

华东交通大学 2016 — 2017 学年第二学期考试卷

(B) 卷

课程名称: 电路原理 I 考试时间: 120 分钟 考试方式: 闭卷

专业: 2016 级电气工程、自动化、建筑电气、电子信息、轨道交通信号。

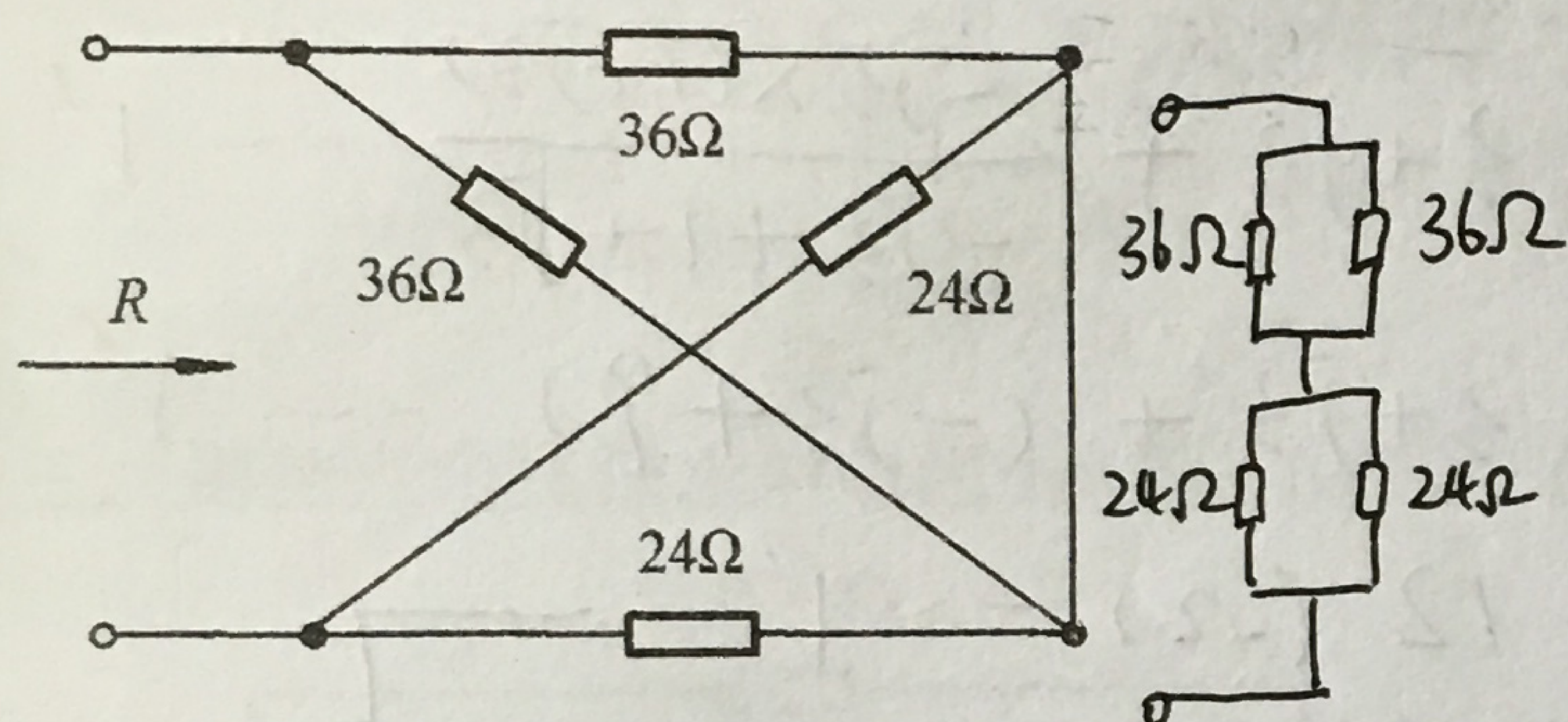
学生姓名: _____ 学号: _____ 教学班级: _____ 教学小班序号: _____

题号	一	二	三	四	五	六	七	八	九	十	总分
得分											
阅卷人											

一、 计算题(每题 4 分, 共 16 分)

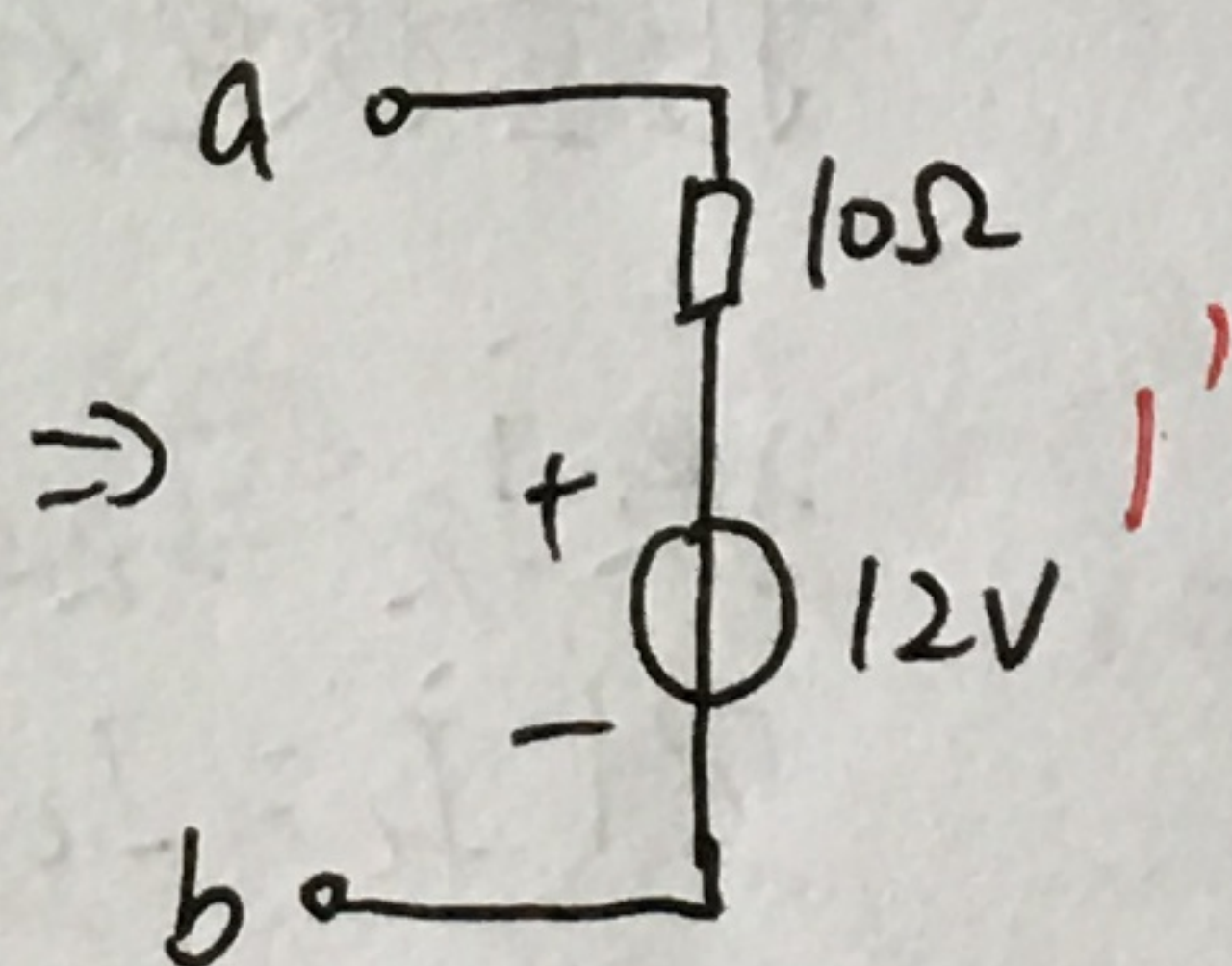
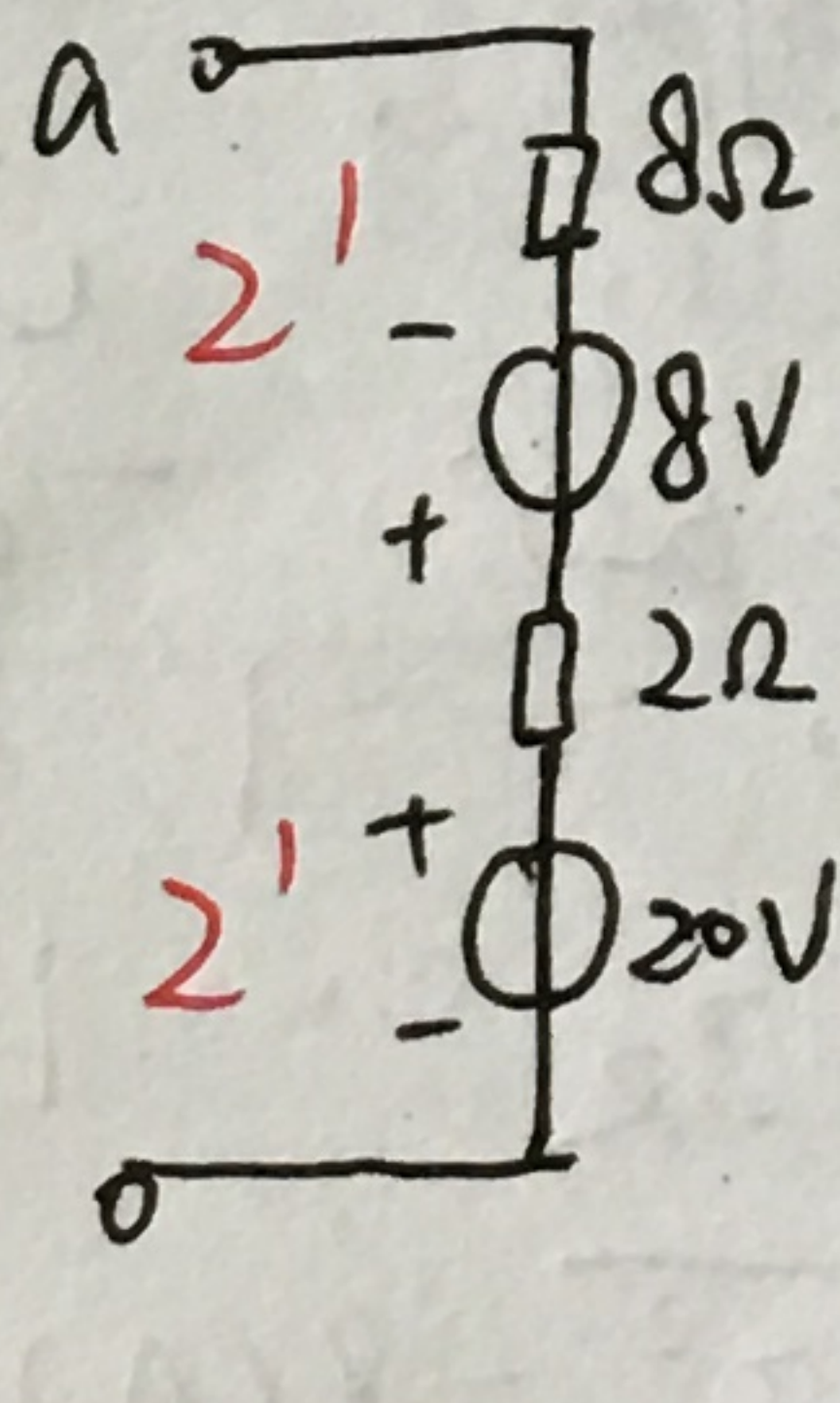
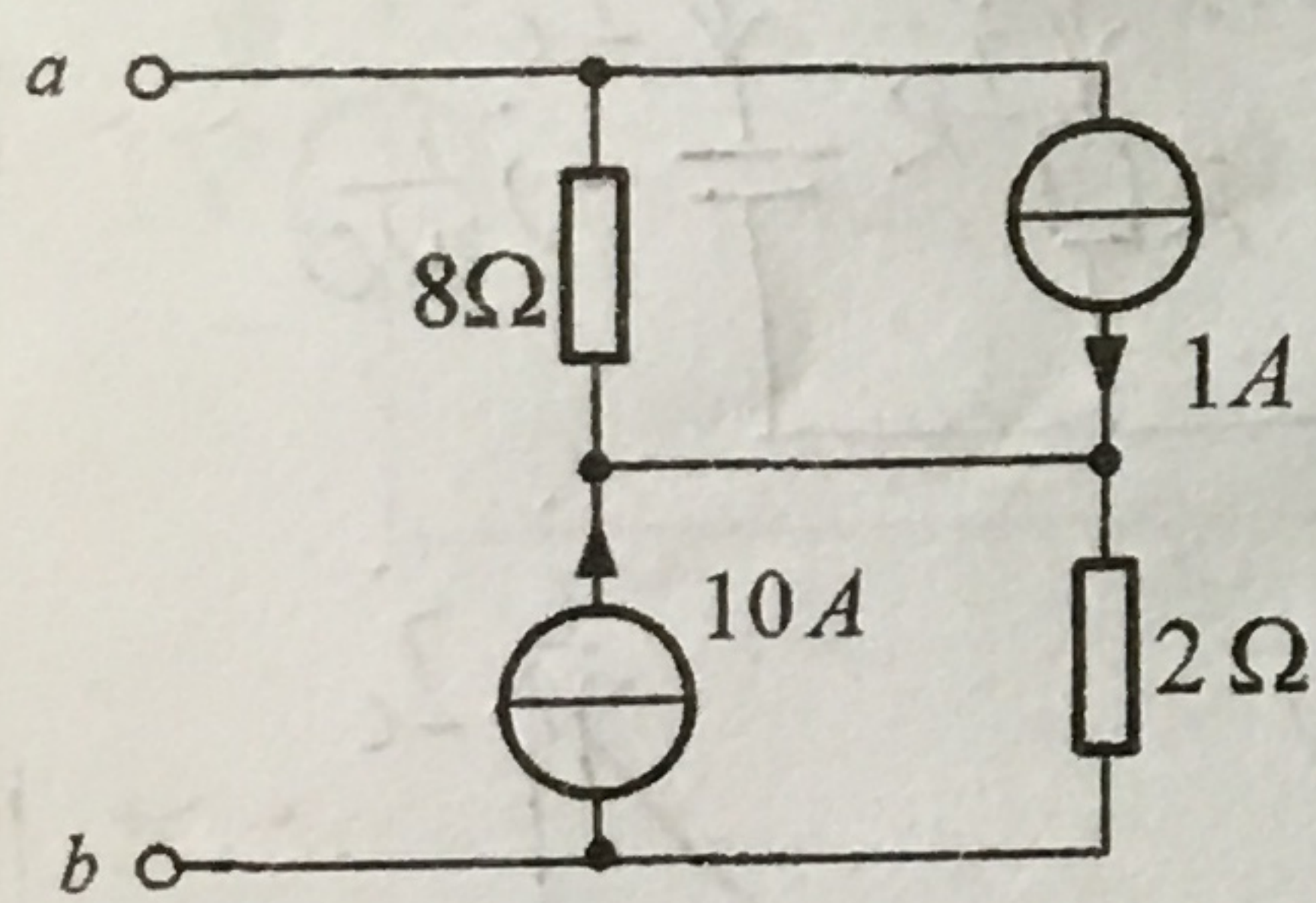
得分

1. 电路如图, 求 a 、 b 两端等效电阻。

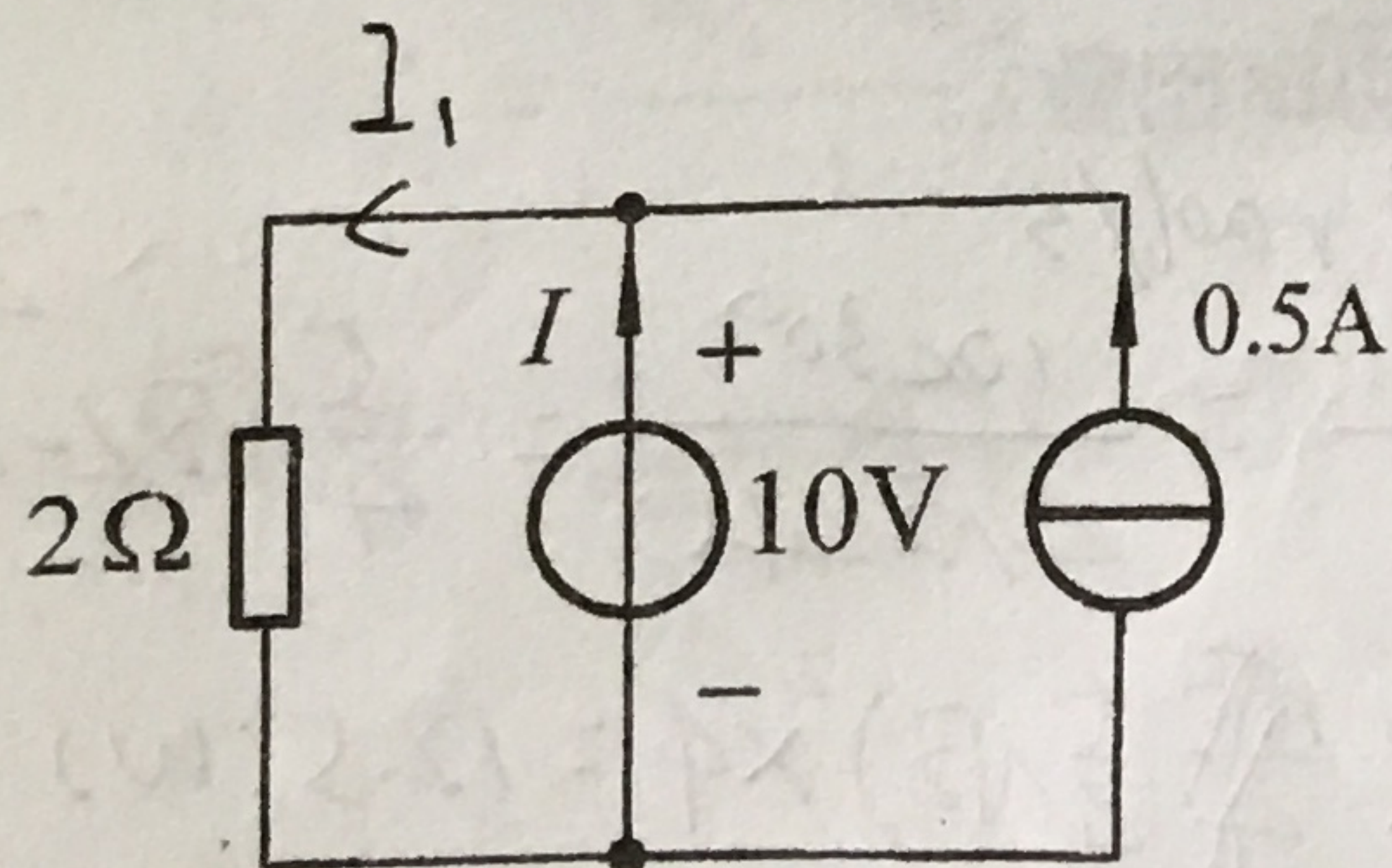


$$\begin{aligned}
 R_{ab} &= 36 // 36 + 24 // 24 \\
 &= 18 + 12 \\
 &= 30 \Omega
 \end{aligned}$$

2. 电路如图所示, 将电路化简为一个电压源与一个电阻相串联的组合。



3. 电路如图, 求电流 I 。

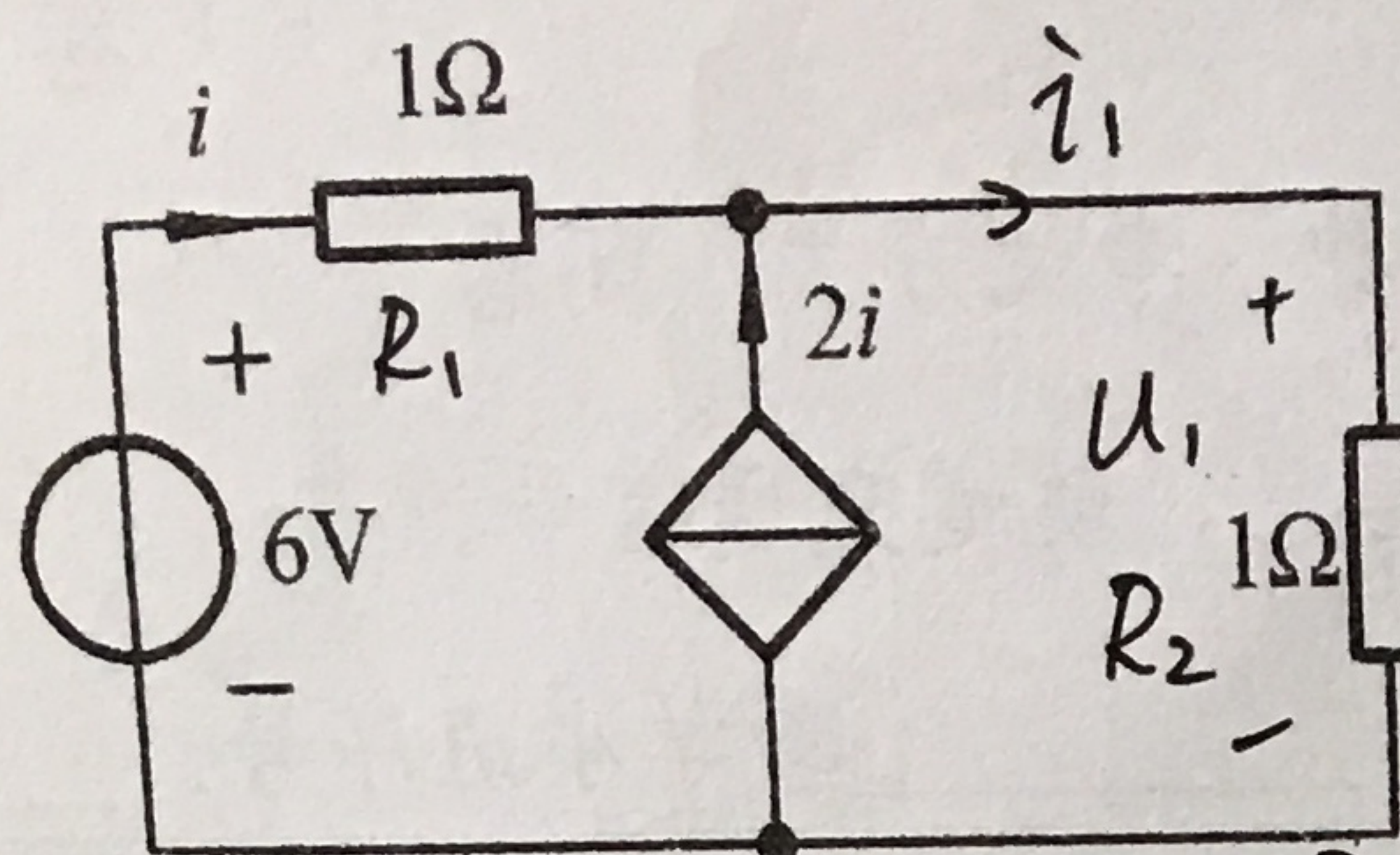


$$I_1 = \frac{10}{2} = 5A$$

$$KCL: I_1 = I + 0.5$$

$$\Rightarrow I = I_1 - 0.5 = 4.5A$$

4. 电路如图，求各元件功率，并验证功率守恒。

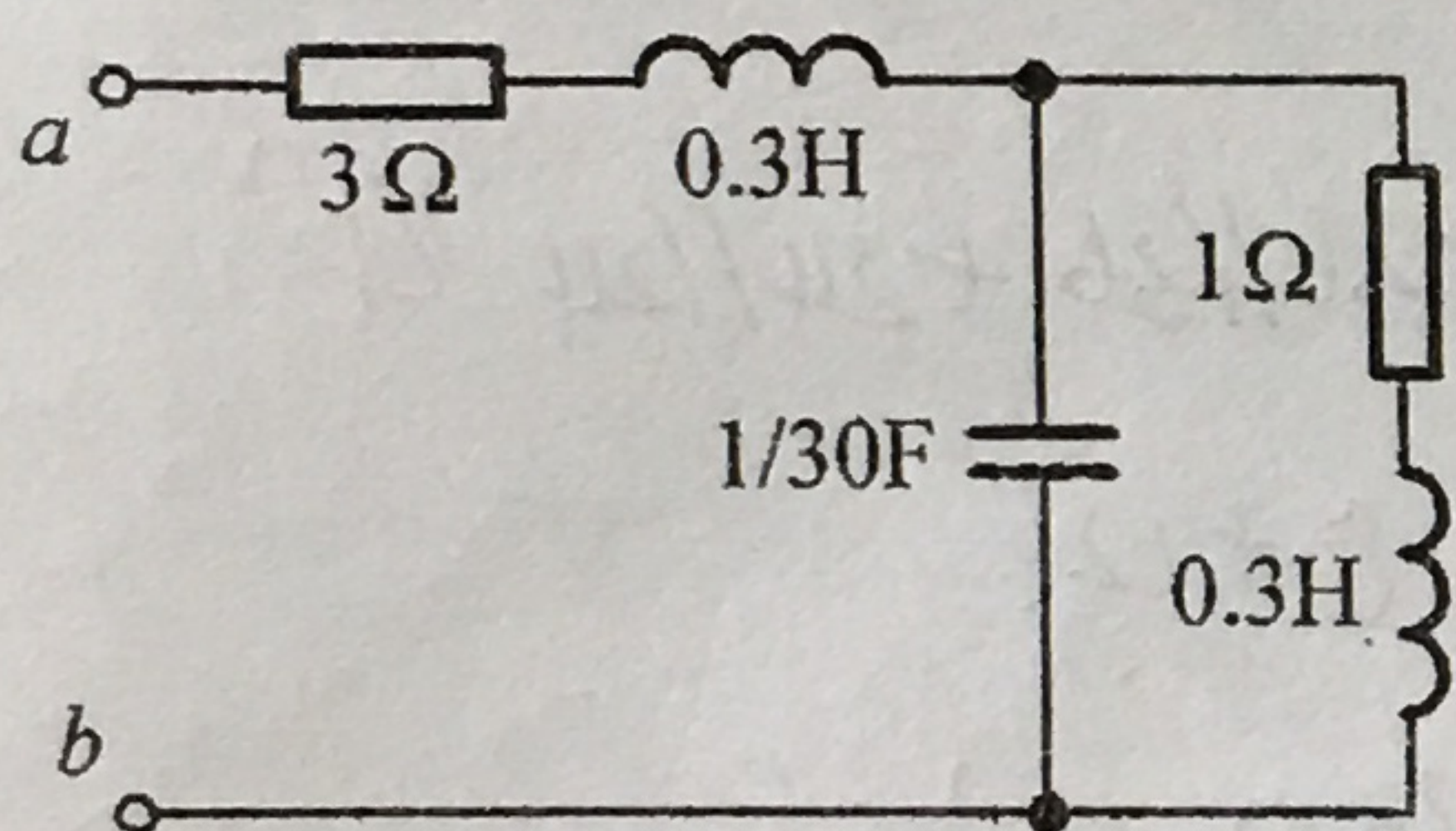


$$\begin{aligned} & \begin{cases} i + 2i = i_1 \\ i + i_1 = 6 \end{cases} \Rightarrow \begin{cases} i = 1.5A \\ i_1 = 4.5A \end{cases} \\ & u_1 = i_1 R_2 = 4.5V \\ & P_{R_1} = i^2 R_1 = 2.25W \text{ 吸} \\ & P_{R_2} = i_1^2 R_2 = 20.25W \text{ 吸} \\ & P_{\text{DCS}} = -u_1 \cdot 2i = -13.5W \text{ 发} \\ & P_U = -6i = -9W \text{ 发} \\ & P_{\text{吸}} = P_{\text{发}} = 22.5W \\ & \text{功率守恒} \end{aligned}$$

得分

二、计算题 (每题 5 分, 共 25 分)

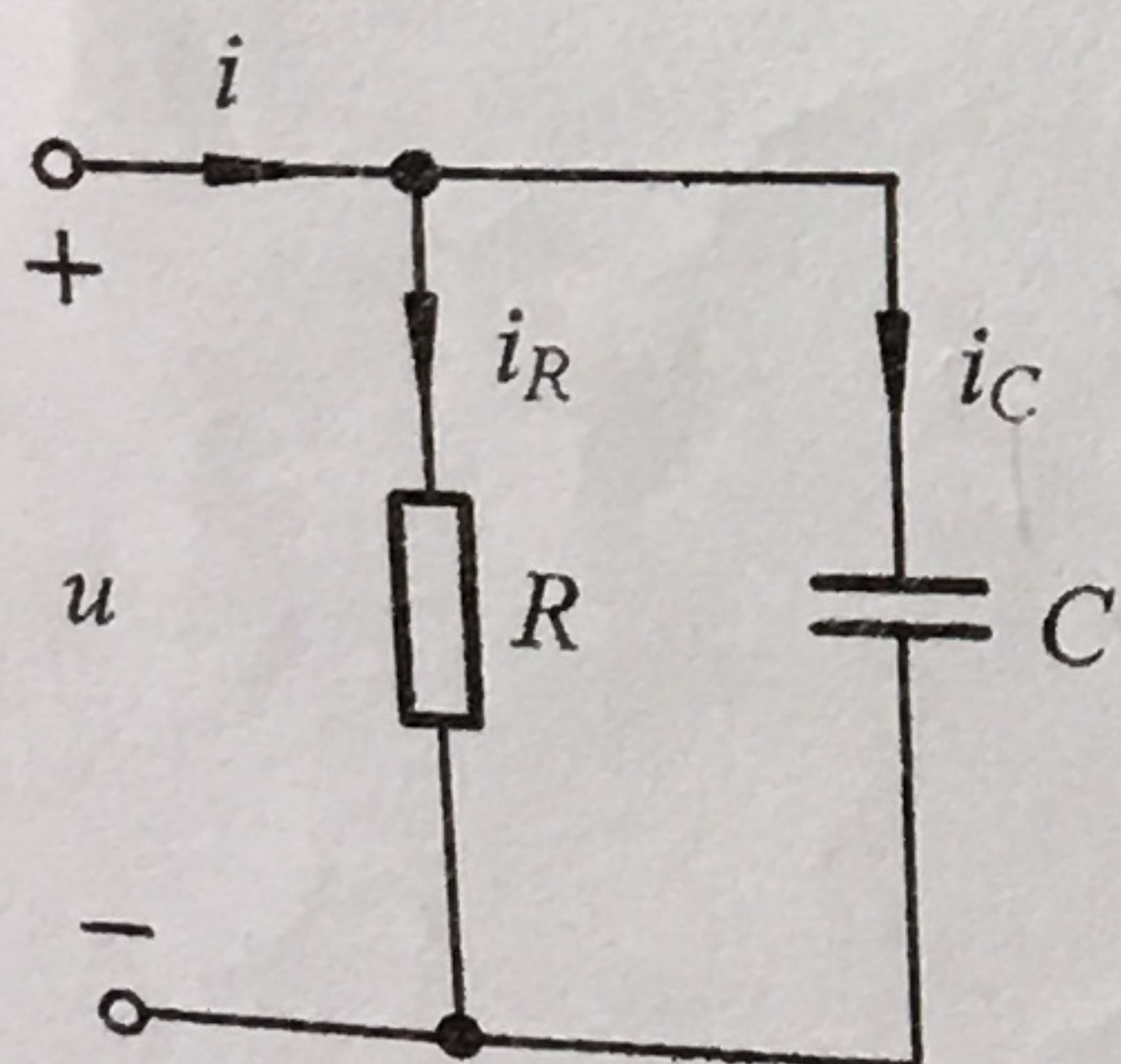
1. 求图示电路的输入阻抗, 该电路的最简串联等效电路及元件参数。 ($\omega = 10 \text{ rad/s}$)。



$$\begin{aligned} Z_{in} &= 3 + j3 + (-j3 // (1 + j3)) \\ &= 3 + j3 + \frac{-j3 \times (1 + j3)}{-j3 + 1 + j3} \\ &= 3 + j3 + (-j3 + 9) \\ &= 12 (\Omega) \end{aligned}$$

最简等效电路为:

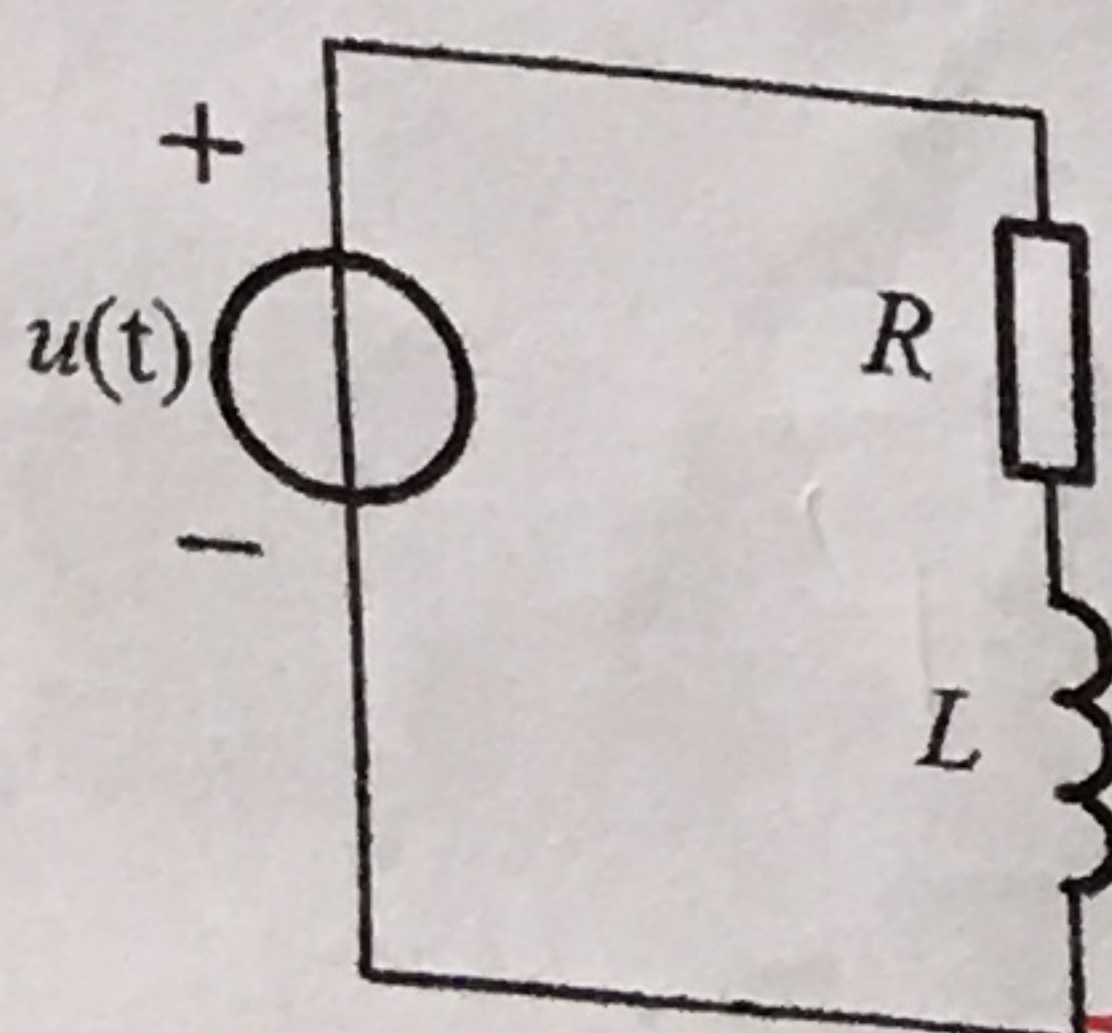
2. 在图示电路中, 已知 $I = 10A$, $I_R = 6A$, 求 I_C 。



相量模型如右图所示:

$$\begin{aligned} & \text{设 } \dot{I}_R = I_R \angle 0^\circ = 6 \angle 0^\circ \\ & \text{则 } \dot{I}_C = I_C \angle 90^\circ \\ & \text{由 KCL: } \dot{I} = \dot{I}_C + \dot{I}_R \\ & \Rightarrow I_C = \sqrt{I^2 - I_R^2} = 8(A) \end{aligned}$$

3. 已知图示电路中, $u(t) = 10\sqrt{2} \cos(10^3 t + 30^\circ) V$, $R = 4\Omega$, $L = 4mH$, 求电路的平均功率 P 、无功功率 Q 、视在功率 S 和功率因数 λ 。



$$\begin{aligned} & \dot{U} = 10 \angle 30^\circ, \quad \omega = 10^3 \text{ rad/s} \\ & \dot{I} = \frac{\dot{U}}{R + j\omega L} = \frac{10 \angle 30^\circ}{4 + j4} = \frac{10 \angle 30^\circ}{4\sqrt{2} \angle 45^\circ} = \frac{5}{4} \sqrt{2} \angle -15^\circ \\ & P = I^2 R = UI \cos \varphi = \left(\frac{5}{4} \sqrt{2} \right)^2 \times 4 = 12.5 (W) \\ & Q = I^2 X_L = 12.5 (Var) \\ & S = U \cdot I = 12.5 \sqrt{2} (V \cdot A) \\ & \lambda = \cos \varphi = \cos 45^\circ = \frac{\sqrt{2}}{2} \end{aligned}$$

4. 已知 RLC 串联电路, $L=64\mu\text{H}$, $C=100\text{pF}$, $R=10\Omega$, 外加电源电压 $U=0.5\text{V}$,

电路处于谐振状态。求谐振频率、电感和电容上的电压有效值 U_L 、 U_C 。

谐振条件 $j\omega L + (-j\frac{1}{\omega C}) = 0 \Rightarrow \omega = \frac{1}{\sqrt{LC}} = 1.25 \times 10^7 \text{ rad/s} \dots 1'$

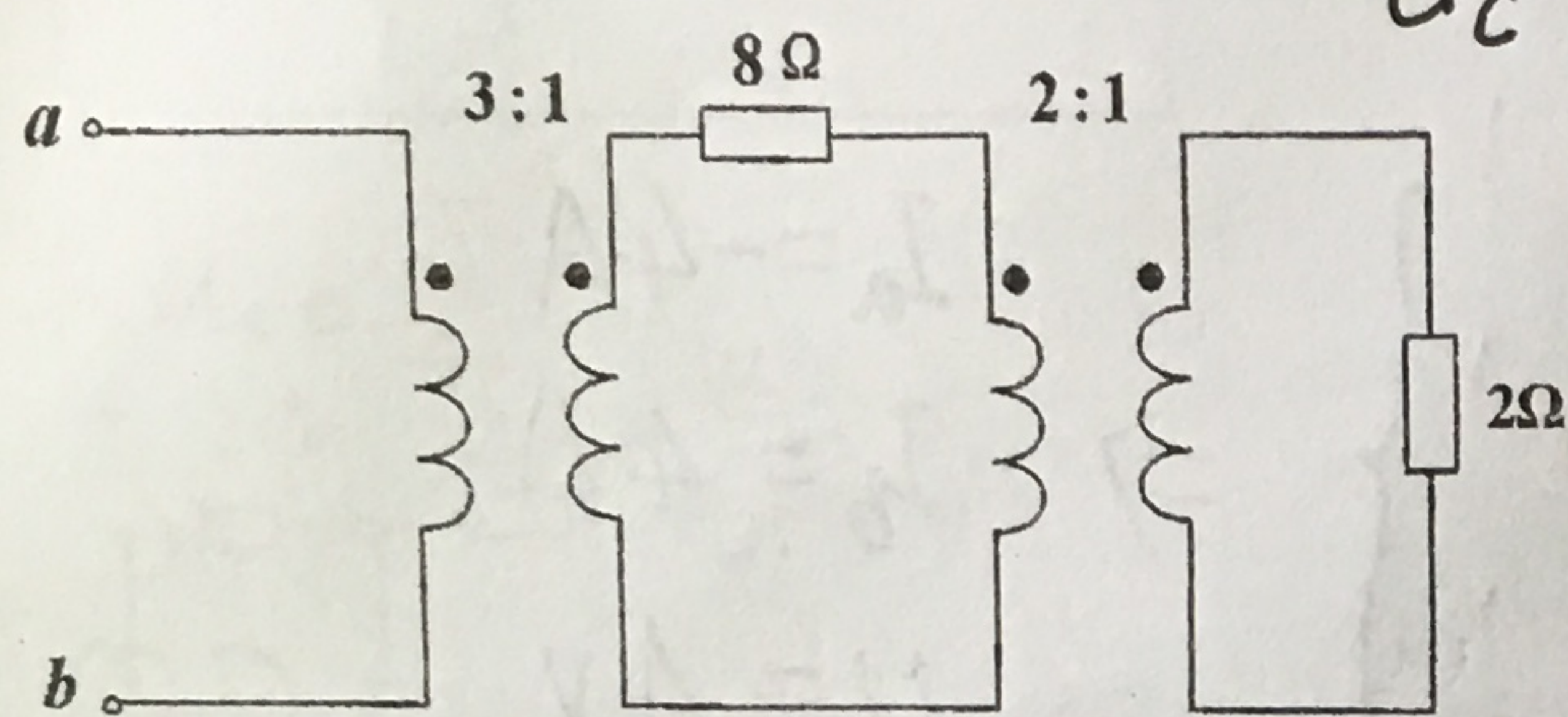
则谐振频率 $f = \frac{\omega}{2\pi} \approx 1.99 \times 10^6 \text{ (Hz)} \dots 1'$

$I = \frac{U}{R} = \frac{0.5}{10} = 0.05 \text{ (A)} \dots 1'$

$U_L = I \cdot \omega L = 40 \text{ (V)} \dots 1'$

$U_C = I \cdot \frac{1}{\omega C} = 40 \text{ (V)} \dots 1'$

5. 求 ab 端等效电阻。

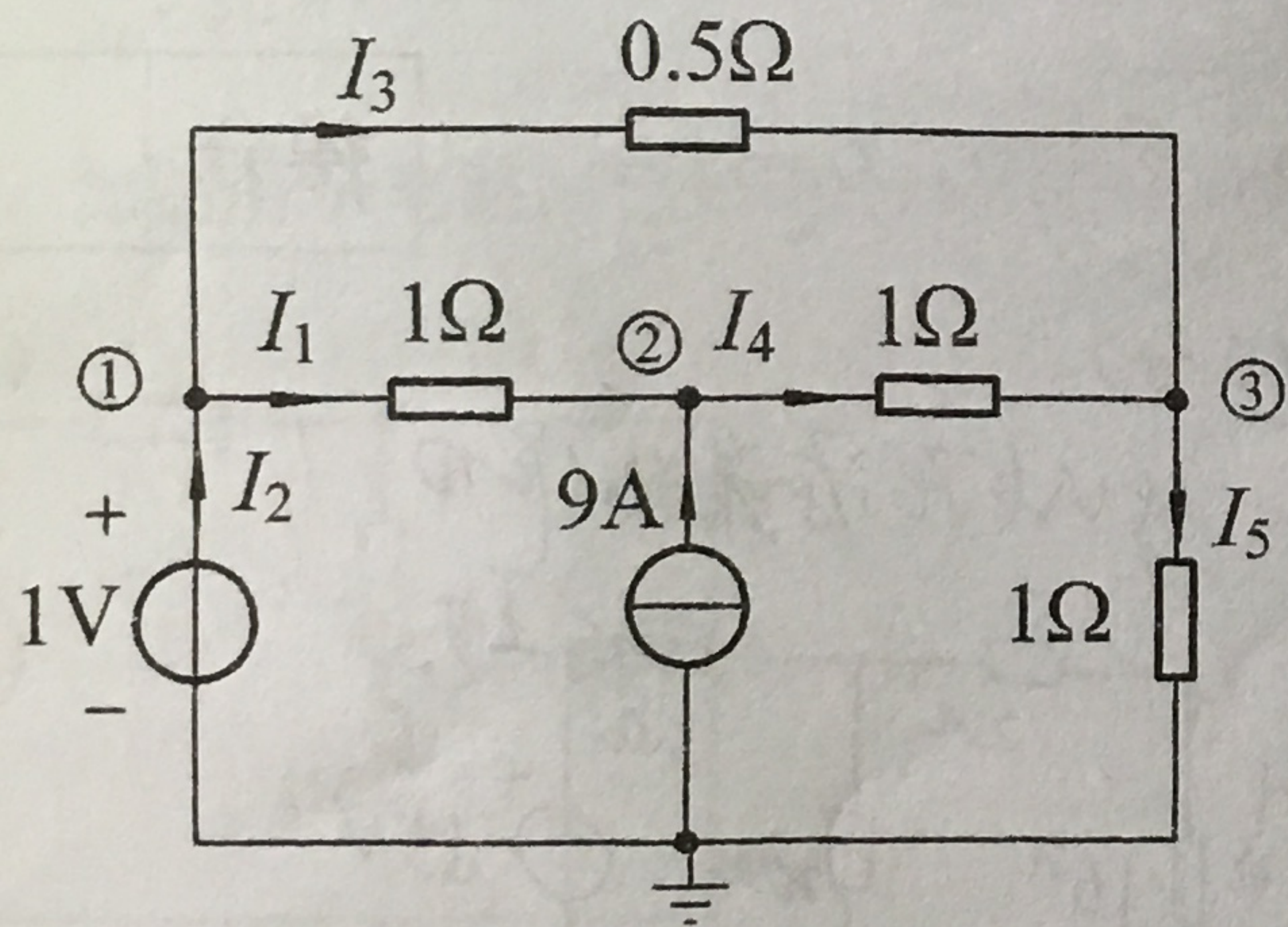


利用变阻抗性质

理想变压器二次侧对一次侧的等效阻抗为 $n^2 \cdot Z \dots 1'$

则 $R_{ab} = 3^2 \times (8 + 2^2 \times 2) = 144 \text{ (}\Omega\text{)} \dots 3'$

三. 用结点电压法求解电流 I_1 、 I_2 、 I_3 、 I_4 、 I_5 。(12分)



得分	
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结点① $U_{n1} = 1\text{V} \dots 3'$

结点②: $-U_{n1} + (1+1)U_{n2} - U_{n3} = 9 \dots 3'$

——③ $-\frac{1}{0.5}U_{n1} - U_{n2} + (\frac{1}{0.5} + 1 + 1)U_{n3} = 0 \dots 3'$

求解: $U_{n2} = 6\text{V} \dots 1'$ $U_{n3} = 2\text{V} \dots 1'$

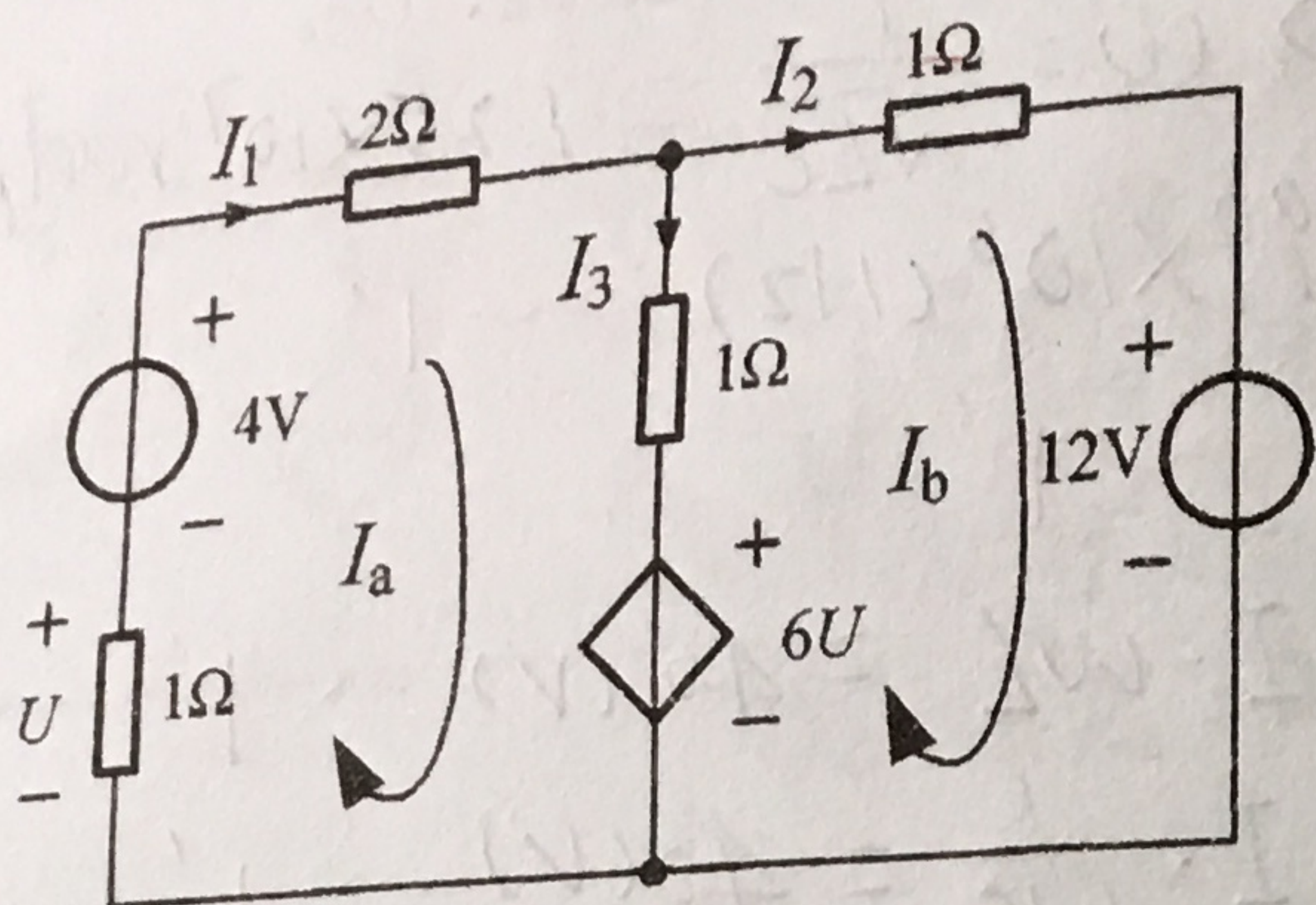
$\therefore I_1 = \frac{U_{n1} - U_{n2}}{1} = -5\text{A}$, $I_3 = \frac{U_{n1} - U_{n3}}{0.5} = -2\text{A}$. $I_2 = I_1 + I_3 = -7\text{A}$

同理 $I_4 = 4\text{A}$. $I_5 = 2\text{A}$. 支路电流合计 $1'$

四. 用网孔求图示电路中的电流 I_1 、 I_2 、 I_3 。(9分)

得分

六. 图中 R_L



$$\begin{cases} (2+1+1)I_1 - I_2 = 4 - 6U & 2' \\ -I_1 + (1+1)I_2 = 6U - 12 & 2' \\ \text{补充 } U = -1 \times I_1 & 2' \end{cases} \Rightarrow \begin{cases} I_1 = -4A \\ I_2 = 4A \\ U = 4V \end{cases}$$

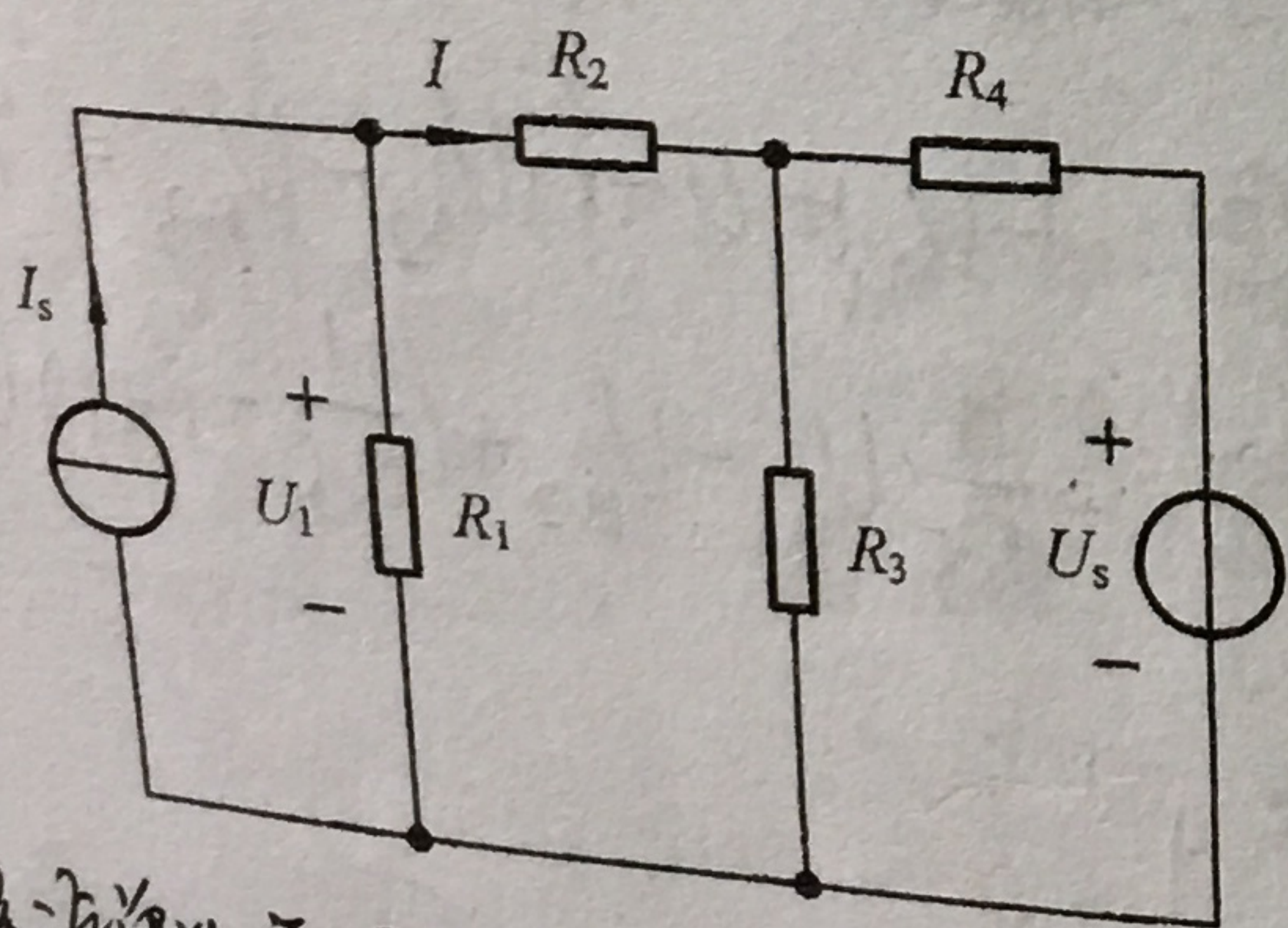
$$\therefore I_1 = I_a = -4A, I_2 = I_b = 4A, I_3 = I_a - I_b = -8A$$

五. 已知 $R_1=16\Omega$, $R_2=2\Omega$, $R_3=20\Omega$, $R_4=5\Omega$, $U_s=55V$,

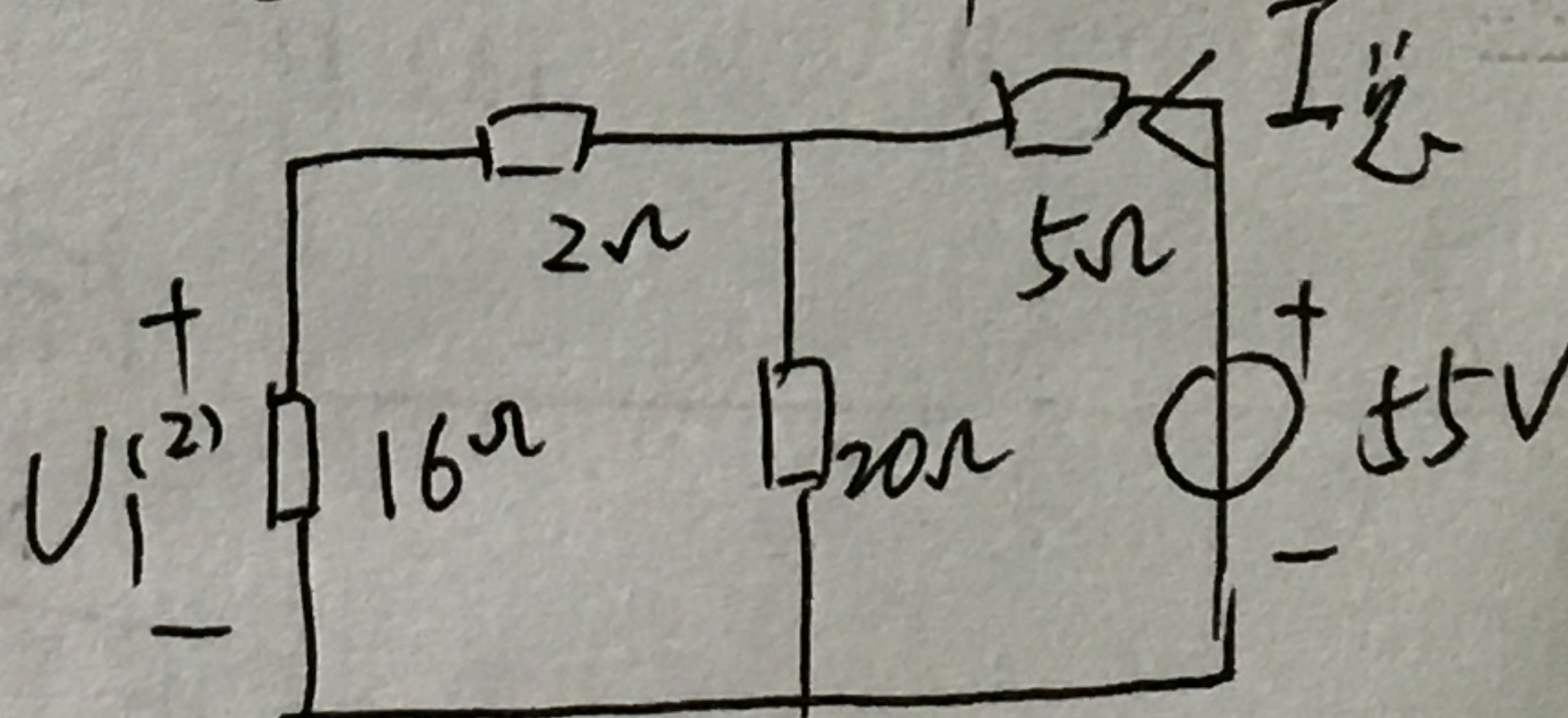
得分

七. 如图所示

$I_s=11A$, 用叠加定理求电流 I 、电压 U_1 。(8分)



②. 55V电压源单独作用. 4'



$$R_{\Sigma} = 18 \parallel 20 + 5 = \frac{150}{38}$$

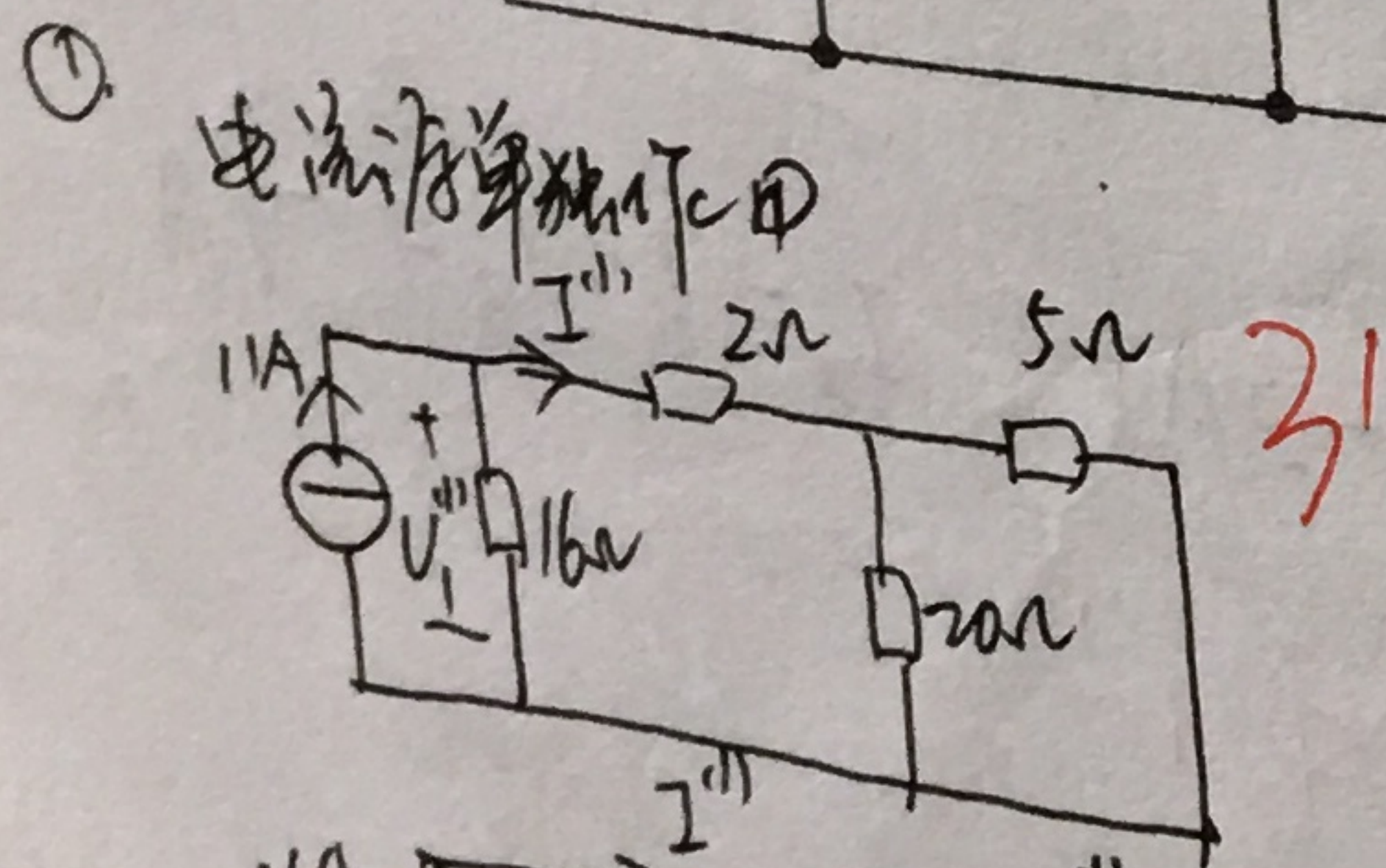
$$I_{\Sigma} = \frac{55}{R_{\Sigma}} = \frac{55}{\frac{150}{38}} = 3.8A$$

$$I^{(2)} = -\frac{20}{18+20} \times 3.8 = -2A$$

$$U_1^{(2)} = -16I^{(2)} = 32V$$

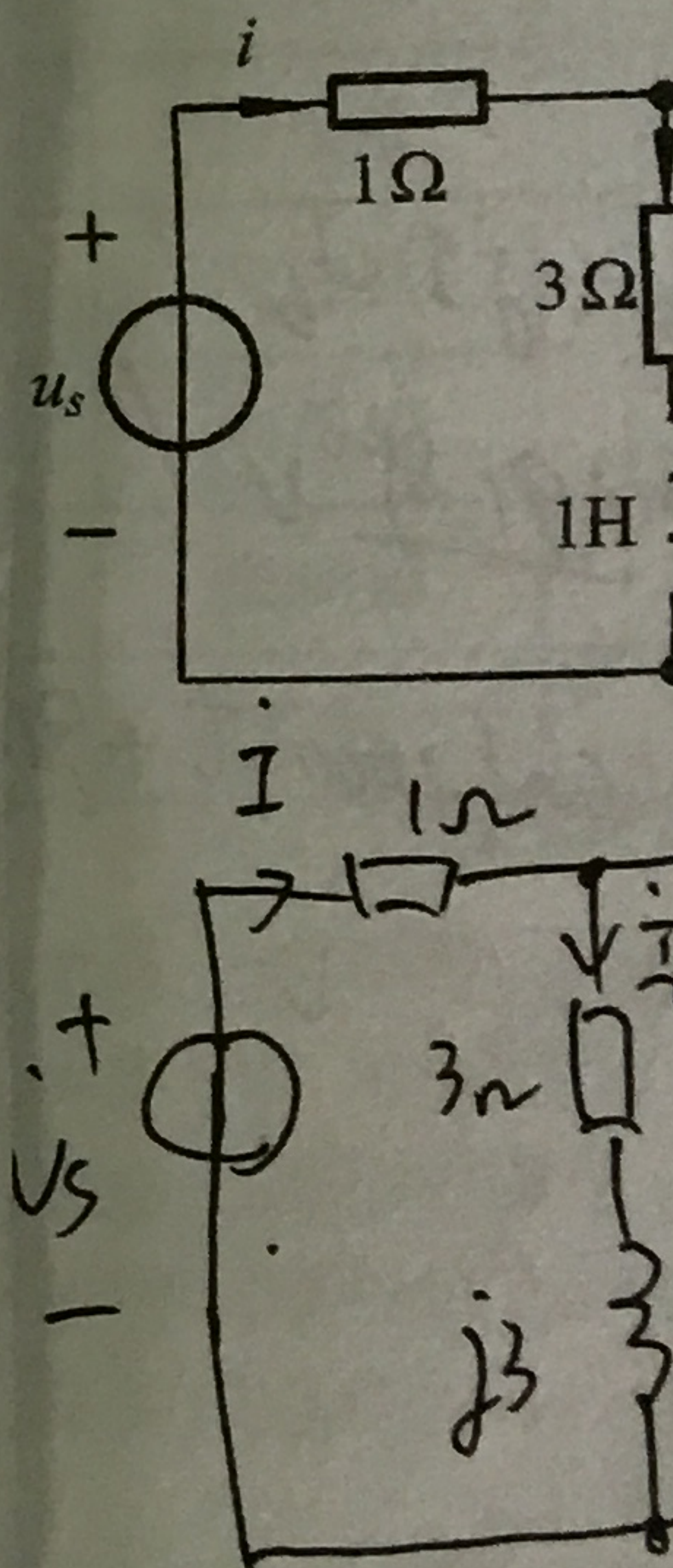
③. $I = I^{(1)} + I^{(2)} = 6A$

$$U_1 = U_1^{(1)} + U_1^{(2)} = 80V$$

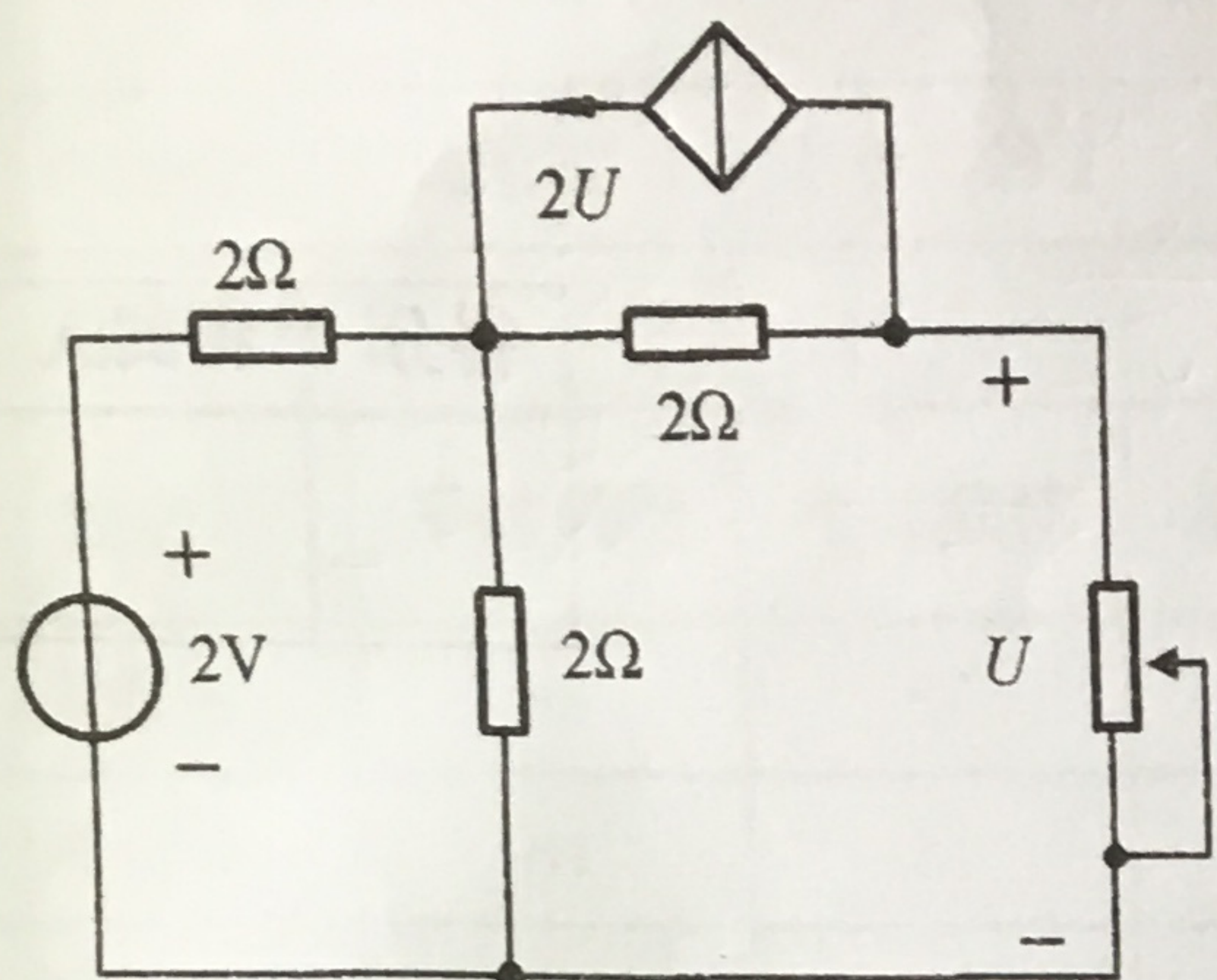


$$I_F = \frac{16}{16+6} \times 11 = 8A$$

$$U_1^{(1)} = 6I^{(1)} = 48V$$

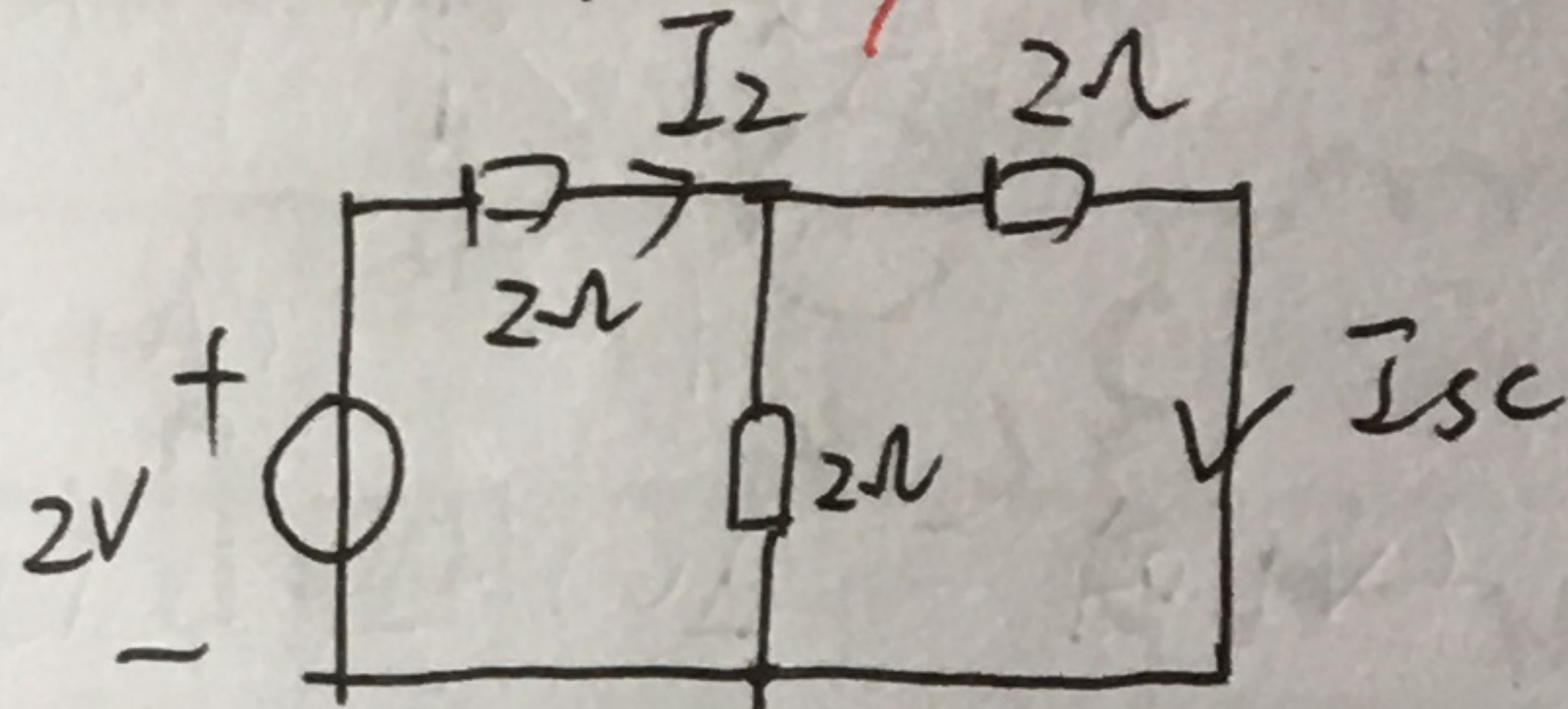


六. 图中 R_L 可变, 试当 R_L 为多大时可获得最大功率, 并求此功率。(8 分)



得分

② 求 R_{eq}



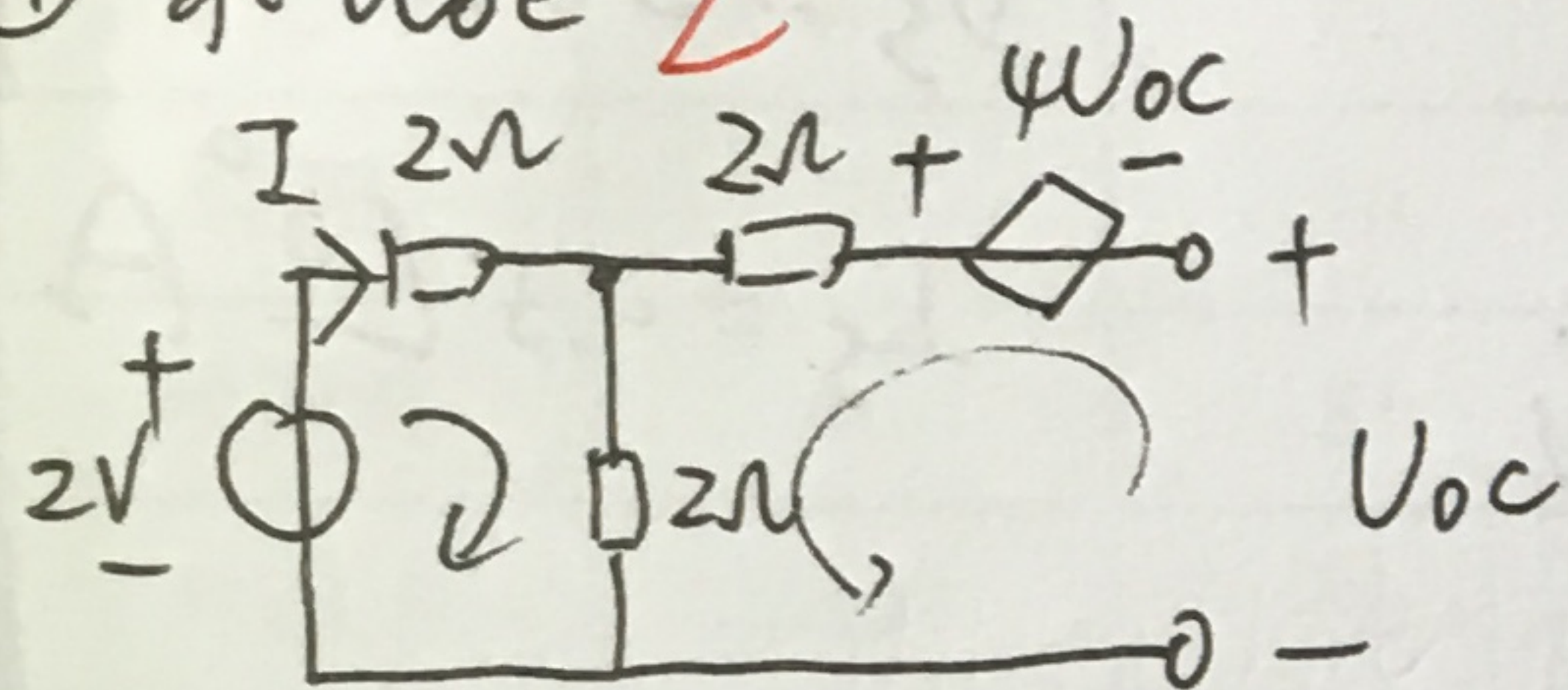
$$R_{eq} = 2 // 2 + 2 = 3\Omega$$

$$I_2 = \frac{2}{3} A$$

$$I_{sc} = \frac{1}{3} A$$

$$R_{eq} = \frac{U_{oc}}{I_{sc}} = \frac{0.2}{\frac{1}{3}} = 0.6\Omega$$

① 求 U_{oc}

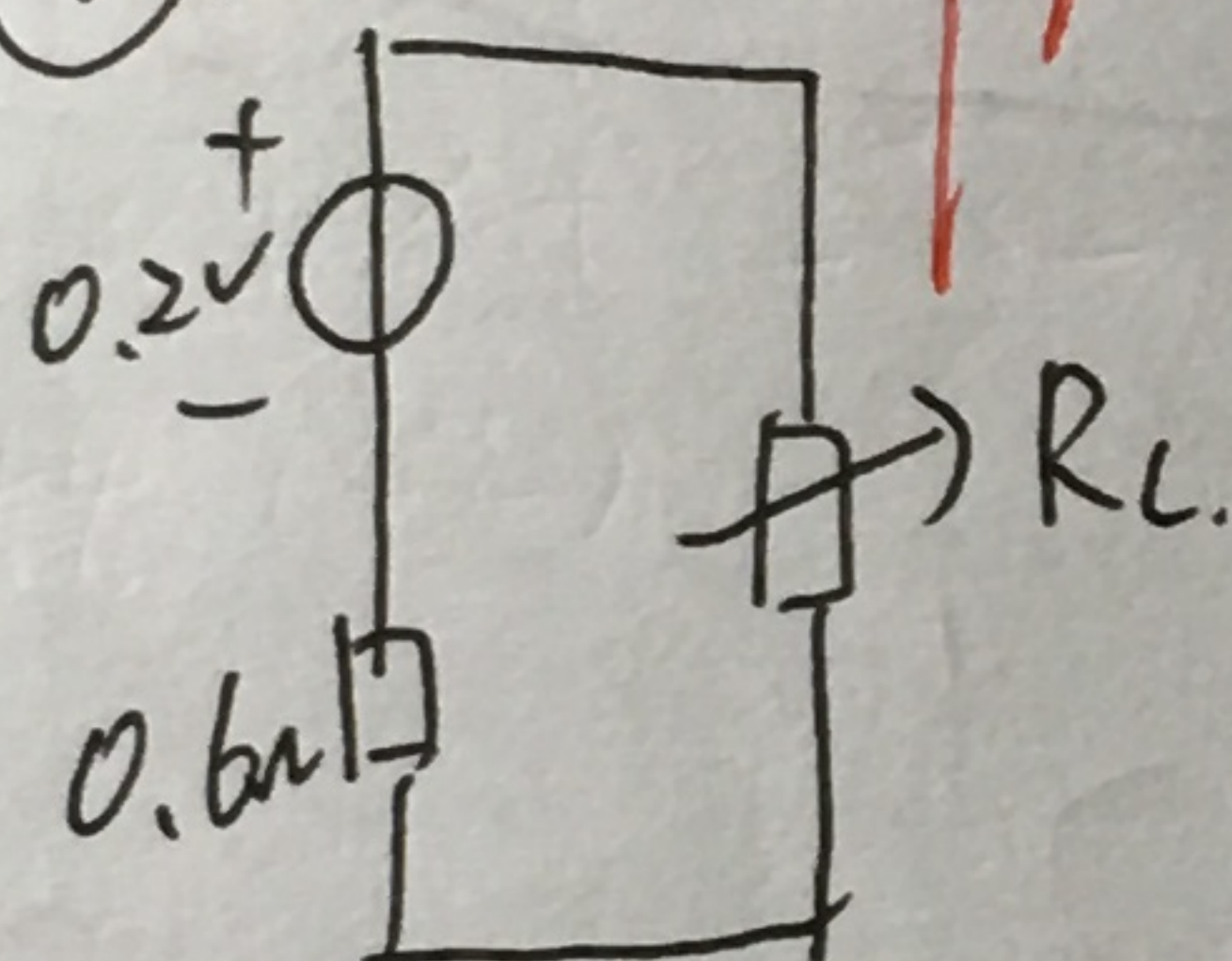


$$I = \frac{2}{2+2} = 0.5 A$$

$$-U_{oc} - 4U_{oc} + 2I = 0$$

$$U_{oc} = 0.2V$$

③

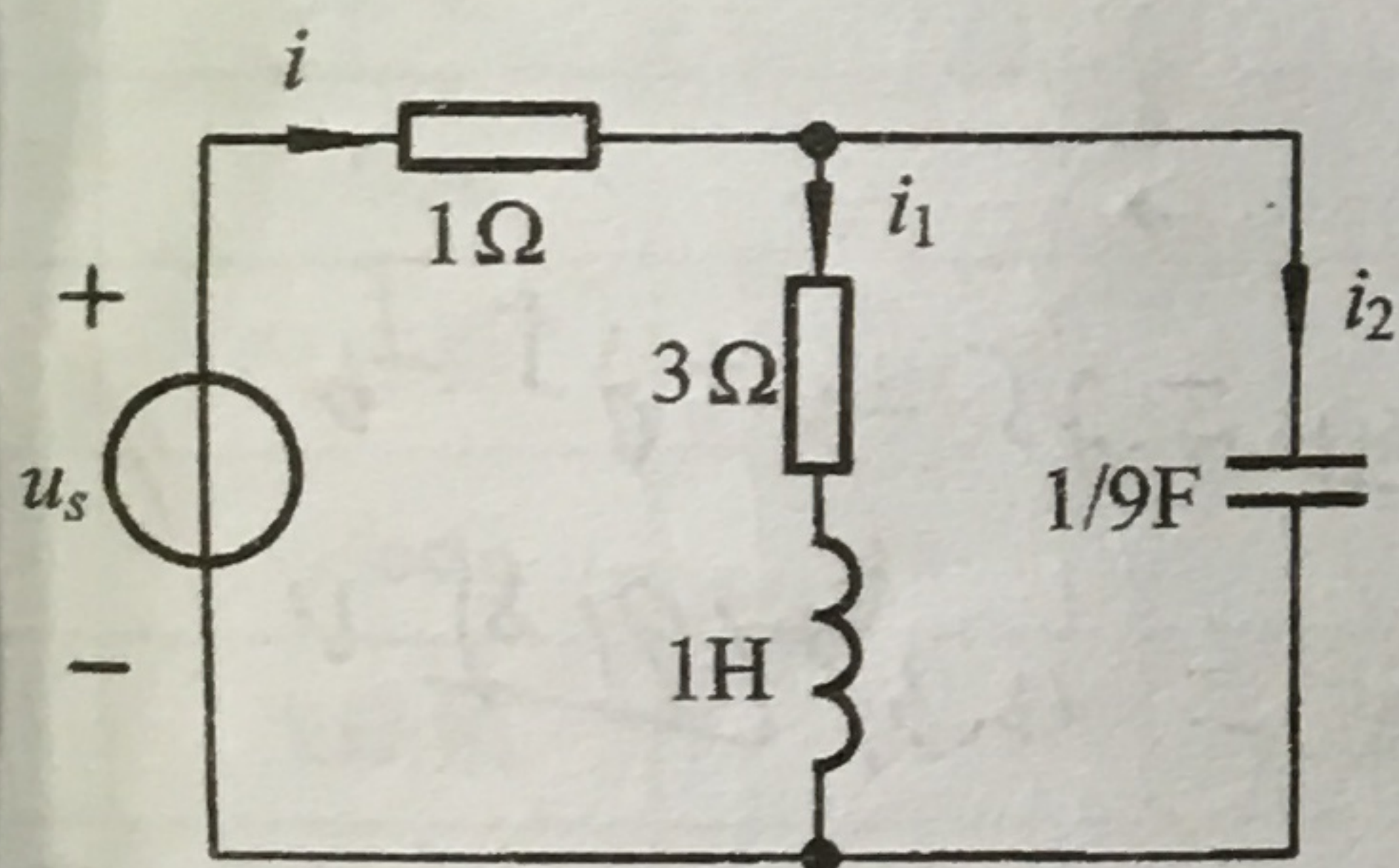


④ 当 $R_L = R_{eq} = 0.6\Omega$ 时获得最大功率

$$P_{max} = \frac{U_{oc}^2}{4R_{eq}} = \frac{0.2^2}{4 \times 0.6} = \frac{1}{60} W$$

得分

七. 如图所示电路, 已知 $u_s(t) = 5\sqrt{2}\cos(3t)$, 试求 $i(t)$ 、 $i_1(t)$ 和 $i_2(t)$ 。(10 分)



$$\dot{U}_s = 5\angle 0^\circ V$$

$$Z = 1 + \frac{(3+j3)(-j3)}{3+j3-j3} = 4-j3 \Omega$$

$$\dot{I} = \frac{\dot{U}_s}{Z} = 1\angle 36.86^\circ A$$

$$\dot{I}_1 = \frac{-j3}{3+j3-j3} \dot{I} = 1\angle -53.13^\circ A$$

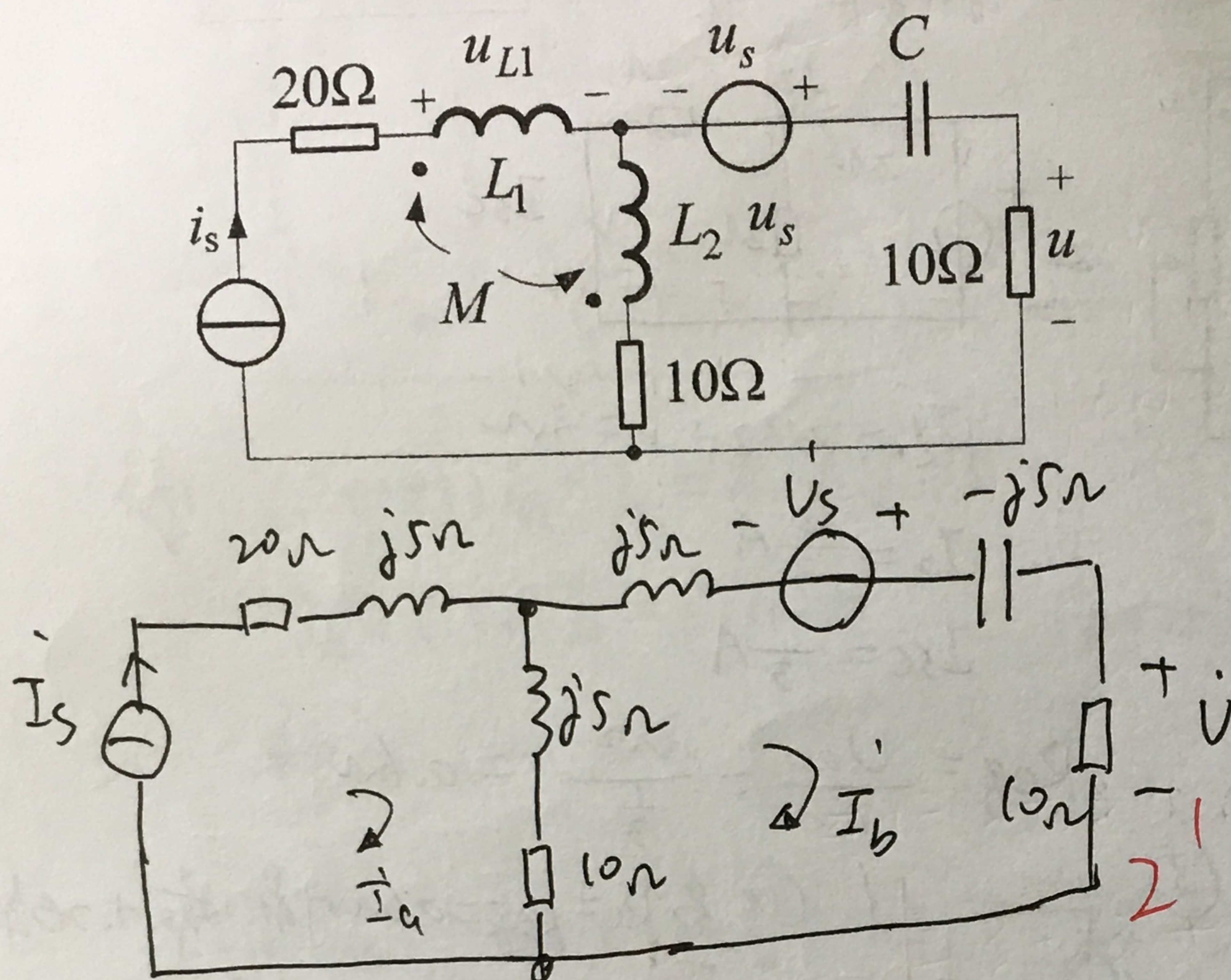
$$\dot{I}_2 = \frac{3+j3}{3+j3-j3} \dot{I} = \sqrt{2}\angle 81.86^\circ A$$

$$i = \sqrt{2} \cos(3t + 36.86^\circ) A$$

$$i_1 = \sqrt{2} \cos(3t - 53.13^\circ) A$$

$$i_2 = 2 \cos(3t + 81.86^\circ) A$$

八. 电路如图所示, $u_s = 2.5\sqrt{2}\cos(20000t)V$, $i_s = 0.5\sqrt{2}\cos(20000t)A$,
 $L_1 = L_2 = 0.5mH$, $M = 0.25mH$, $C = 10\mu F$, 求电压 u 、电压 u_{L1} 。(12分)



得分	评阅人

$$\dot{U}_s = 2.5\angle 0^\circ V$$

$$\dot{I}_s = 0.5\angle 0^\circ A$$

$$\dot{I}_a = 0.5\angle 0^\circ$$

$$-(10 + j5)\dot{I}_a + (10 + 10 + j5)\dot{I}_b = 2.5\angle 0^\circ$$

$$\text{得: } \dot{I}_b = 0.38\angle 4.39^\circ A$$

$$\dot{U} = 10\dot{I}_b = 3.8\angle 4.39^\circ V$$

$$u = 3.8\sqrt{2}\cos(20000t + 4.39^\circ) V$$

$$\dot{U}_{L1} = j5\dot{I}_s + j5\dot{I}_b$$

$$= 4.39\angle 91.89^\circ V$$

$$u_{L1} = 4.39\sqrt{2}\cos(20000t + 91.89^\circ) V$$