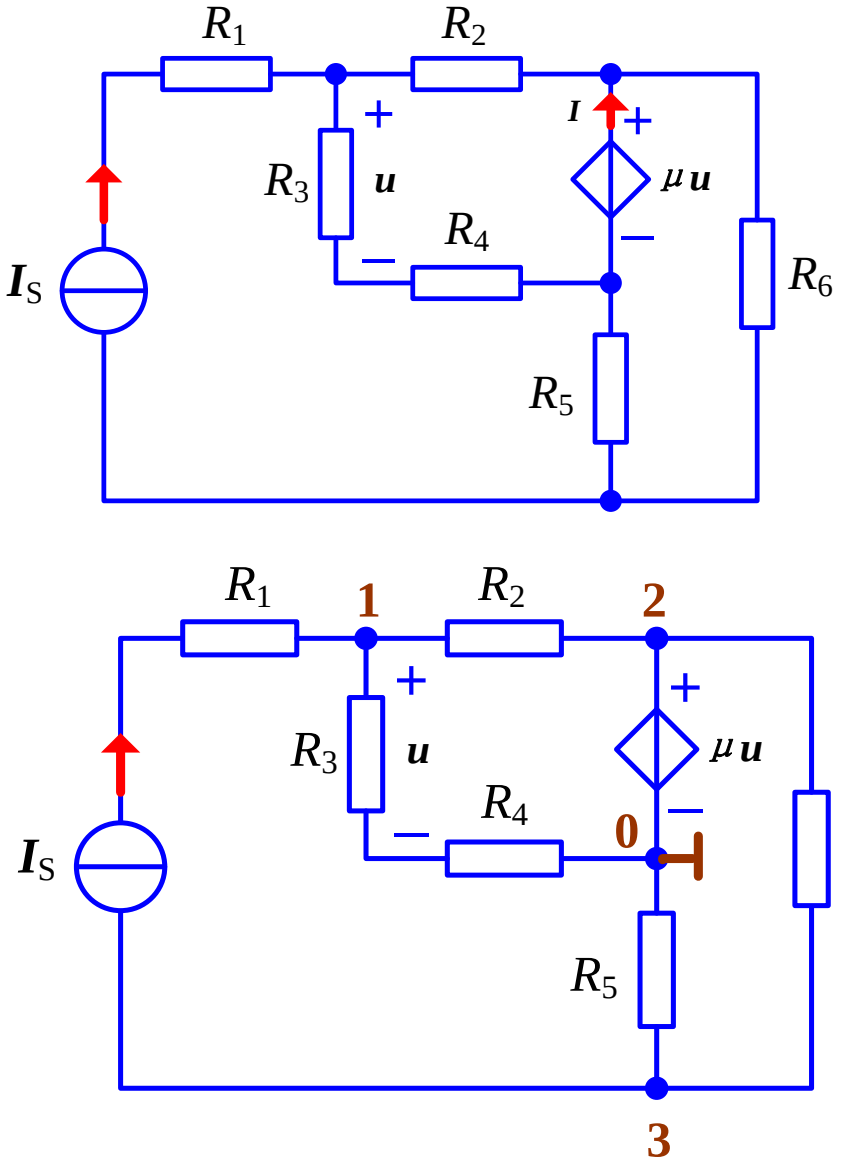
【题6】 用结点法求u=?





$$\begin{cases} (\dfrac{1}{R_2}+\dfrac{1}{R_3+R_4})u_{n1}-\dfrac{1}{R_2}u_{n2}-\dfrac{1}{R_3+R_4}u_{n3}=I_S \\ (\dfrac{1}{R_2}+\dfrac{1}{R_6})u_{n2}-\dfrac{1}{R_2}u_{n1}=I \\ (\dfrac{1}{R_5}+\dfrac{1}{R_3+R_4})u_{n3}-\dfrac{1}{R_3+R_4}u_{n1}=-I \\ u_{n2}-u_{n3}=\mu u \\ u=\dfrac{u_{n1}-u_{n3}}{R_3+R_4}\times R_3 \end{cases}$$

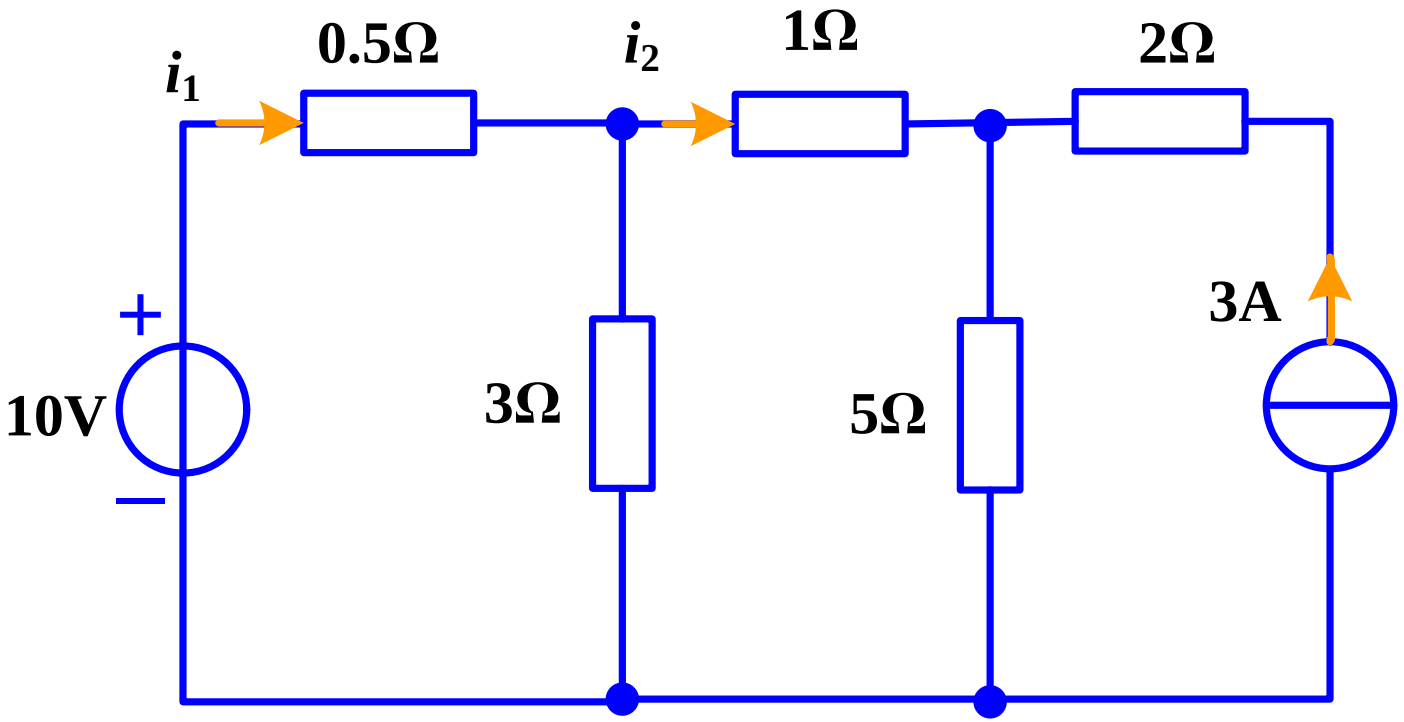
【题6】 用结点法求u=?



$$\begin{cases} \left(\frac{1}{R_2}+\frac{1}{R_3+R_4}\right)u_{n1}-\frac{1}{R_2}u_{n2}=I_S \\ u_{n2}=\mu u=\mu\frac{u_{n1}}{R_3+R_4}\times R_3 \\ \left(\frac{1}{R_5}+\frac{1}{R_6}\right)u_{n3}-\frac{1}{R_6}u_{n2}=-I_S \end{cases}$$

书面测试题：求图示电路中的电流 i_1和i_2

要求：学号尾号为单数的同学用回路法；
学号尾号为双数的同学用结点法。



作业

- 3-26　【多个无伴电压源】