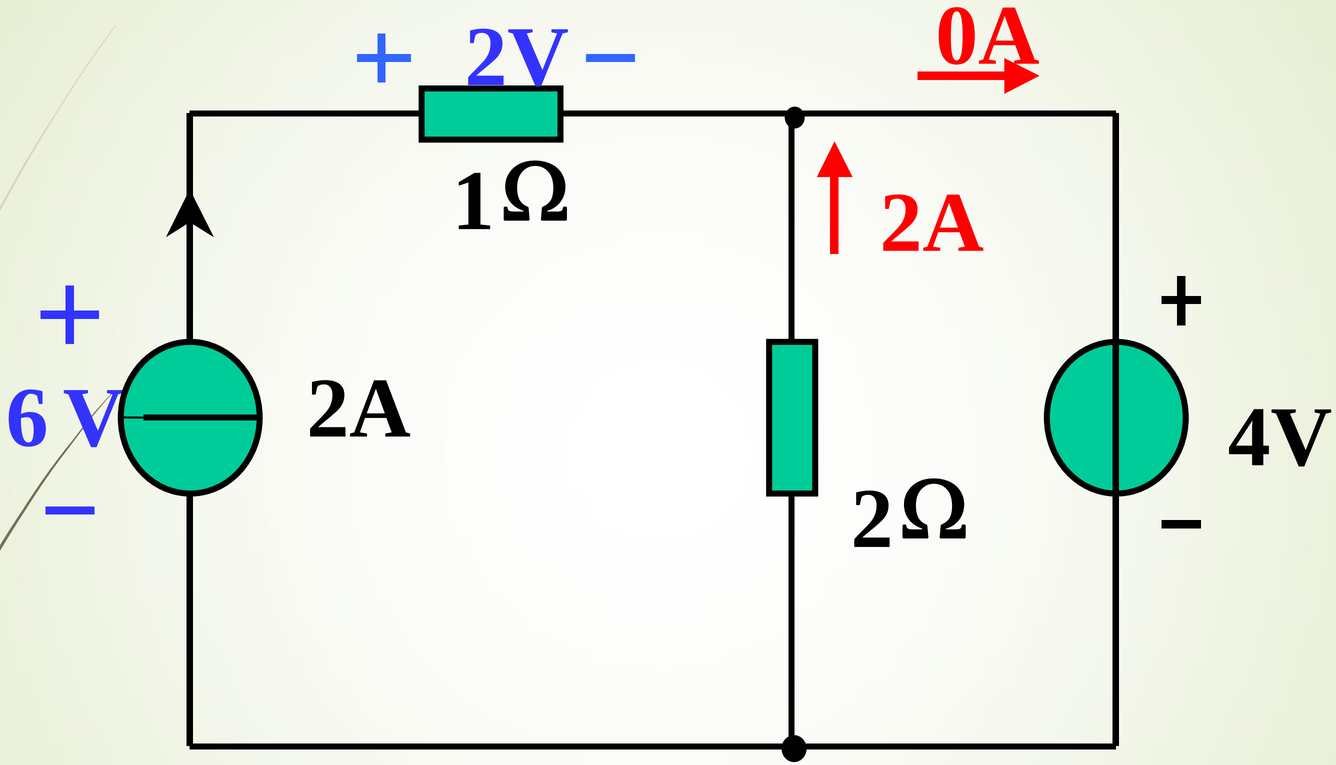
L19 总复习 -part1

L19 Review – part1

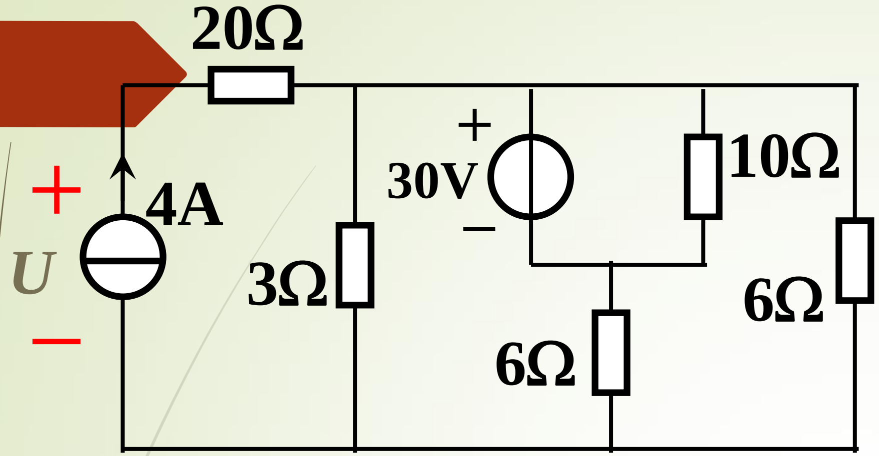
1. 求电源的功率。

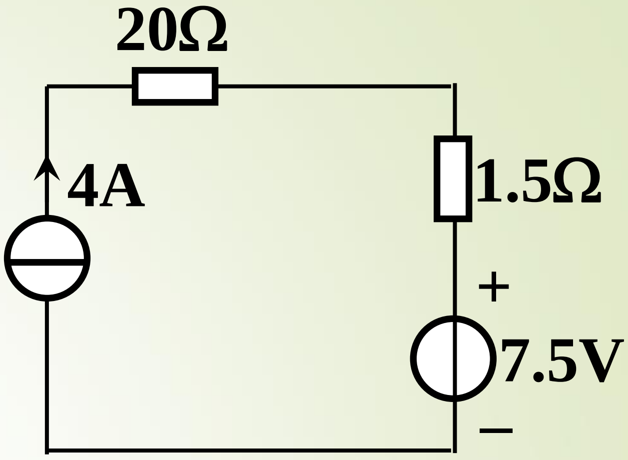


$P_{if} = 2 \times 6 = 12W$ （发出12W）

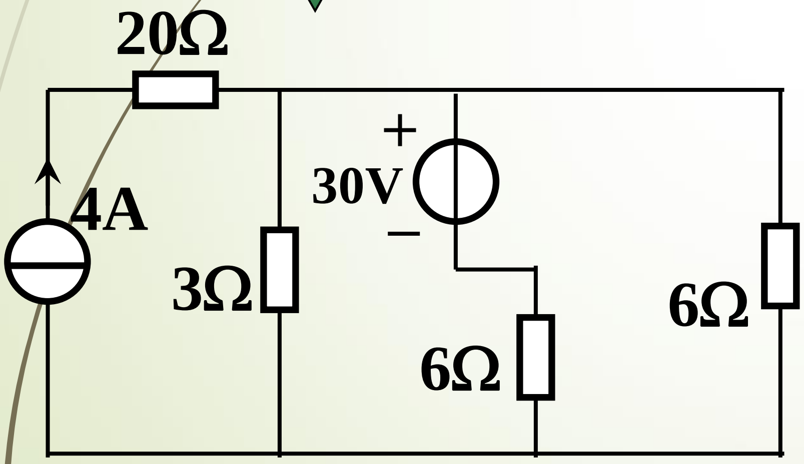
$P_{uf} = 4 \times 0 = 0W$ （吸收0W）

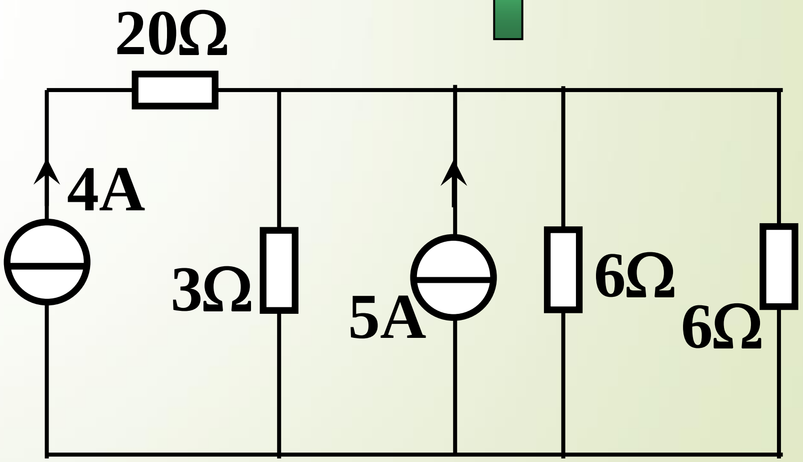
2. 求每个电源发出的功率.



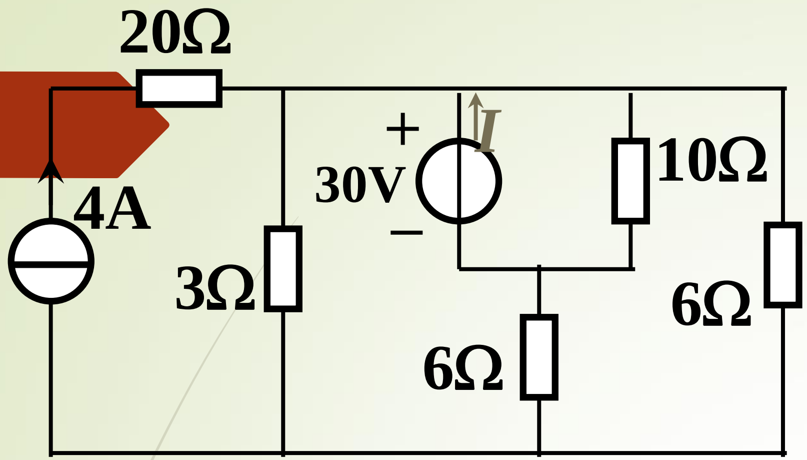


$$U = 4\times(20+1.5)+7.5 = 93.5\ \text{V}$$



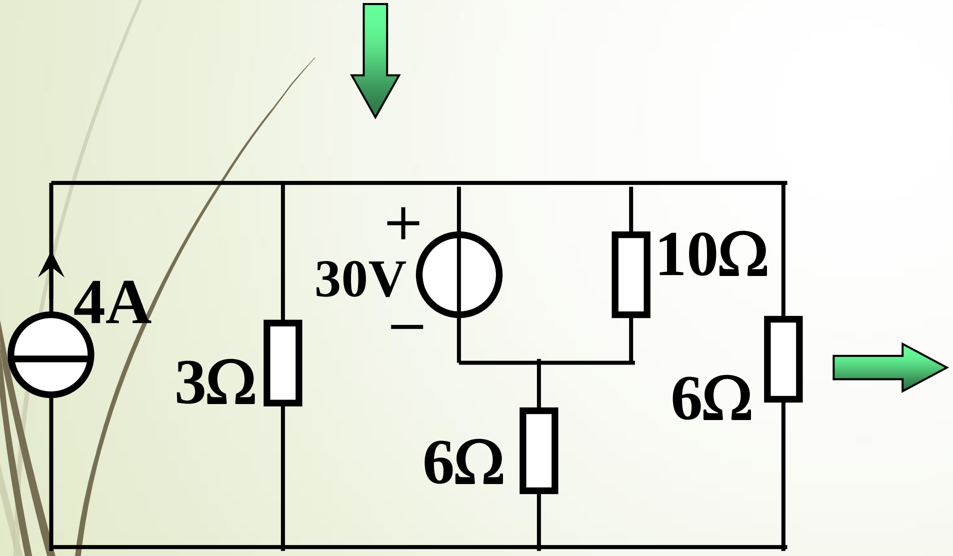


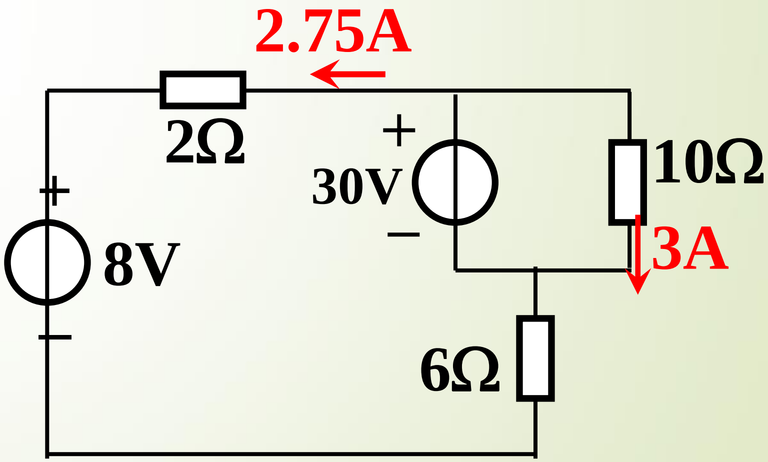
$$P_{i发} = 93.5\times 4 = 374\ \text{W}$$

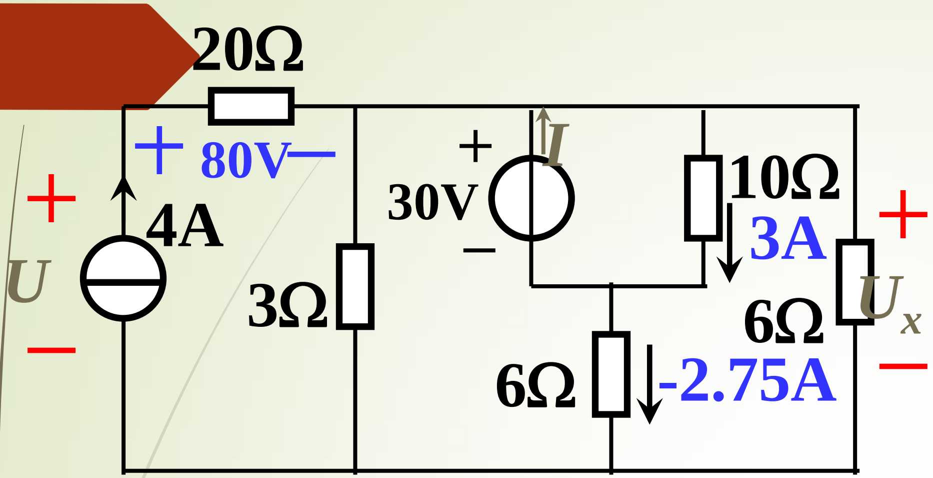


$$I = 3 + 2.75 = 5.75\ \text{A}$$

$$P_{u发} = 5.75 \times 30 = 172.5\ \text{W}$$





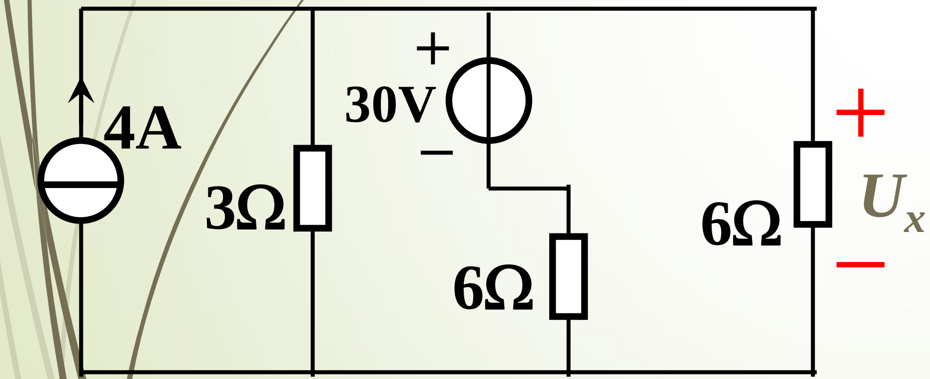


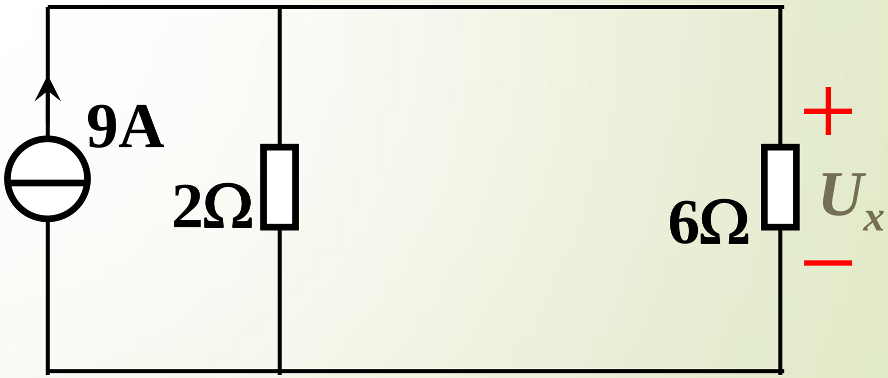
$$U = 80 + 13.5 = 93.5\ \text{V}$$

$$P_{i\text{发}} = 93.5\times 4 = 374\ \text{W}$$

$$I = 3-(-2.75) = 5.75\ \text{A}$$

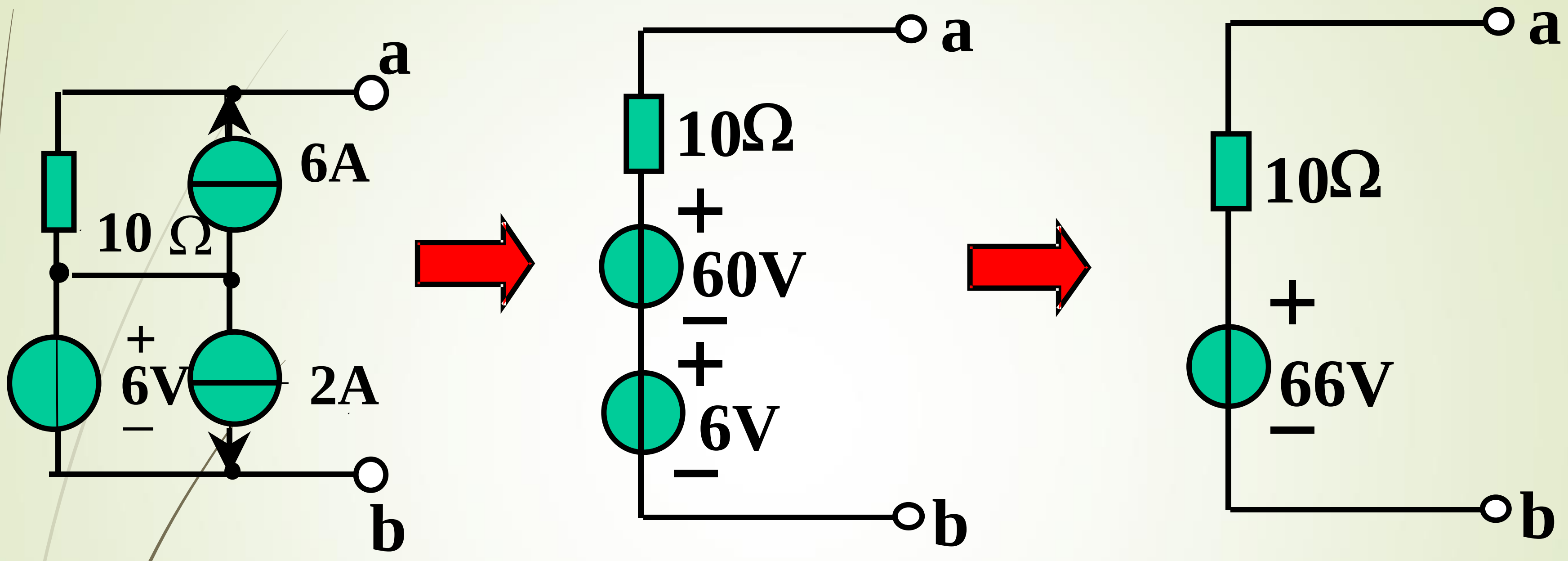
$$P_{u\text{发}} = 5.75\times 30 = 172.5\ \text{W}$$



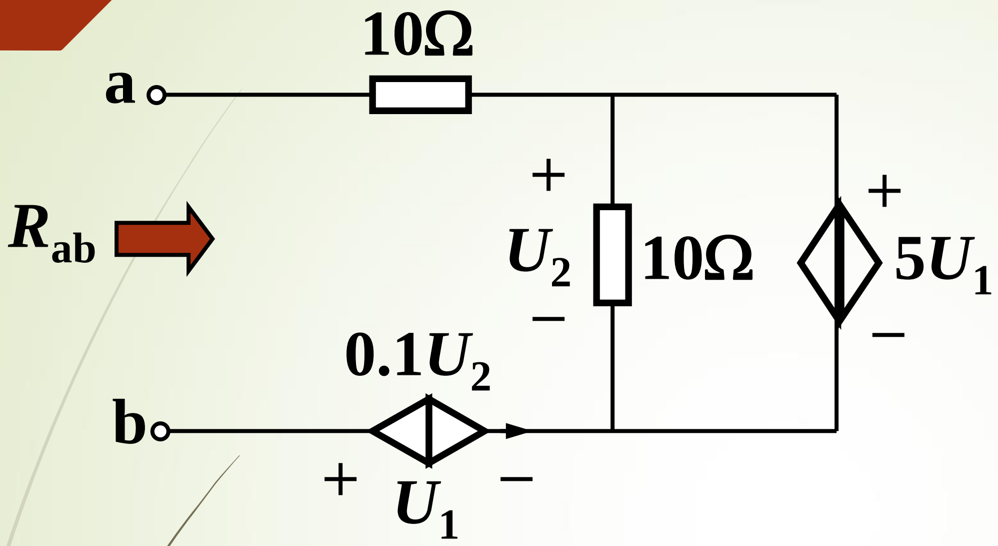


$$U_x = 9\times\frac{2\times 6}{2+6} = 13.5\ \text{V}$$

3、电源的等效变换

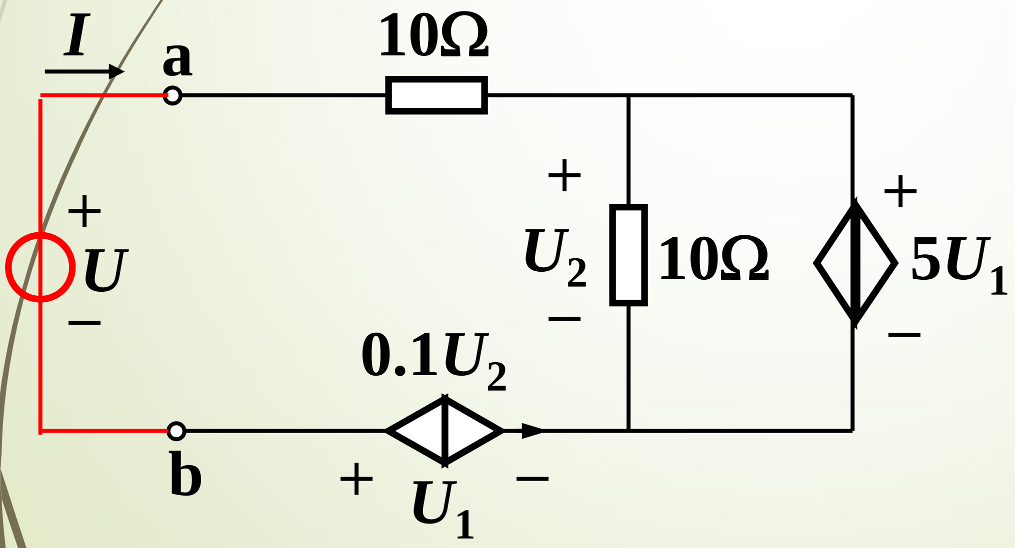


4. 求输入电阻 R_{ab} .



解：加压求流

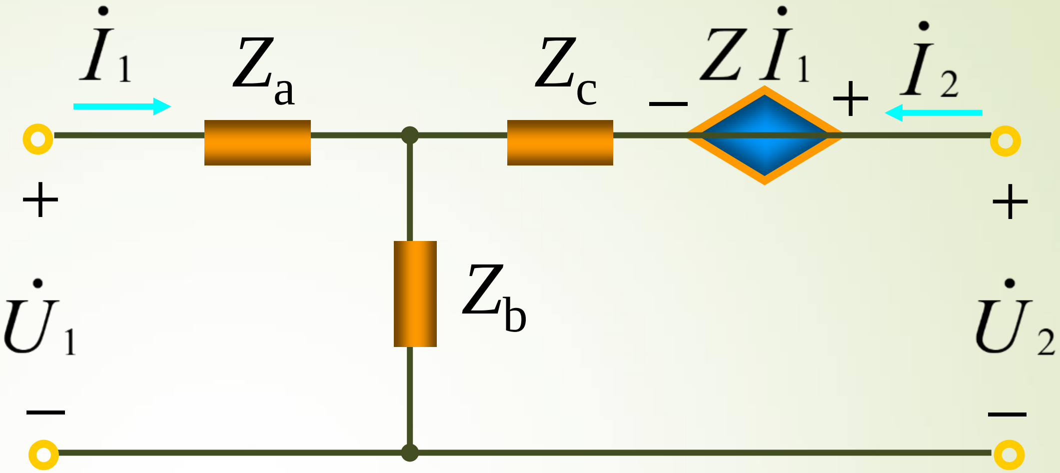
$$\begin{cases} U_2 = 5U_1 \\ U = 10I + U_2 - U_1 \\ I = -0.1U_2 \end{cases}$$



U_1=0.1U_2?

$$\begin{cases} U_2=-10I \\ U_1=-2I \\ U=10I+U_2-U_1 \\ \quad =10I-10I+2I \\ \quad =2I \\ R_{ab}= U/I = 2\Omega \end{cases}$$

5、 求图示两端口的Z参数。



解

列KVL方程：

$$\dot{U}_1 = Z_a\dot{I}_1 + Z_b(\dot{I}_1 + \dot{I}_2) = (Z_a + Z_b)\dot{I}_1 + Z_b\dot{I}_2$$

$$\dot{U}_2 = Z_c\dot{I}_2 + Z_b(\dot{I}_1 + \dot{I}_2) + Z\dot{I}_1$$

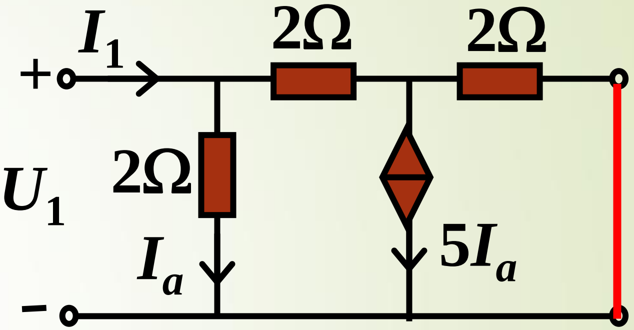
$$= (Z_b + Z)\dot{I}_1 + (Z_b + Z_c)\dot{I}_2$$

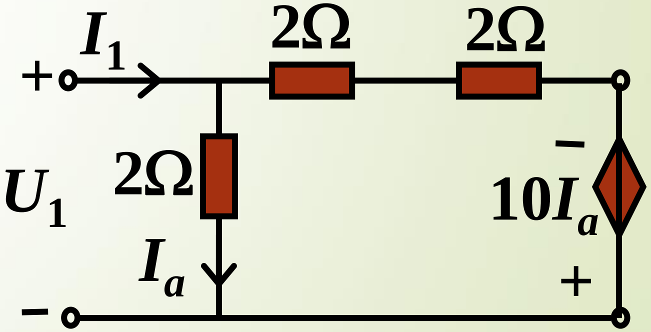
$$\rightarrow [Z] = \begin{bmatrix} Z_a + Z_b & Z_b \\ Z_b + Z & Z_b + Z_c \end{bmatrix}$$

6、 求图示二端口网络的 G 参数

法 1: 根据定义

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}=\begin{bmatrix} G_{11} & G_{12} \\ G_{21} & G_{22} \end{bmatrix}\begin{bmatrix} U_1 \\ U_2 \end{bmatrix}$$



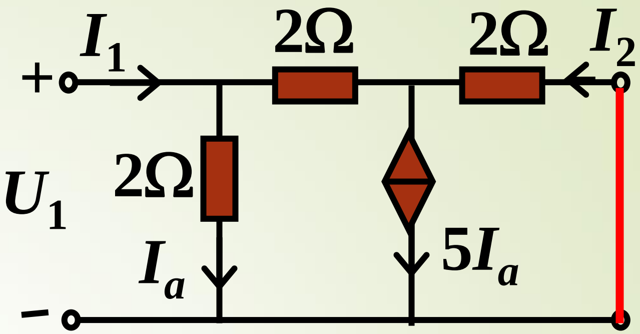


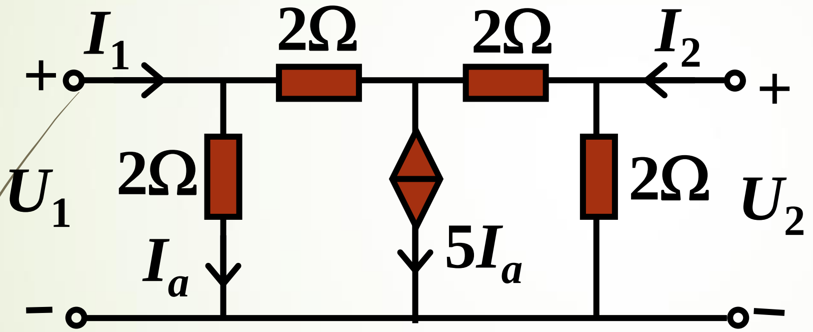
$$G_{11}=\frac{I_1}{U_1}\bigg|_{U_2=0}=\frac{\frac{U_1}{2}+\frac{U_1+10\frac{U_1}{2}}{4}}{U_1}=2\text{S}$$

$$G_{21} = \frac{I_2}{U_1}\bigg|_{U_2=0}$$

$$U_1 = 2(5\times\frac{U_1}{2} - I_2) - 2I_2$$

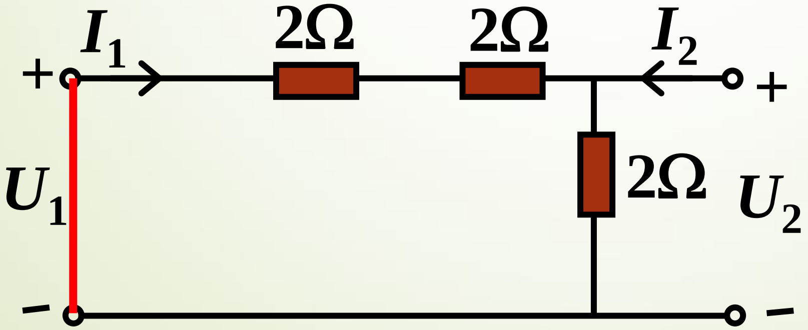
$$G_{21} = \frac{I_2}{U_1}\bigg|_{U_2=0} = 1\text{S}$$





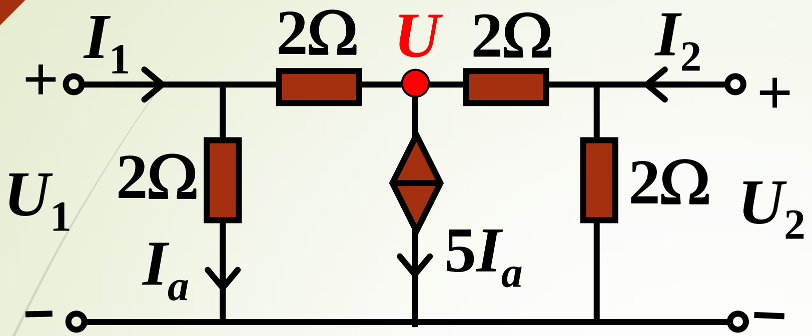
$$G_{12} = \frac{I_1}{U_2}\bigg|_{U_1=0} = -\frac{1}{4}\text{S}$$

$$G_{22} = \frac{I_2}{U_2}\bigg|_{U_1=0} = \frac{3}{4}\text{S}$$



$$G = \begin{bmatrix} 2 & -0.25 \\ 1 & 0.75 \end{bmatrix}\text{S}$$

法 2：直接列方程



$$I_1 = \frac{U_1}{2} + \frac{U_1 - U}{2}$$

$$I_2 = \frac{U_2}{2} + \frac{U_2 - U}{2}$$

用U_1和U_2表示U：

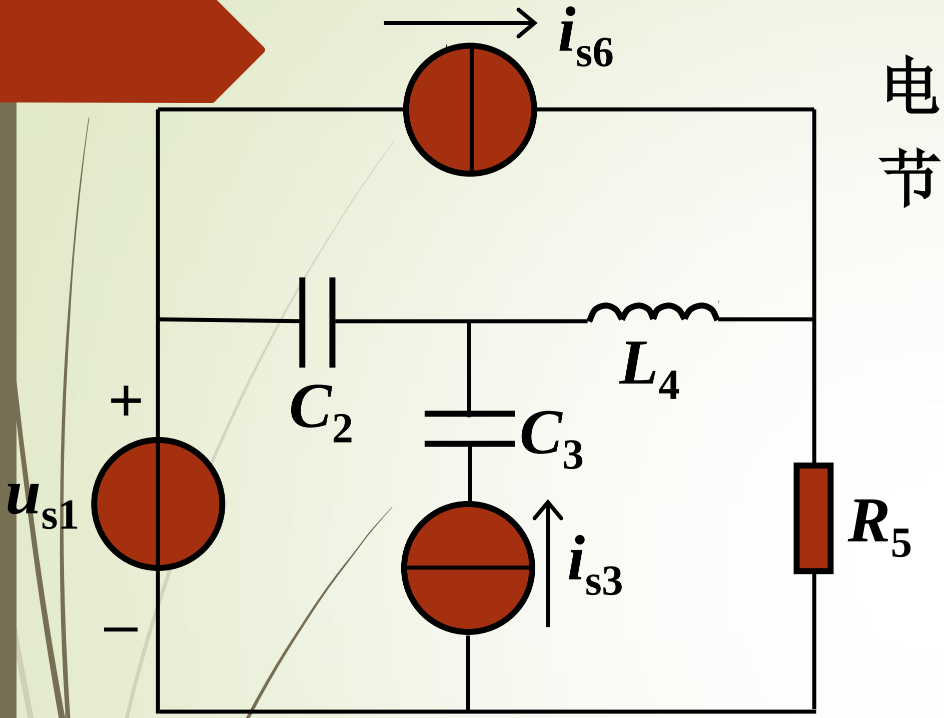
$$\frac{U - U_1}{2} + \frac{U - U_2}{2} + 5\frac{U_1}{2} = 0 \Longrightarrow U = -2U_1 + 0.5U_2$$

$$I_1 = 2U_1 - 0.25U_2$$

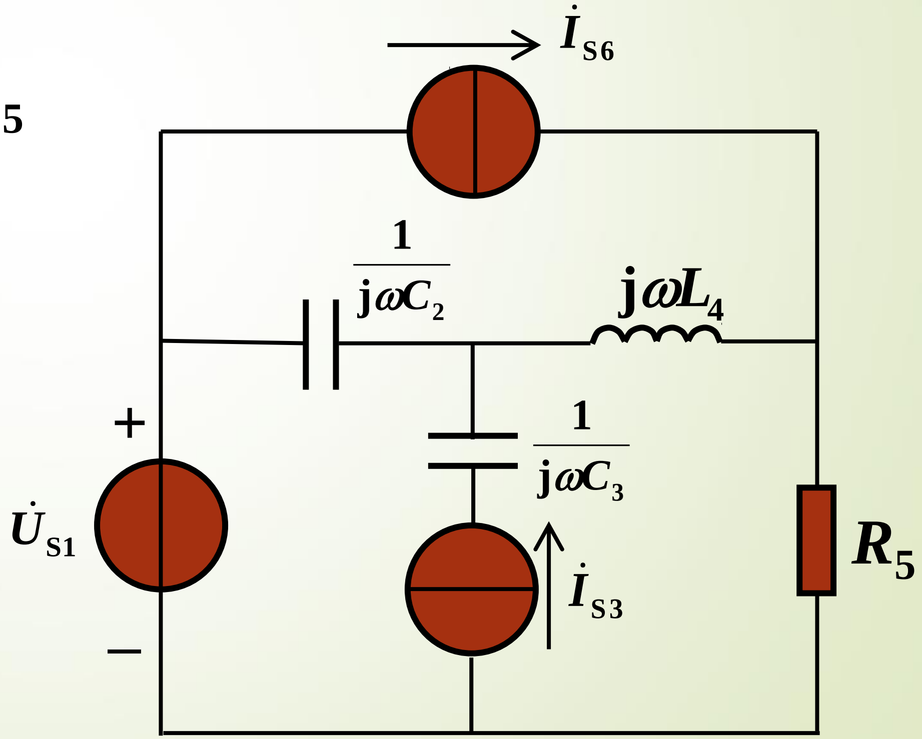
$$I_2 = U_1 + 0.75U_2$$

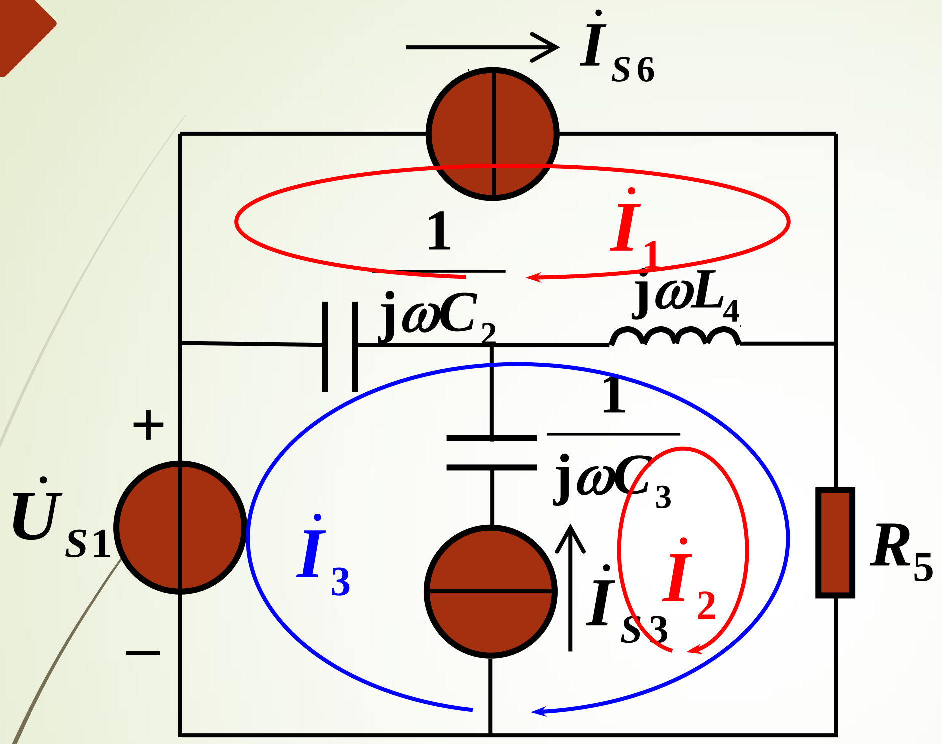
$$G = \begin{bmatrix} 2 & -0.25 \\ 1 & 0.75 \end{bmatrix} \mathrm{S}$$

7、回路法：



电路如图所示. 写出其相量形式的节点方程和回路方程.





回路法：

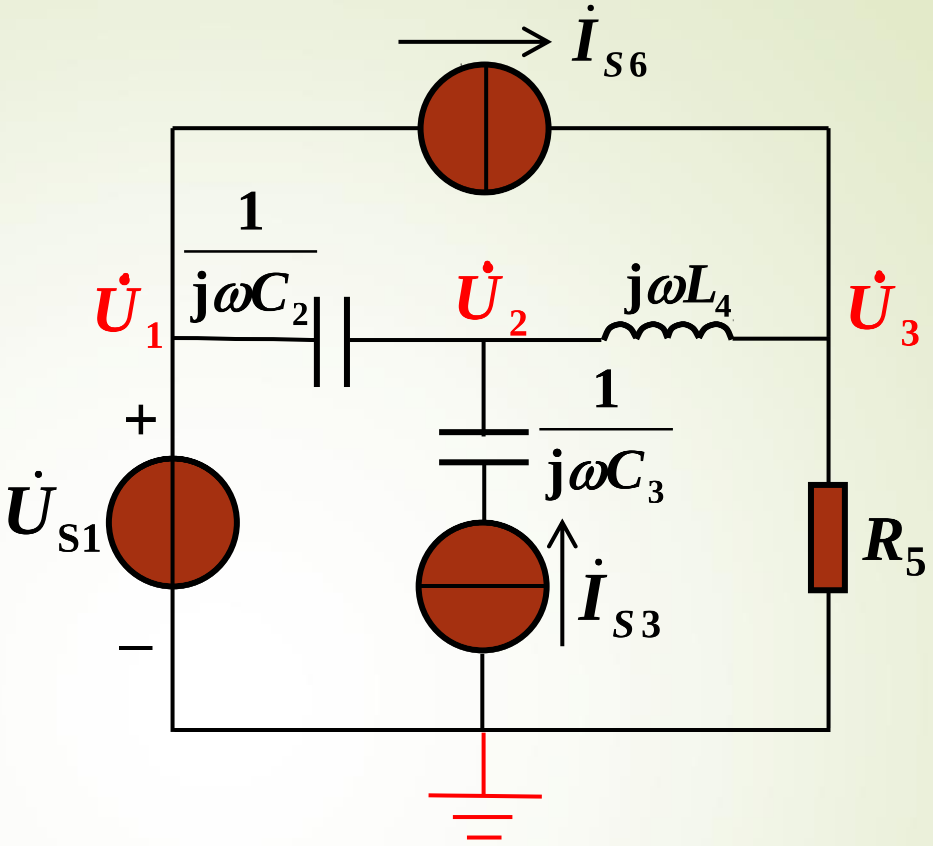
$$\dot{I}_1 = \dot{I}_{S6}$$

$$\dot{I}_2 = \dot{I}_{S3}$$

$$\left(\frac{1}{j\omega C_2}+j\omega L_4+R_5\right)\dot{I}_3-\left(\frac{1}{j\omega C_2}+j\omega L_4\right)\dot{I}_1$$

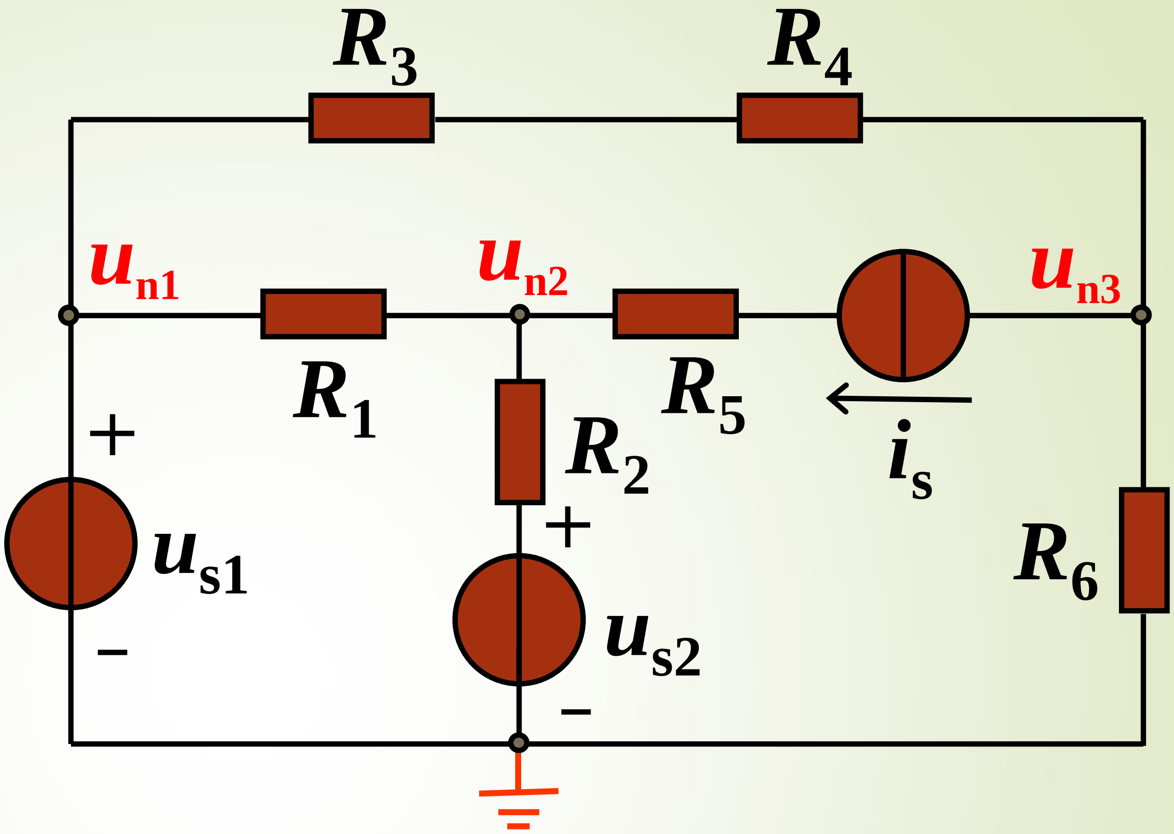
$$+(j\omega L_4+R_5)\dot{I}_2=\dot{U}_{S1}$$

8、节点法:



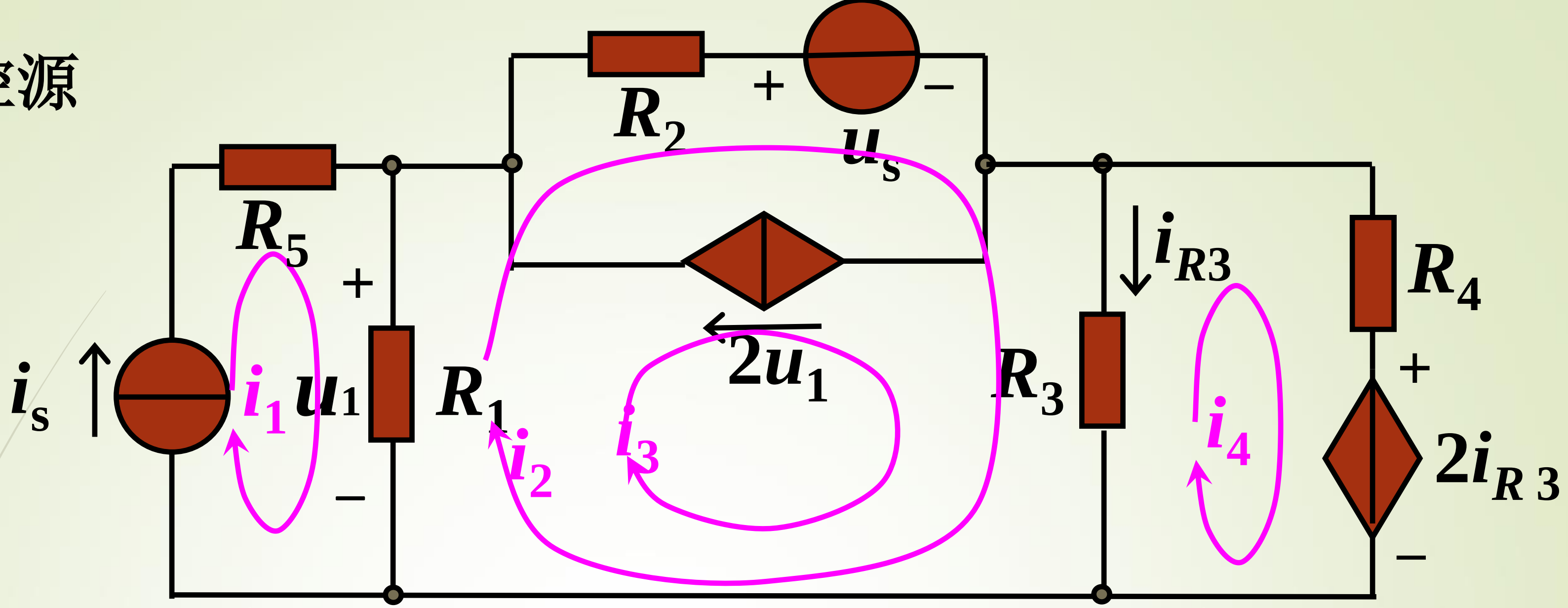
$$\begin{cases} \dot{U}_1 = \dot{U}_{S1} \\ -j\omega C_2 \dot{U}_1 + (j\omega C_2 + \frac{1}{j\omega L_4})\dot{U}_2 - \frac{1}{j\omega L_4}\dot{U}_3 = \dot{I}_{S3} \\ -\frac{1}{j\omega L_4}\dot{U}_2 + (\frac{1}{j\omega L_4} + \frac{1}{R_5})\dot{U}_3 = \dot{I}_{S6} \end{cases}$$

方法2：选电压源u_{s1}支路所接的节点之一作为参考节点，则$u_{n1}= u_{s1}$，此时可不必再列节点1的方程。



$$\begin{cases} u_{n1}=u_{s1} \\ -\dfrac{1}{R_1}u_{n1}+\left(\dfrac{1}{R_1}+\dfrac{1}{R_2}\right)u_{n2}=\dfrac{u_{S2}}{R_2}+i_S \\ -\dfrac{1}{R_3+R_4}u_{n1}+\left(\dfrac{1}{R_3+R_4}+\dfrac{1}{R_6}\right)u_{n3}=-i_S \end{cases}$$

含受控源

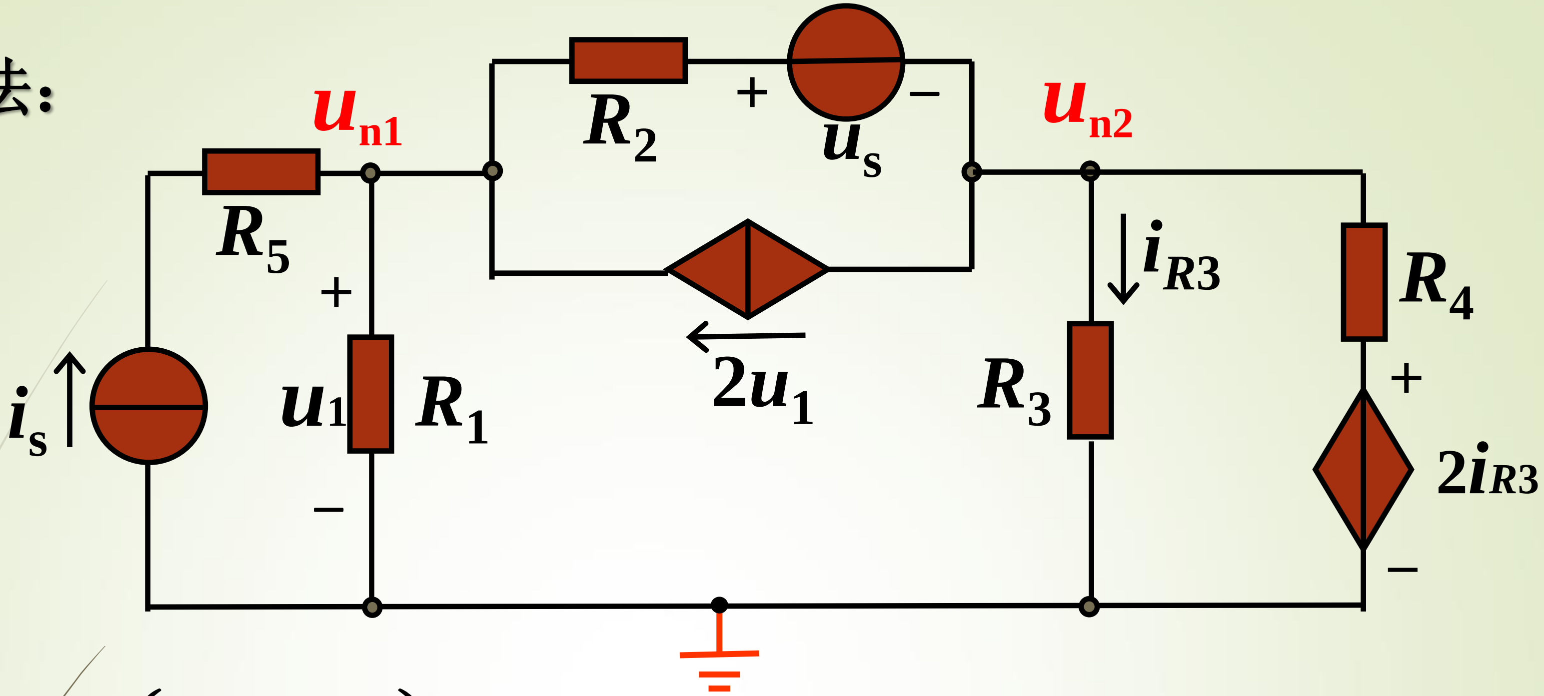


回路法：(1) 先将受控源看作独立源列写方程；

(2) 补充受控源控制量与回路电流关系的方程。

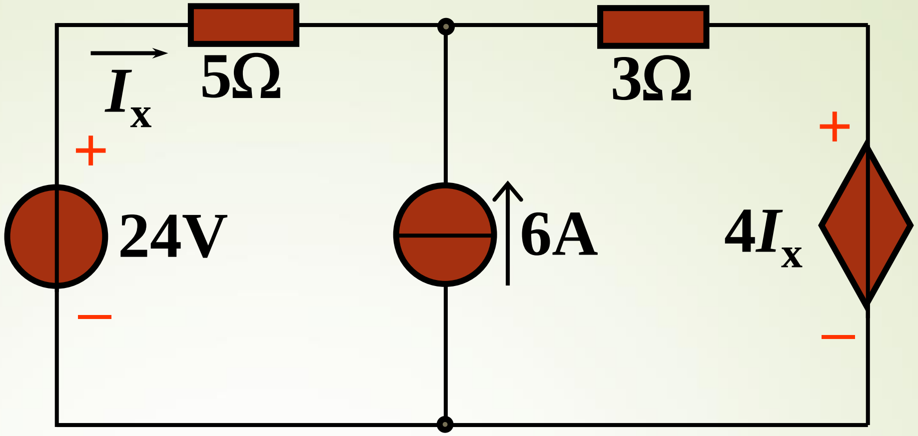
$$\begin{cases} i_1 = i_s \\ -R_1 i_1 + (R_1 + R_2 + R_3) i_2 + (R_1 + R_3) i_3 - R_3 i_4 = -u_s \\ i_3 = -2u_1 \\ -R_3 i_2 - R_3 i_3 + (R_3 + R_4) i_4 = -2 i_{R3} \\ u_1 = R_1 (i_1 - i_2 - i_3) \\ i_{R3} = i_2 + i_3 - i_4 \end{cases}$$

节点法：

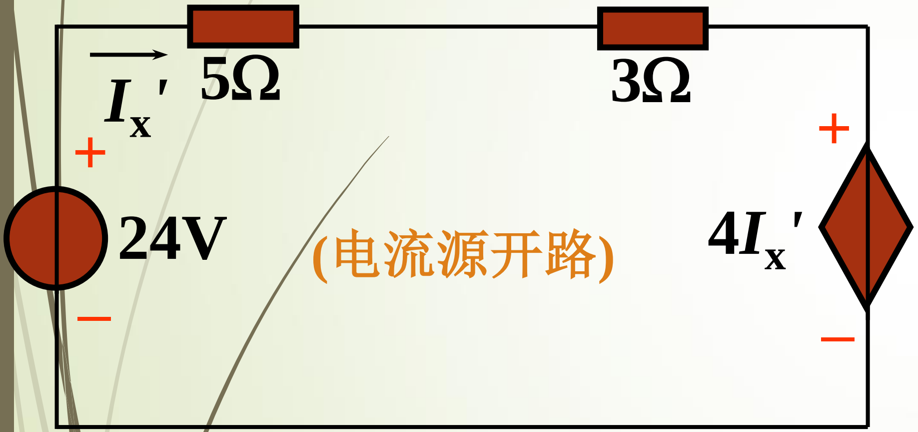


$$\begin{cases} \left(\frac{1}{R_1}+\frac{1}{R_2}\right)u_{n1}-\frac{1}{R_2}u_{n2}=i_s+\frac{u_s}{R_2}+2u_1 \\ -\frac{1}{R_2}u_{n1}+\left(\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}\right)u_{n2}=-\frac{u_s}{R_2}-2u_1+\frac{2i_{R3}}{R_4} \\ \left.\begin{array}{l} u_1=u_{n1} \\ i_{R3}=\frac{u_{n2}}{R_3} \end{array}\right\} \text{补充方程} \end{cases}$$

9、用叠加定理求 I_x .



解:



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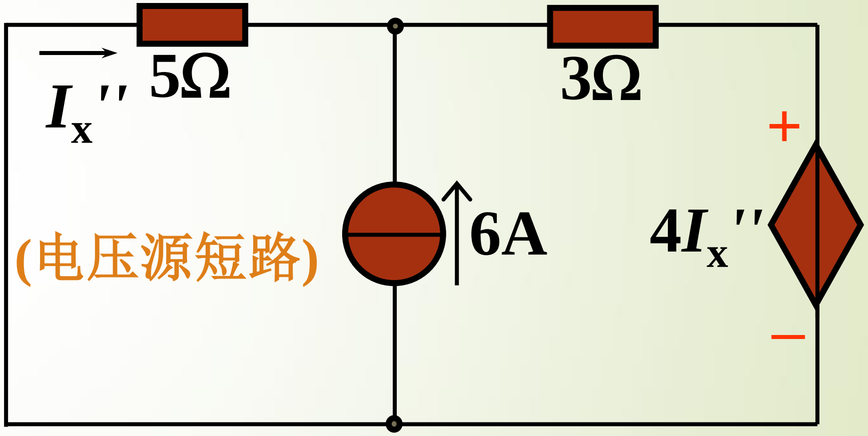


24V电压源单独作用

$5I_X'+3I_X'+4I_X'=24 \rightarrow I_X'=2\text{A}$

6A电流源单独作用

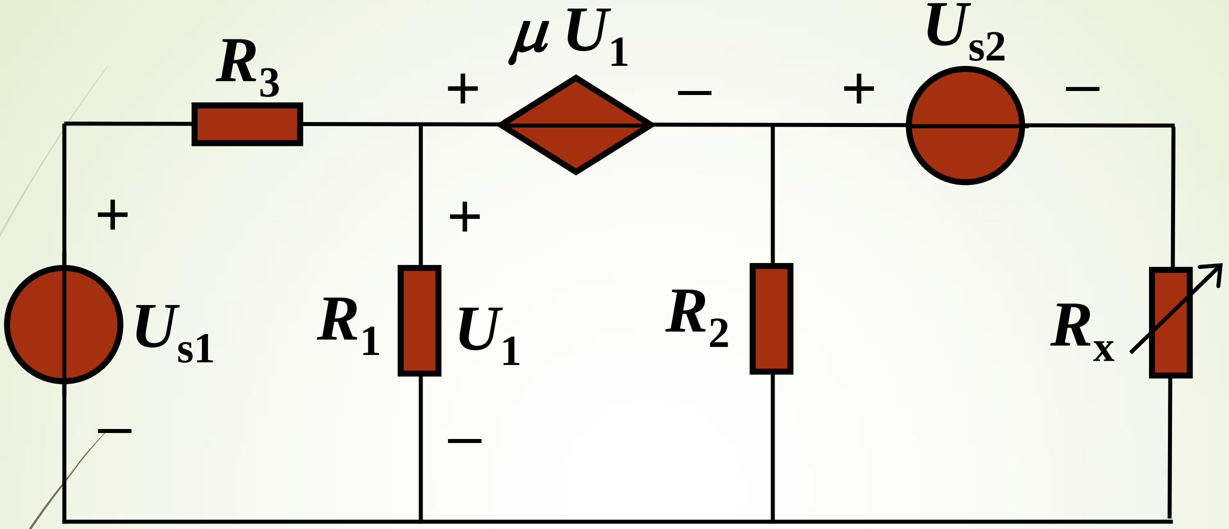
$5I_X''+3(I_X''+6)+4I_X''=0 \rightarrow I_X''=-1.5\text{A}$

$I_X=I_X'+I_X''=2-1.5=0.5\text{A}$

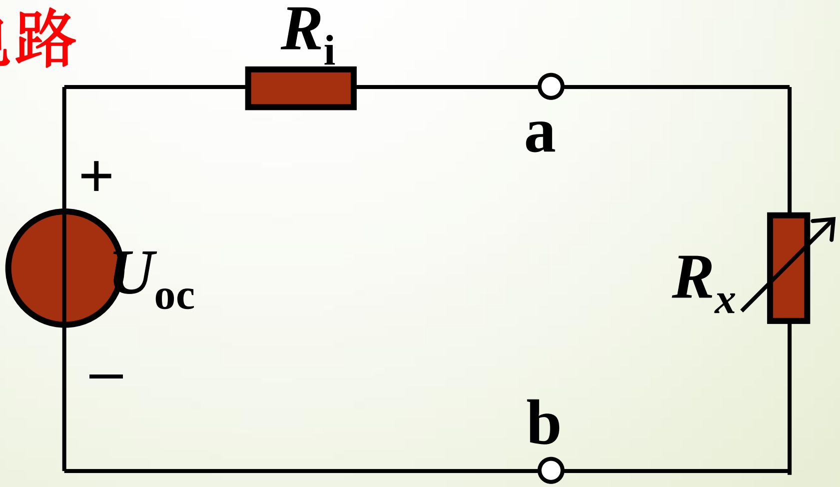
* 注意: 独立源可以进行叠加，受控源保留不变。

10、已知：$U_{S1}=100\text{V}, U_{S2}=120\text{V}, R_1=R_2=10\Omega, R_3=20\Omega, \mu=0.5$,

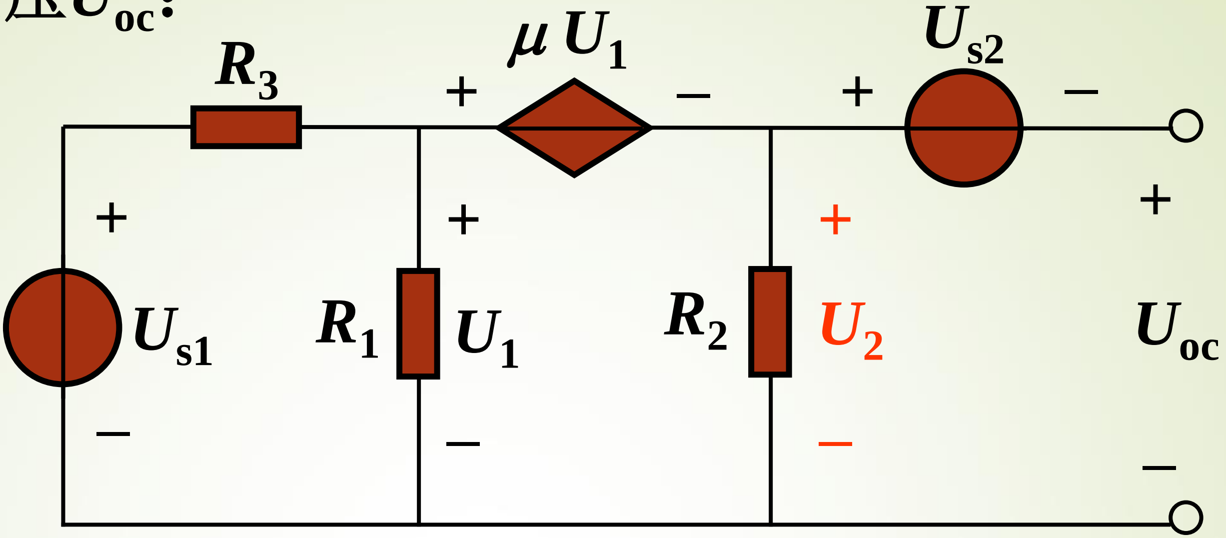
试问：R_x为何值时其上可获得最大功率？并求此最大功率$P_{\max}$.



解： 用戴维南等效电路



求开路电压U_{oc}：

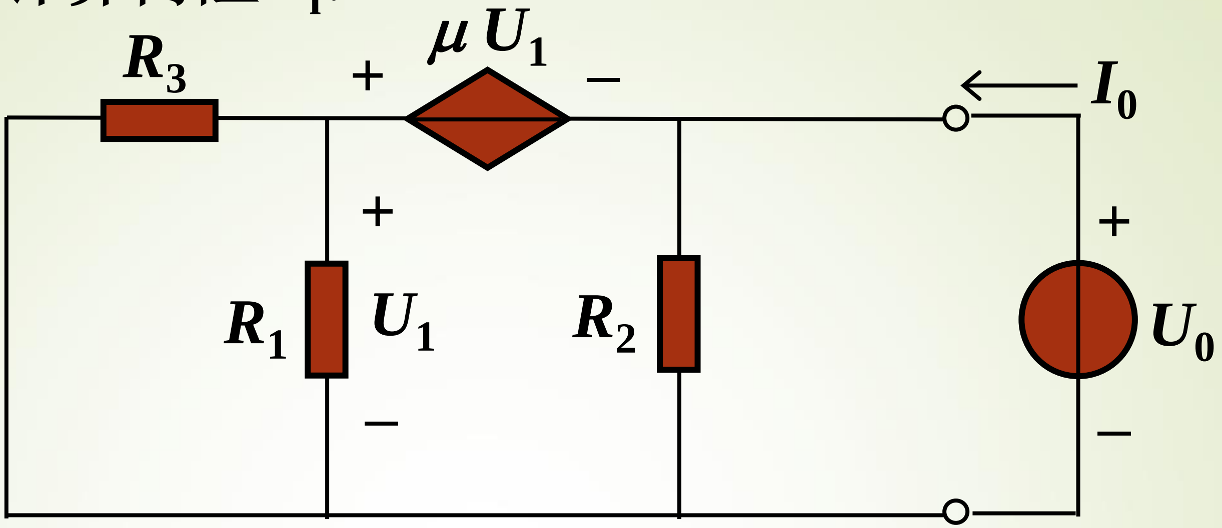


$$U_{OC} = -U_{S2} + U_2$$

$$\begin{cases} U_{S1} = \left(\dfrac{(1-\mu)U_1}{R_2} + \dfrac{U_1}{R_1}\right)R_3 + U_1 \\ U_2 = (1-\mu)U_1 \end{cases} \Rightarrow \begin{cases} U_1 = 25\text{V} \\ U_2 = 12.5\text{V} \end{cases}$$

$$U_{OC} = -U_{S2} + U_2 = -120 + 12.5 = -107.5\text{V}$$

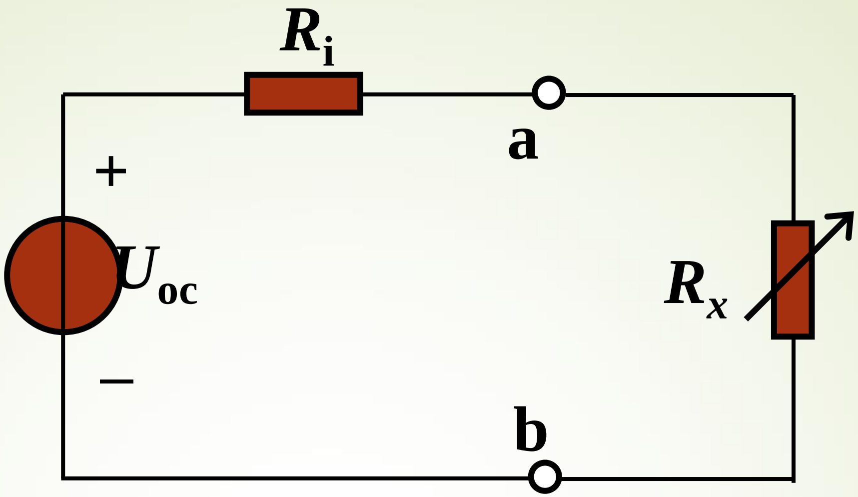
加压求流计算内阻R_i：



$$\begin{cases} I_0 = \dfrac{U_0}{R_2} + \dfrac{U_1}{R_3 // R_1} \\ U_0 = -\mu U_1 + U_1 \end{cases} \Rightarrow I_0 = \frac{U_0}{R_2} + \frac{U_0/(1-\mu)}{R_3 // R_1}$$

则 $$R_i = \frac{U_0}{I_0} = 1\Bigg/\left(\frac{1}{R_2} + \frac{1/(1-\mu)}{R_3 // R_1}\right)$$

$$= 1\Bigg/\left(\frac{1}{10} + \frac{1/(1-0.5)}{10\times 20/(10+20)}\right) = 2.5\ \Omega$$

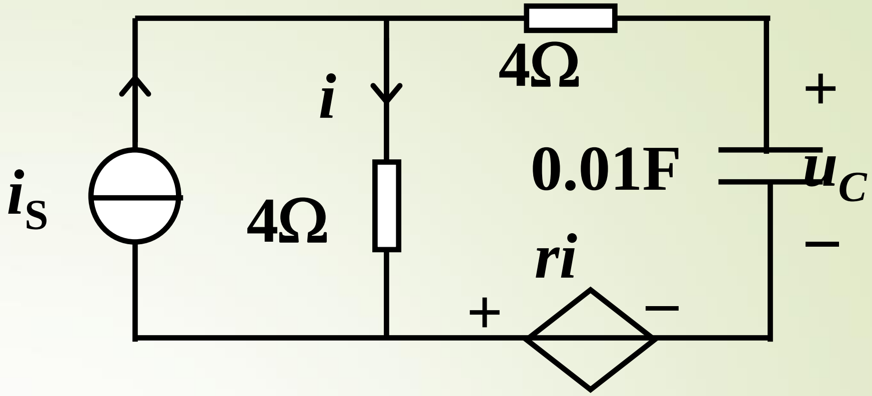


$R_x = R_i = 2.5\Omega$ 时 R_x 上获得最大功率。

此时最大功率为

$$P_{max} = \frac{U_{oc}^2}{4R_i} = \frac{107.5^2}{4\times 2.5} = 1155.6\text{W}$$

11、图示电路中，已知$t < 0$时，$i_S = 0$；$t \geq 0$时，i_S=2A，r=2Ω。求$t \geq 0$时的 $i(t)$。



解：三要素法

$$u_C(0^+) = u_C(0^-) = 0$$

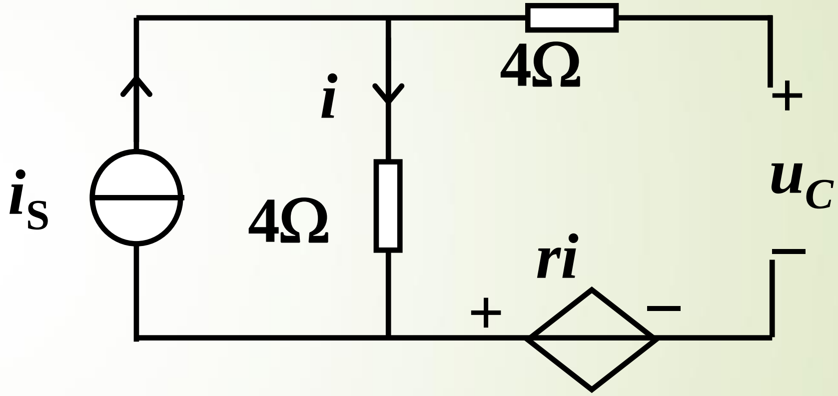
$$u_C(\infty) = 4i + ri = 12\text{V}$$

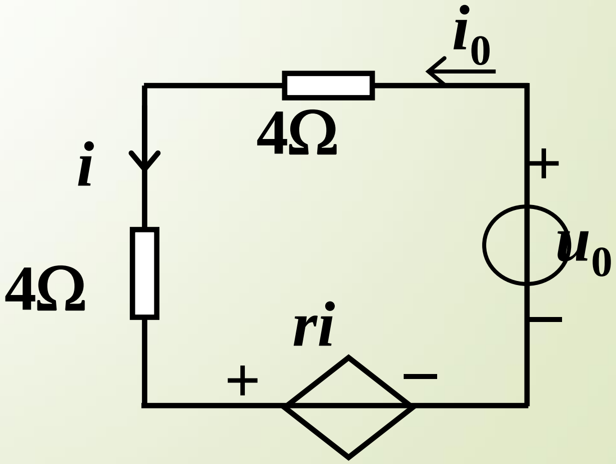
$$R_{eq} = \frac{u_0}{i_0} = 10\Omega$$

$$\tau = R_{eq}C = 0.1\text{s}$$

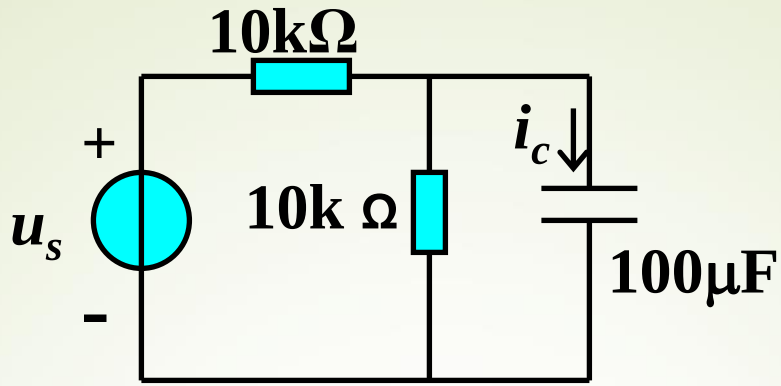
$$u_C(t) = 12 + (0 - 12)\text{e}^{-10t}$$

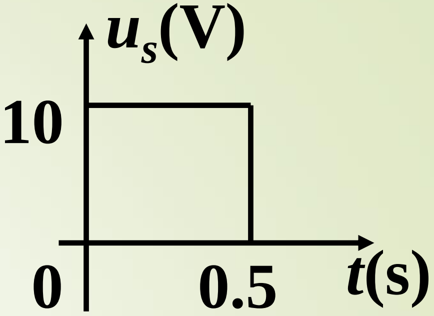
$$= 12(1 - \text{e}^{-10t})\text{V} \qquad t \geq 0^+$$





12、 求 $i_C(t)$.





$u_C(0^-)=0$

解： $0 \le t \le 0.5$

$$u_C(0^+)=u_C(0^-)=0$$

$$u_C(\infty)=5\text{V}$$

$$\tau = R_{eq}C = 0.5\text{s}$$

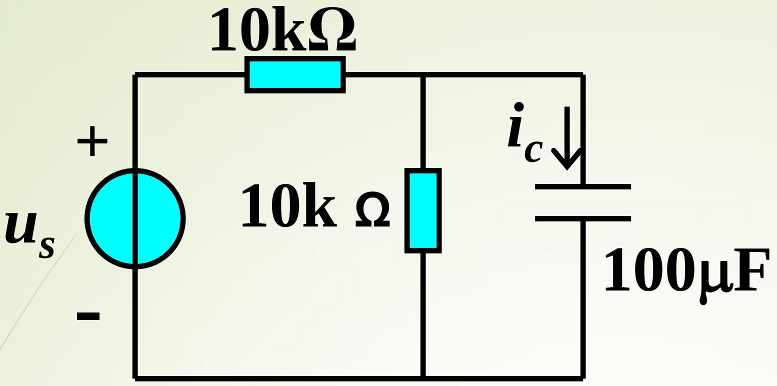
$$u_C(t)=5\left(1-\mathrm{e}^{-2t}\right)\text{V}$$

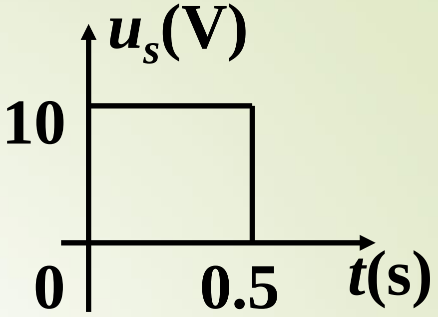
$$i_C(0^+)=1\text{mA}$$

$$i_C(\infty)=0$$

$$\tau = R_{eq}C = 0.5\text{s}$$

$$i_C(t)=C\frac{\mathrm{d}u_C(t)}{\mathrm{d}t}=\mathrm{e}^{-2t}\text{mA}$$





$u_C(0^-)=0$

$0 \leq t \leq 0.5$ $\quad u_C(t) = 5\left(1 - e^{-2t}\right)V$

$t \geq 0.5$ $\quad u_C(0.5^+) = u_C(0.5^-) = 3.16V$

$$i_C(0.5^+) = -0.632\text{mA}$$

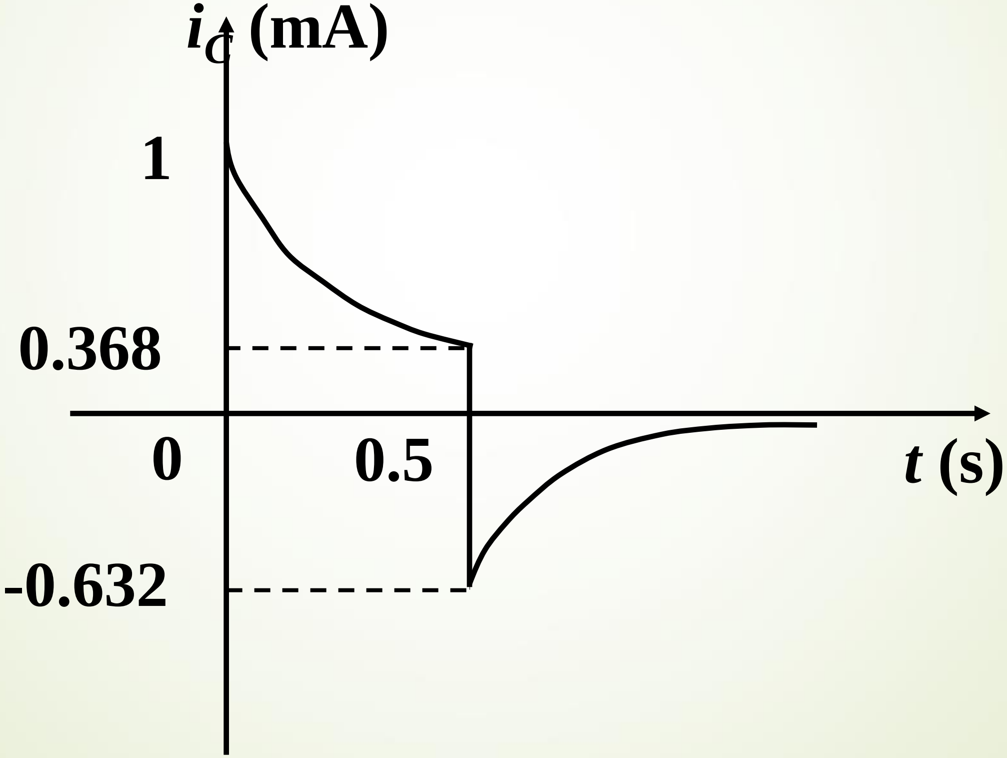
$$i_C(\infty) = 0$$

$$\tau = R_{eq}C = 0.5s$$

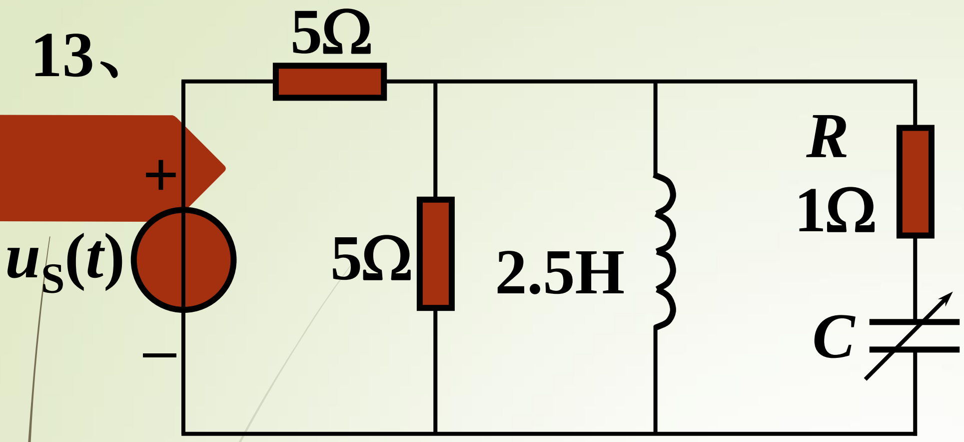
$$i_C(t) = -0.632e^{-2(t-0.5)}\text{mA}$$

$0 \le t \le 0.5$ $\quad i_C(t) = e^{-2t}\text{mA}$

$t \ge 0.5$ $\quad i_C(t) = -0.632e^{-2(t-0.5)}\text{mA}$



13、

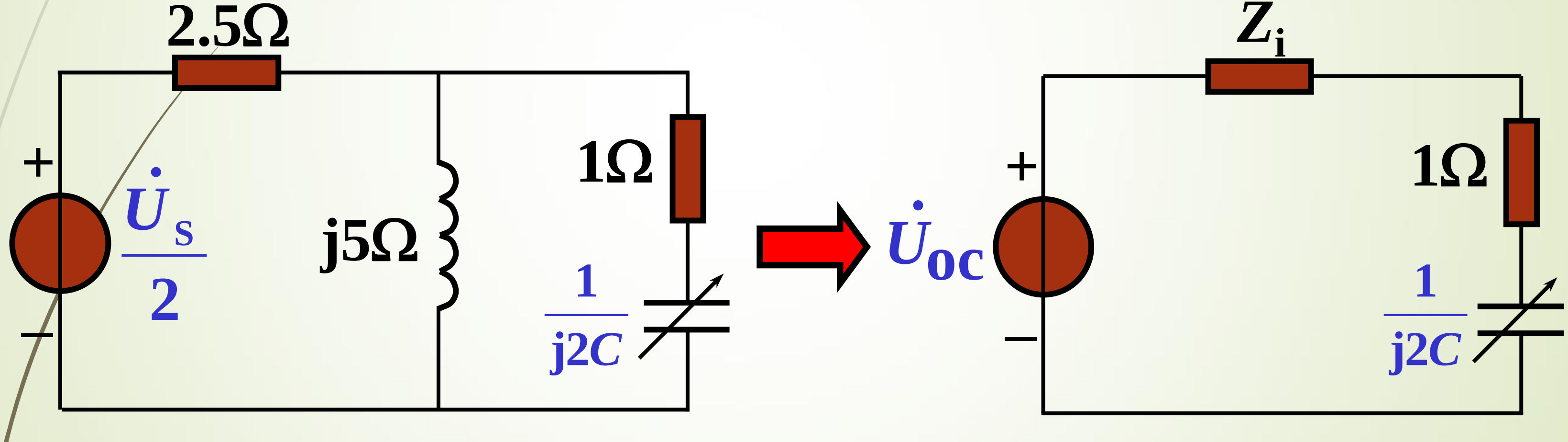


$$u_s(t)=\sqrt{2}\sin(2t-45^\circ)\ \mathrm{V}$$

求 *C* 的值，使得 ***R*** 获得最大功率.

解： 戴维南定理

$$\dot{U}_S = 1\angle -45^\circ\ \mathrm{V}$$

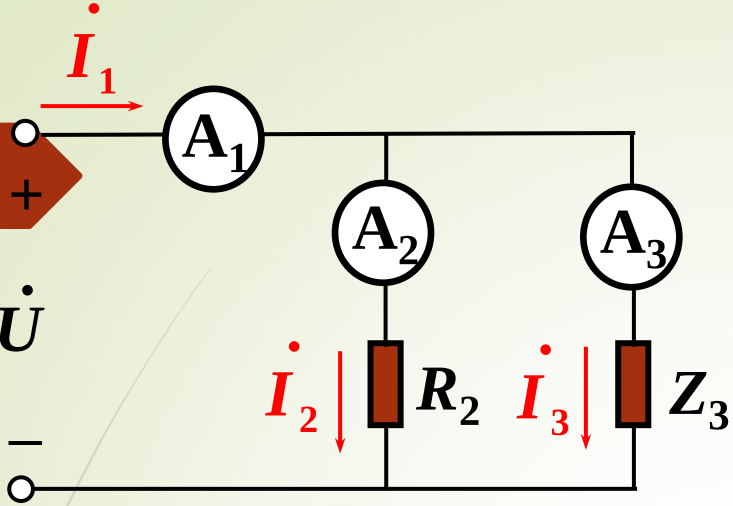


$$Z_i=\frac{2.5\times \mathrm{j}5}{2.5+\mathrm{j}5}=2+\mathrm{j}1\Omega$$

当$-\mathrm{j}1/(2C)=-\mathrm{j}1$ 时, ***R*** 获得最大功率

$$\frac{1}{2C}=1,\quad C=0.5\,\mathrm{F}$$

14、

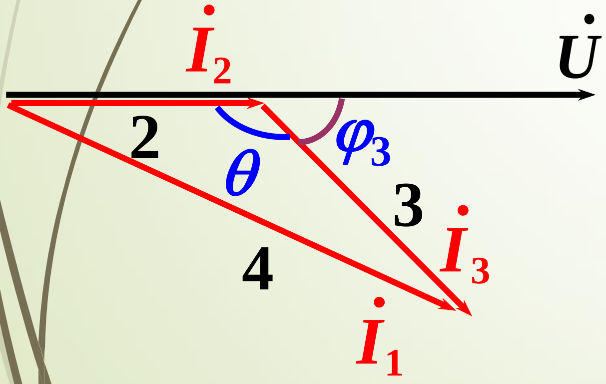


U=220V，f=50Hz，A_1 的读数是4A, A_2 的读数是2A, A_3的读数是3A, Z_3 是感性的. 求 R_2 和Z_3。

解： $Z_3=|Z_3|\angle\varphi_3$

显然，$R_2=\dfrac{U}{I_2}=\dfrac{220}{2}=110\,\Omega$

求 Z3. **法 1:** 画相量图. 选电压做参考相量



根据余弦定理:

$$4^2=3^2+2^2-2\times3\times2\times\cos\theta$$

$$\cos\theta=-\frac{4^2-3^2-2^2}{2\times4\times2}=-\frac{1}{4},\quad \theta=104.5^{\circ}$$

$$\varphi_3=180^{\circ}-\theta=180^{\circ}-144.5^{\circ}=75.5^{\circ}$$

$$|Z_3|=\frac{U}{I_3}=\frac{220}{3}=73.3\Omega,\quad Z_3=73.3\angle75.5^{\circ}\,\Omega=18.4+\mathrm{j}71\Omega$$

法 2: 由总阻抗Z和阻抗Z_3的模列两个方程求R_3和X_3。

设 $Z_3 = R_3 + jX_3$

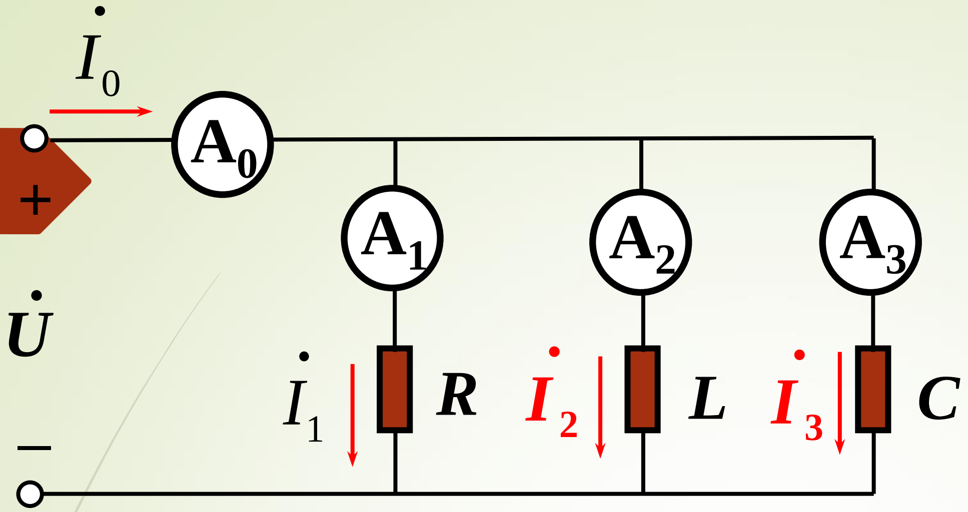
$$Z = \frac{R_2(R_3 + jX_3)}{R_2 + R_3 + jX_3}$$

$$\begin{cases} |Z| = \dfrac{R_2\sqrt{R_3^2 + X_3^2}}{\sqrt{(R_2 + R_3)^2 + X_3^2}} = \dfrac{U}{I_1} = \dfrac{220}{4} \\ |Z_3| = \sqrt{R_3^2 + X_3^2} = \dfrac{U}{I_3} = \dfrac{220}{3} \end{cases}$$

$$R_3 = 18.3\Omega$$

$$X_3 = 71\Omega$$

15、



f=50Hz时，A_0 的读数是 5A, A_1 的读数是3A, A_2的读数是4A。若U不变，频率升为100Hz，请问此时 I_0= ?