《Fundamentals of Electric Circuits》 homework CH.13

13.14 **Obtain the Thevenin equivalent circuit for the circuit in Fig. 13.83 at terminals a-b.** (10')

$j\omega M = 2j$

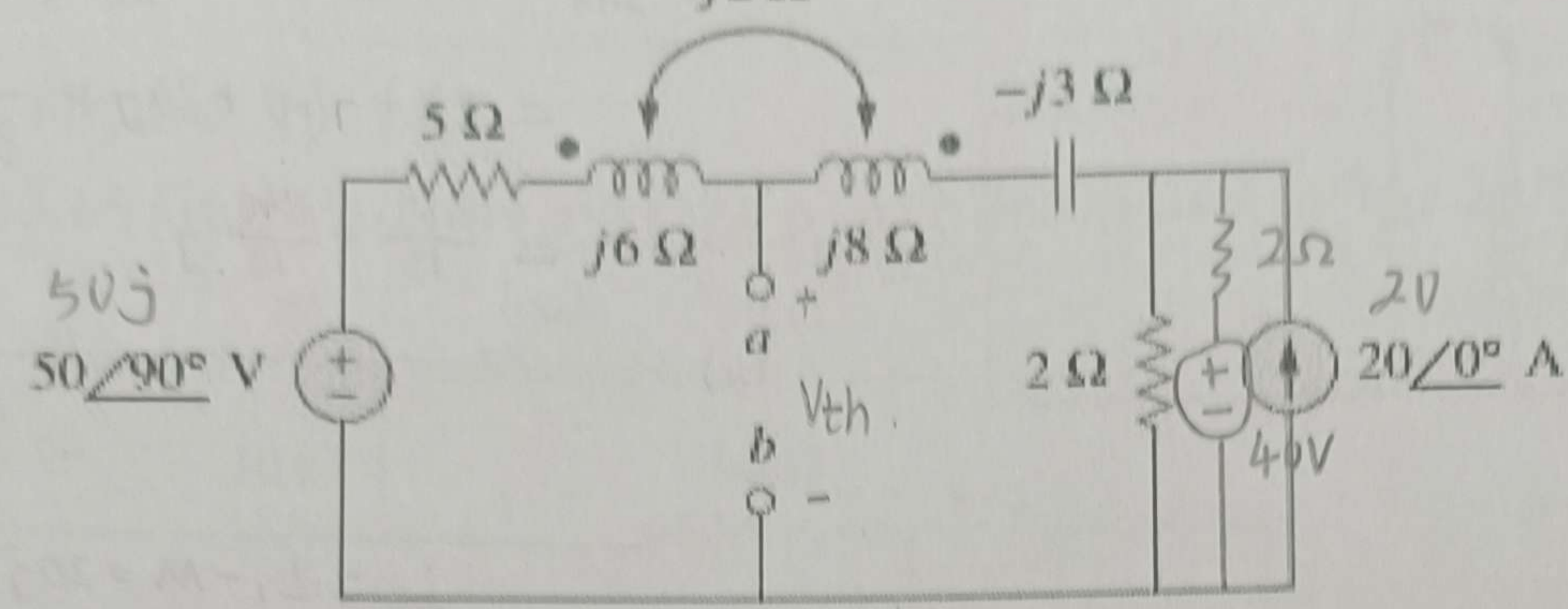


Figure 13.83

解: for the whole loop: I

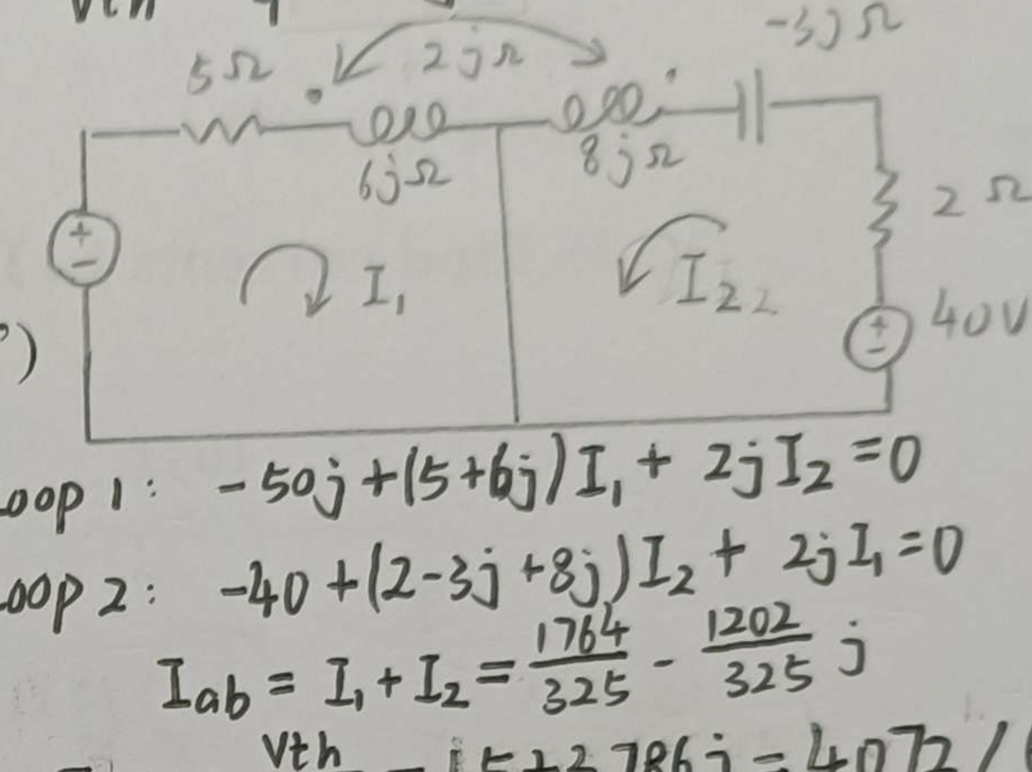
$L_{eq} = L_1 + L_2 - 2M = 10j\ \Omega$

$-50j + (5 + 10j - 3j + 2)I + 40 = 0$

$I = \frac{5}{7} + \frac{45}{7}j$

$V_{th} - 50j + (5 + 6j)I - 2jI = 0$

$V_{th} = \frac{155}{7} + 15j = 26.75\angle 34.11°$ $\boxed{ANS}$



Loop 1: $-50j + (5 + 6j)I_1 + 2jI_2 = 0$

Loop 2: $-40 + (2 - 3j + 8j)I_2 + 2jI_1 = 0$

$I_{ab} = I_1 + I_2 = \frac{1764}{325} - \frac{1202}{325}j$

$Z_{th} = \frac{V_{th}}{I_{ab}} = 1.5 + 3.786j = 4.072\angle 68.39°$ $\boxed{ANS}$

$\frac{1}{j\omega C} = \frac{1}{j \times 2 \times 0.5}$

13.25 **For the network in Fig.13.94, find Z_{ab} and I_o.** (10')

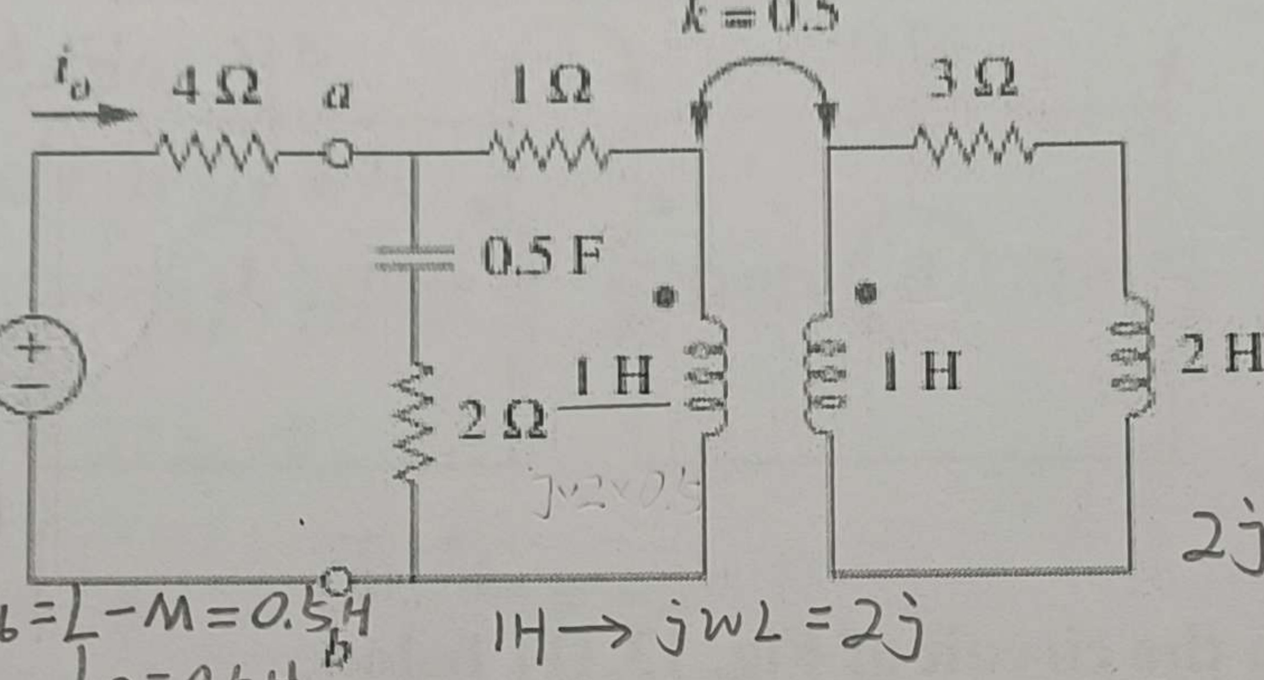
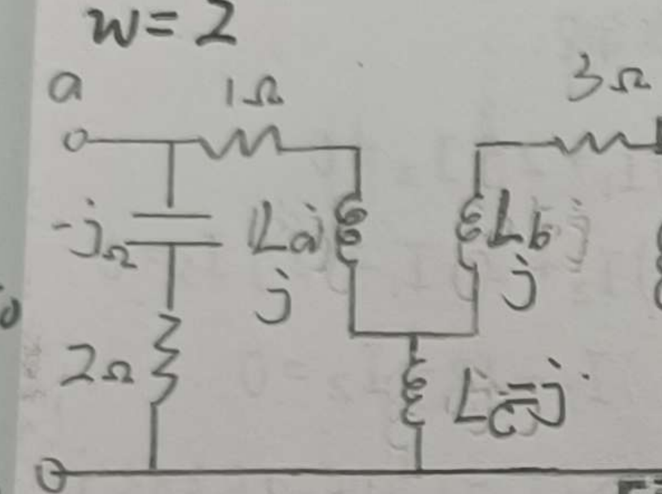


Figure 13.94

13.25解:

$k = 0.5 = \frac{M}{\sqrt{L_1 L_2}} \Rightarrow M = 0.5H$

$w = 2$



$L_a = L_b = L - M = 0.5H$

$L_c = 0.5H$

$1H \rightarrow j\omega L = 2j$

$\vec{Z}_{ab} = (2 - j) \parallel [(1 + j) + j \parallel (5j + 3)]$

$= \frac{656}{457} + \frac{212}{457}j = 1.435 + 0.4639j$ $\boxed{ANS}$

$\vec{I}_o = \frac{12(-j)}{4 + 1.435 + 0.4639j}$

$= -0.1871 - 2.192j$ $\boxed{ANS}$

13.28 **In the circuit of Fig.13.97, find the value of X that will give maximum power transfer to the 20-Ω load.** (10') $j\omega M$

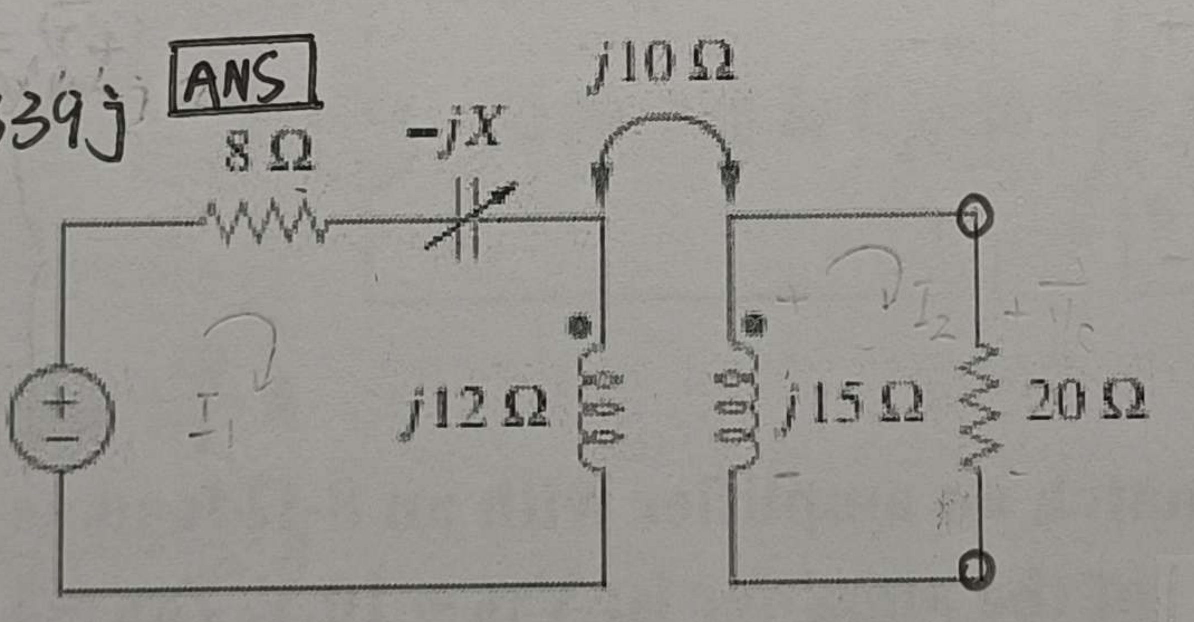
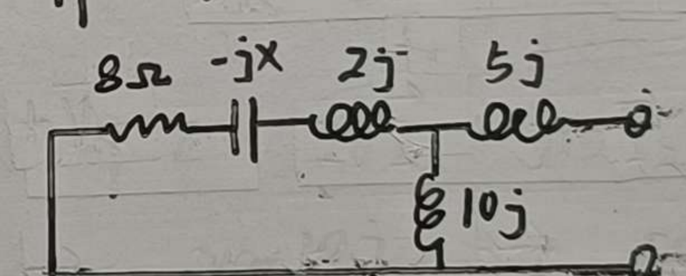


Figure 13.97

解: if $|\vec{Z}_{th}| = 20$, we get max P_L



$\vec{Z}_{th} = [8 + (2 - X)j] \parallel 10j + 5j$

$= \frac{(15X - 80) + 120j}{8 + (12 - X)j}$

$\frac{(15X - 80)^2 + 120^2}{8^2 + (12 - X)^2} = 20^2 \Rightarrow X_1 = 28.73, X_2 = 12.41$ $\boxed{ANS}$

13.29 **In the circuit of Fig.13.98, find the value of the coupling coeficient k that will make the 10-Ω resistor dissipate 320 W. For this value of k, find the energy stored in the coupled coils at $t = 1.5$s.** (10')

13.29 解:

$k = \frac{M}{\sqrt{L_1 L_2}} \Rightarrow M = 38.73k$ mH

$P_{R\,avg} = 320W = I_{rms}^2 \cdot R$

$I_{rms} = 4\sqrt{2}$ A

$|\vec{I}_1| = 8$ A, $w = 1000$ rad/s

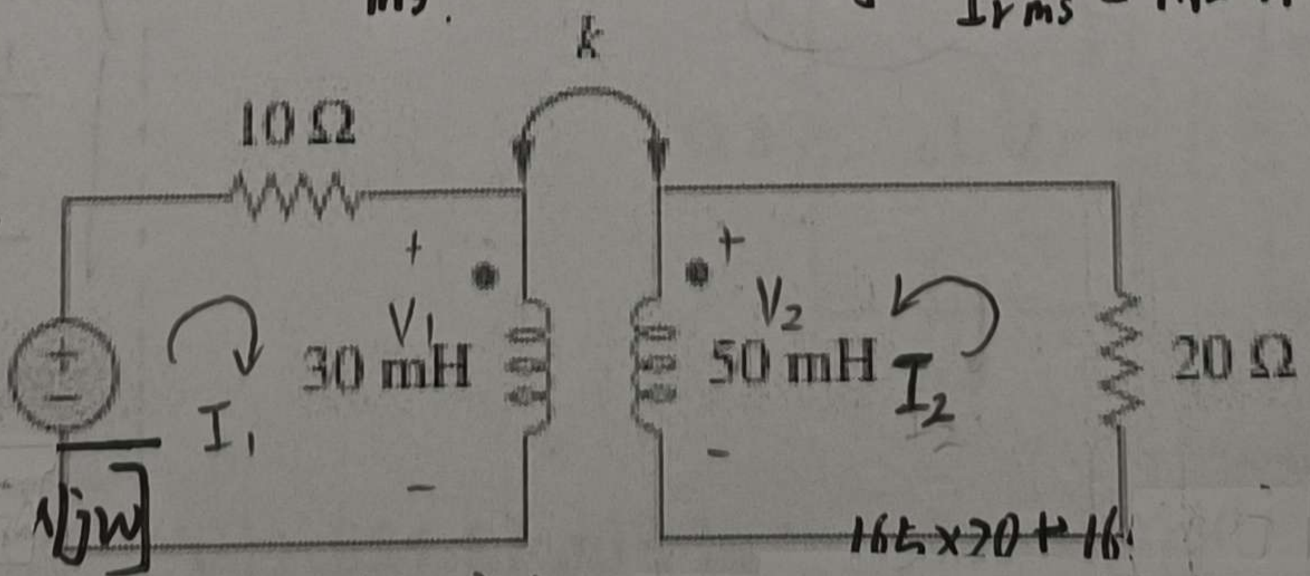


Figure 13.98

$\vec{I}_1 = \frac{\vec{V}}{\vec{Z}_{in}} = \frac{165\angle 0°}{10 + j30 + \frac{38.73^2 k^2}{20 + j50}}$

$= \frac{165(20 + 50j)}{(10 + 30j)(20 + 50j) + 38.73^2 k^2}$

$= \frac{165 \times 20 + 165 \times 50j}{(200 - 1500 + 38.73^2 k^2) + 1100j}$

$\frac{(165 \times 20)^2 + (165 \times 50)^2}{(-1300 + 38.73^2 k^2)^2 + 1100^2} = 8^2$

计算器求解

$\Rightarrow k = 0.9845$ $\boxed{ANS}$

$w = \frac{1}{2}L_1 I_1^2 + \frac{1}{2}L_2 I_2^2 + MI_1 I_2$

$\vec{I}_1 = 7.768 - 1.913j = 8.00\cos(wt - 13.83°)$

$j\omega L_2 \cdot I_2 + j\omega M I_1 + 20I_2 = 0$

$\vec{I}_2 = \frac{-j\omega M I_1}{j\omega L_2 + 20}$

$= \frac{-j \times 38.73 \times 0.9845 \times (7.768 - 1.913j)}{j \times 50 + 20}$

$= -5.610 - 0.7851j = 5.665\cos(wt - 172.0°)$

$i_1 = 8\cos\left(\frac{1.5 \times 180°}{\pi} - 13.83\right) = 2.457$ A

$i_2 = 5.665\cos\left(\frac{1.5 \times 180°}{\pi} - 172\right) = 0.3896$ A

$W = 130.88$ mJ $\boxed{ANS}$

13.30 **(a) Find the input impedance of the circuit in Fig.13.99 using the concept of reflected impedance.**

(b) Obtain the input impedance by replacing the linear transformer by its T quivalent. (10')

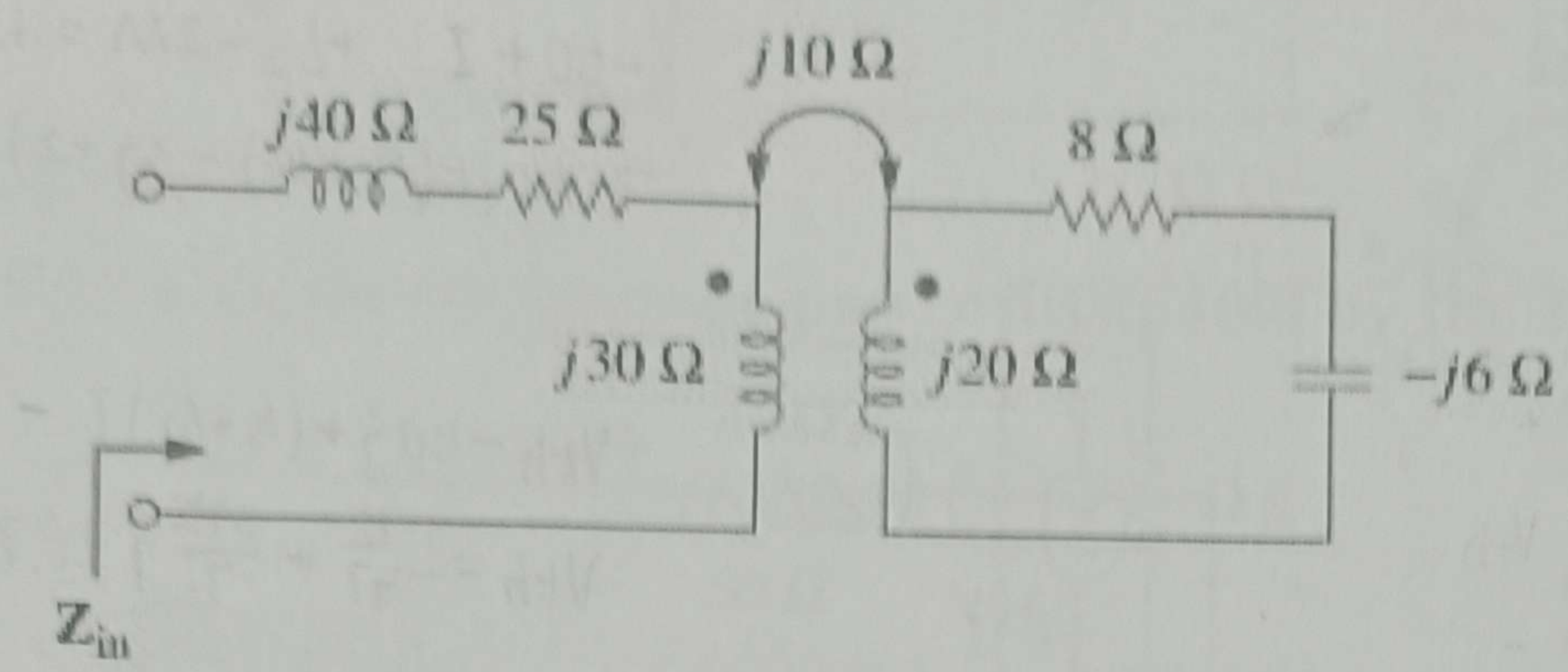


Figure 13.99

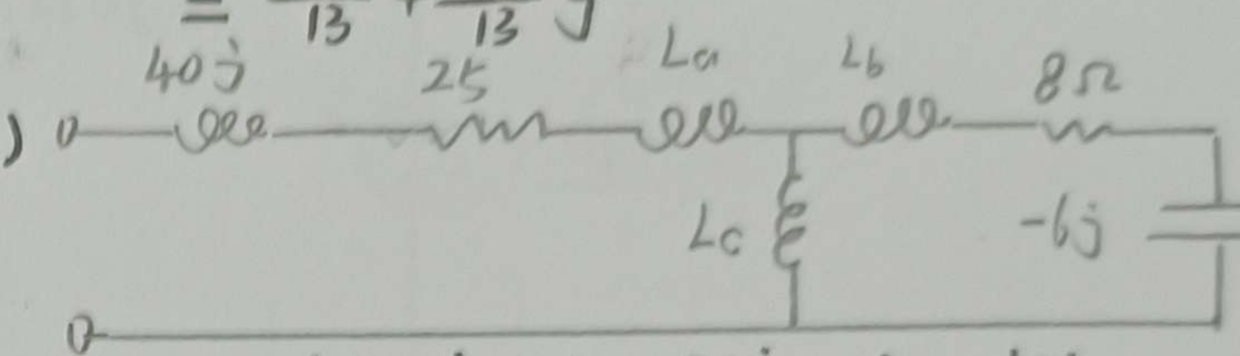
解:

(a) $\overrightarrow{Z_{in}} = R_1 + jwL_1 + \dfrac{w^2M^2}{R_2 + jwL_2 + Z_L}$

$= 25 + j40 + 30j + \dfrac{100}{8 - 6j + 20j}$

$= \dfrac{365}{13} + \dfrac{840}{13}j$

(b)



$La = L_1 - M = 20j$, $Lc = 10j$

$Lb = L_2 - M = 10j$

$Z_{in} = 40j + 25 + 20j + 10j \,||\, (8 - 6j + 10j)$

$= 60j + 25 + \dfrac{10j(8+4j)}{10j + 8 + 4j}$

$= \dfrac{365}{13} + \dfrac{840}{13}j$

13.35 Find currents I_1, I_2, and I_3 in the circuit of Fig.13.104. (10')

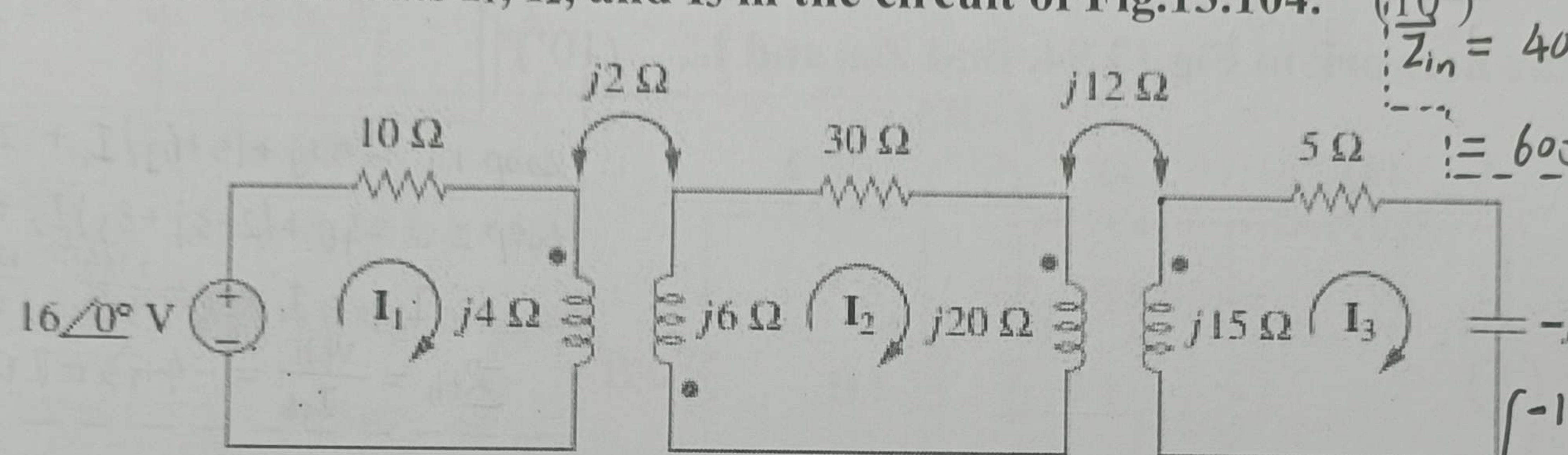


Figure 13.104

13.35 解:

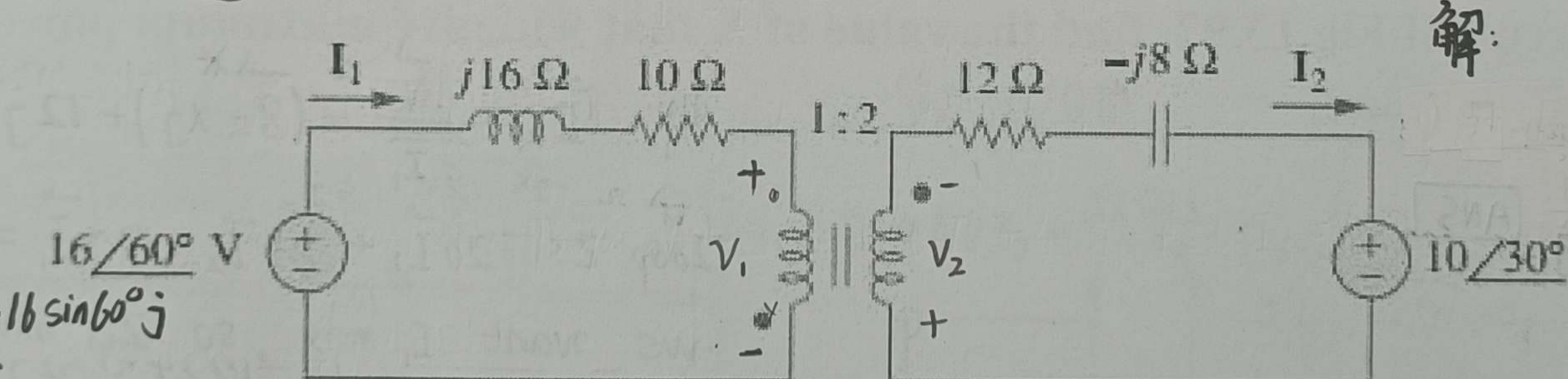
$\begin{cases} -16 + (10 + 4j)I_1 + 2jI_2 = 0 \\ (30 + 20j + 6j)I_2 + 2jI_1 - 12jI_3 = 0 \\ (5 - 4j + 15j)I_3 - 12jI_2 = 0 \end{cases}$

$\Rightarrow \begin{cases} I_1 = 1.374 - 0.5383j \\ I_2 = -0.0554 - 0.0557j \\ I_3 = -0.0272 - 0.0731j \end{cases}$

13.46 **(a) Find I_1 and I_2 in the circuit of Fig. 13.111 below.**

(b) Switch the dot on one of the windings. Find I_1 and I_2 again. (10')

解:



$16\cos 60° + 16\sin 60° j$

$= 8 + 8\sqrt{3}j$

Figure 13.111

a) $\begin{cases} -16\angle 60° + (16j + 10)I_1 + V_1 = 0 \\ 10\angle 30° + V_2 + (12 - 8j)I_2 = 0 \\ \dfrac{V_2}{V_1} = +n = 2 \\ \dfrac{I_1}{I_2} = -n = -2 \end{cases}$

$= 1.07\angle 5.9°$

$\Rightarrow I_1 = 1.067 + 0.1096j$

$I_2 = -0.5333 - 0.0548j$

b) Switch dot $= 0.54\angle -174.1°$

$\begin{cases} -16\angle 60° + (16j + 10)I_1 + V_1 = 0 \\ 10\angle 30° + V_2 + (12 - 8j)I_2 = 0 \\ \dfrac{V_2}{V_1} = -2 \\ \dfrac{I_1}{I_2} = 2 \end{cases}$

$\Rightarrow I_1 = 0.5630 + 0.2637j = 0.63\angle 25°$

$I_2 = 0.2831 + 0.1319j = 0.31\angle 25°$

13.54 A transformer is used to match an amplifier with an 8-Ω load as shown in Fig. 13.119. The Thevenin equivalent of the amplifer is: V_{Th} = 10 V, Z_{Th} = 128 Ω.

(a) Find the required turns ratio for maximum energy power transfer.

(b) Determine the primary and secondary currents.

(c) Calculate the primary and secondary voltages. (10')

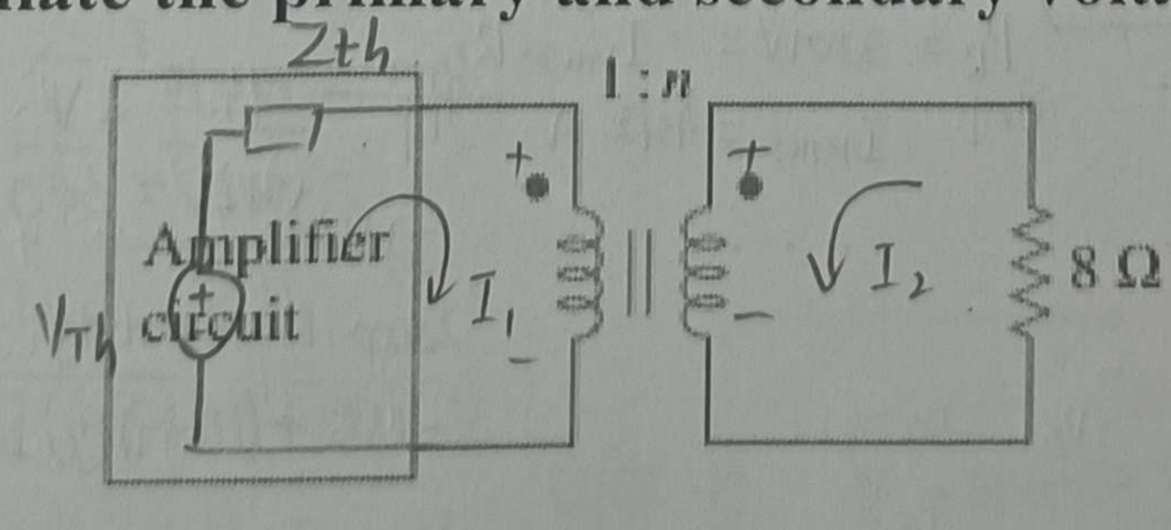


Figure 13.119

13.54

解: a) $\begin{cases} -V_{Th} + I_1 \cdot Z_{th} + V_1 = 0 \\ V_2 + 8I_2 = 0 \\ \dfrac{V_2}{V_1} = n \\ \dfrac{I_1}{I_2} = -n \end{cases}$

$\Rightarrow I_2 = \dfrac{-10}{128n + \frac{8}{n}}$

$I_{2\,max} \Rightarrow 128n = \dfrac{8}{n}$

$n = \dfrac{1}{4}$

13.63 Find the mesh currents in the circuit of Fig. 13.128. (10')

b) $I_2 = \dfrac{-10}{64} = -\dfrac{5}{32}$ A

$I_1 = -\dfrac{1}{4} \times \dfrac{-10}{64} = \dfrac{5}{128}$ A

c) $V_2 = -8I_2 = 1.25$ V

$V_1 = 5$ V

13.63解:
$$\begin{cases} -12\angle 0^\circ + I_1 + V_1 = 0 \\ +V_{21} + I_2(7-6j) + V_{22} = 0 \\ +V_3 + I_3(9+18j) = 0 \end{cases}$$

$$\frac{I_1}{I_2} = 2 \qquad \frac{V_{21}}{V_1} = -2$$

$$\frac{I_2}{I_3} = -3 \qquad \frac{V_3}{V_{22}} = 3$$

$$\Rightarrow \begin{cases} I_1 = 3.6 + 1.2j \\ I_2 = 1.8 + 0.6j \\ I_3 = -0.6 - 0.2j \end{cases}$$

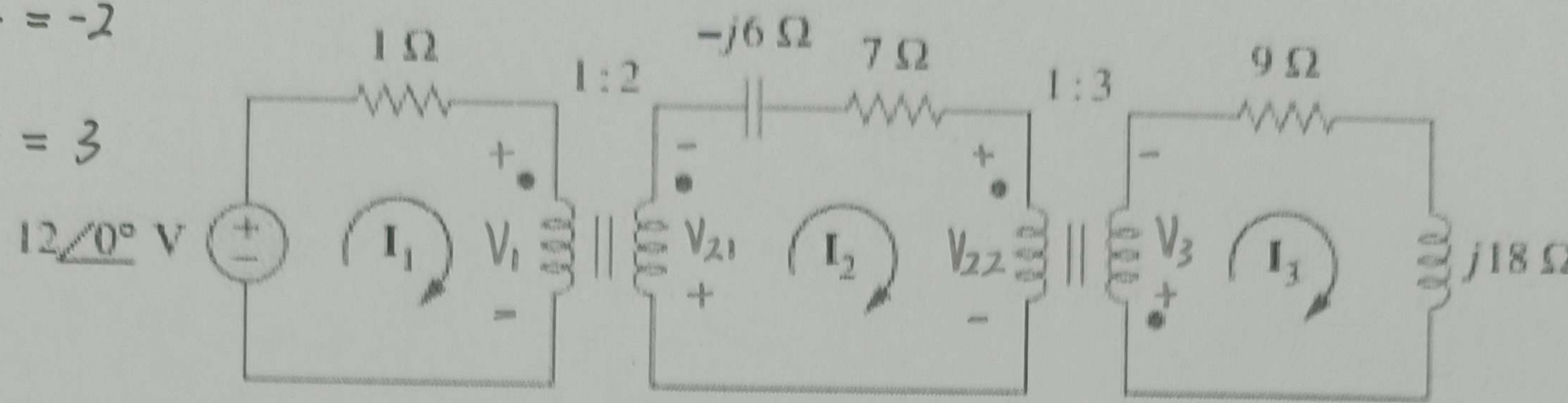


Figure 13.128

13.65 Calculate the average power dissipated by the 20-Ω resistor in Fig. 13.130. (10')

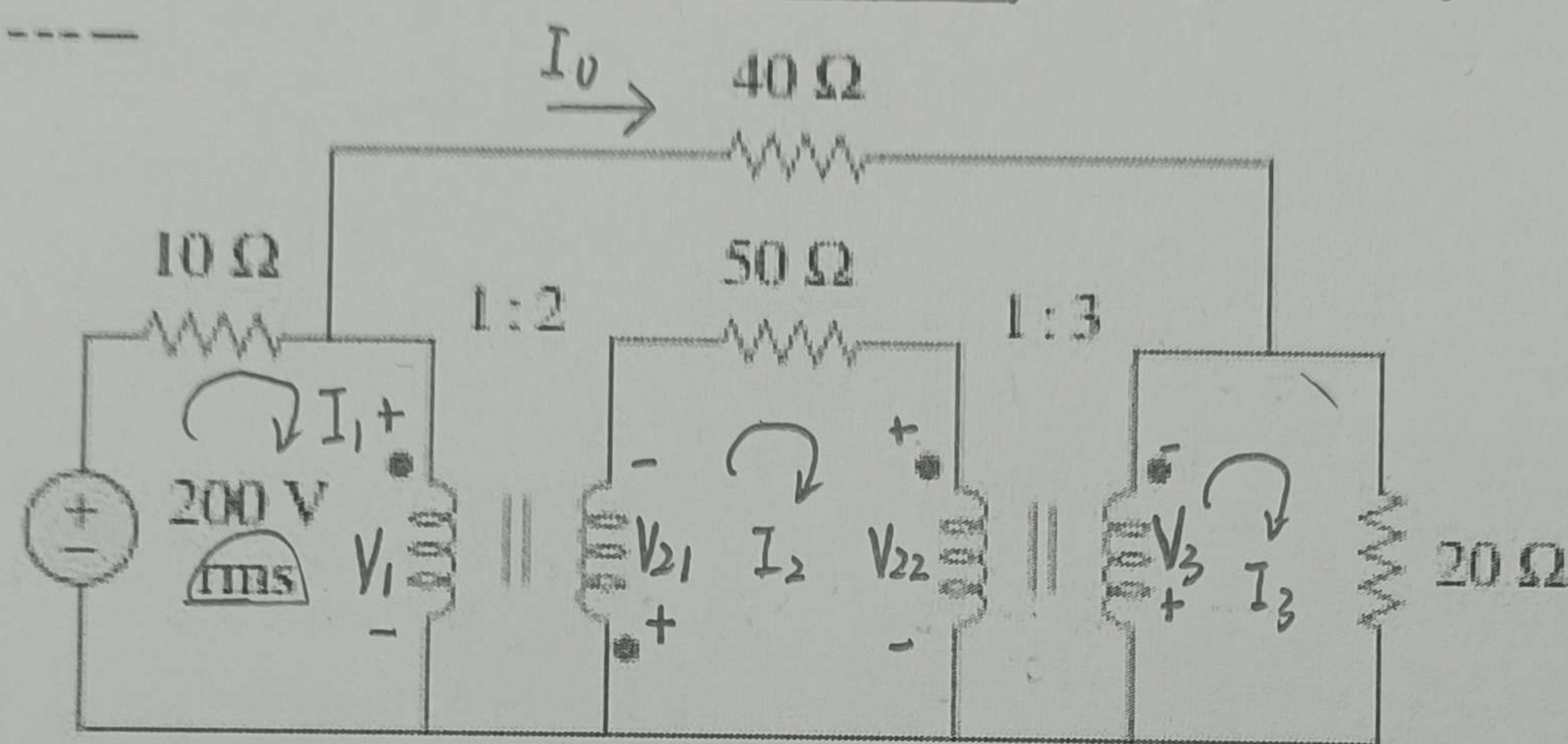


Figure 13.130

解:
$$-200 + 10I_1 + V_1 = 0$$
$$+V_{21} + 50I_2 + V_{22} = 0$$
$$V_3 + 20I_3 = 0$$

$$\frac{V_{21}}{V_1} = 2 \qquad \frac{I_1 - I_0}{I_2} = -2$$

$$\frac{V_3}{V_{22}} = -3 \qquad \frac{I_2}{I_3 - I_0} = 3$$

unknowns: $I_1, I_2, I_3, V_1, V_{21}, V_{22}, V_3, I_0$; 8

the outer loop: $-200 + 10I_1 + 40I_0 + 20I_3 = 0$

8 equations.

$$\Rightarrow \begin{cases} I_3 = \frac{84}{113}\text{ A} \\ I_2 = -\frac{456}{113}\text{ A} \\ I_1 = \frac{1148}{113}\text{ A} \end{cases}$$

$$P_{R,avg} = R \cdot I_3^2 = 11.05\text{ W}$$