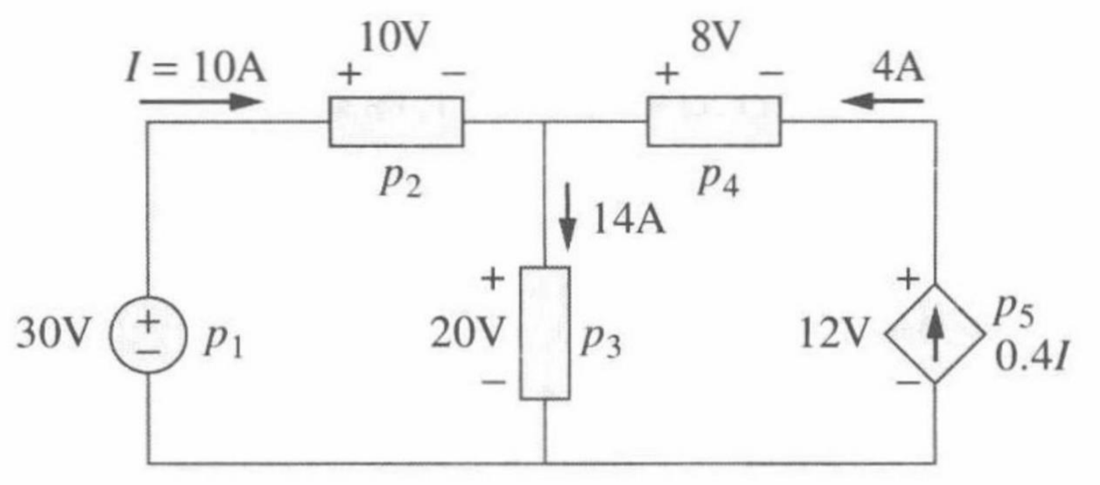
1.18 计算下图中各个元件的吸收的功率。



解：

$p_1 = 30(-10) =$ **-300 W**

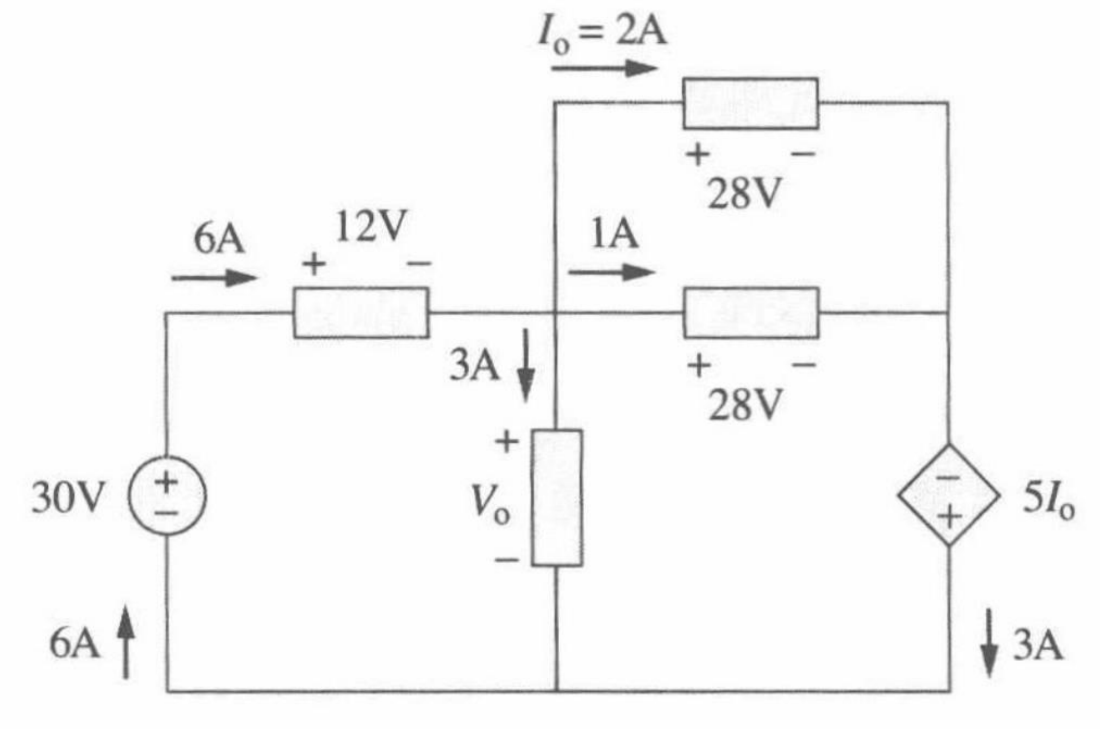
$p_2 = 10(10) =$ **100 W**

$p_3 = 20(14) =$ **280 W**

$p_4 = 8(-4) =$ **-32 W**

$p_5 = 12(-4) =$ **-48 W**

1.20 计算下图中的 V_o 以及每个元件吸收的功率。



解：

30V 电压源 p = 30x(–6) = –180 W

12V 元件 p = 12x6 = 72 W

2A 电流流过的 28V 元件 p= 28x2 = 56 W

1A 电流流过的 28V 元件 p= 28x1 = 28 W
5Io 受控源 p = 5x2x(–3) = –30 W
因为电路中所有元件吸收的功率和为零
3Vo = 180–72–56–28+30 = 54 W
Vo = 18 V.

1.23 一台 1.8kW 的热水器需要 15min 烧开一定量的水，如果一天烧一次水，并且电费为 10 美分/kW·h，计算工作 30 天需要的电费。

解：

W = pt = 1.8x(15/60) x30 kWh = 13.5kWh

C = 10 x13.5 = **135**

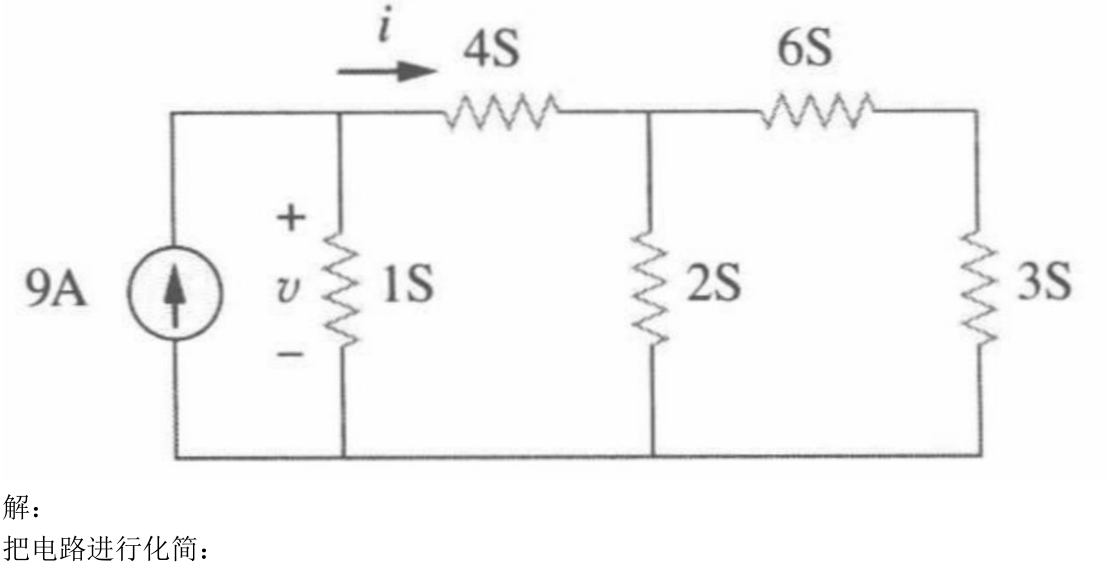
1.36 电池的额定容量可以用 A·h 或者 W·h 表示。A·h 通过 W·h 除以标准的 12V 获得。如果一块汽车电池的额定容量为 20A·h：（a）求该电池工作 15 分钟所能提供的最大电流；（b）如果该电池以 2mA 的电流放电，则能持续放电多少天？

解：

(a) I = 20/0.25 = **80A**

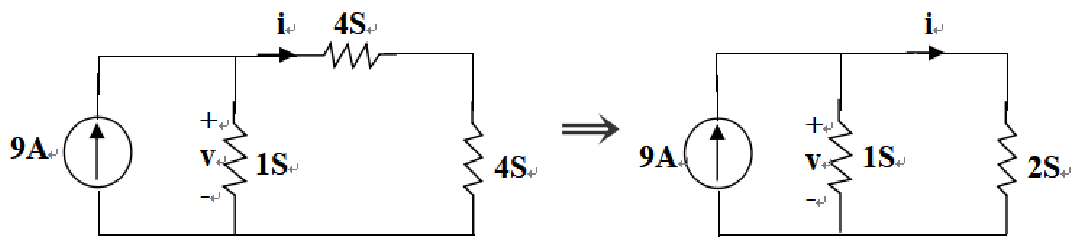
(b) (20/0.002)/24 = **416.7**

2.33 求下图所示电路的 v 和 i



解：

把电路进行化简：

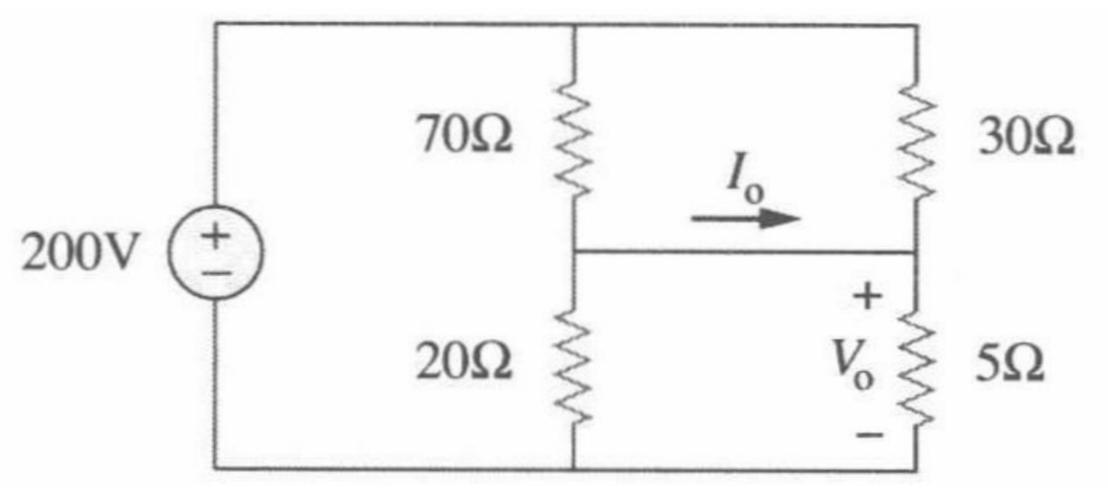


$6S \| 3S = \dfrac{6\text{x}3}{9} = 2\text{S}$ and 2S + 2S = 4S

运用分流定理：

$$\text{i} = \frac{1}{1+\frac{1}{2}}(9) = \textbf{6 A}, \text{ v} = 3(1) = \textbf{3 V}$$

2.35 计算下图所示电路的 V_O 和 I_O



解：

把电路进行化简：

$$70\|30 = \frac{70\text{x}30}{100} = 21\Omega \quad , \quad 20\|5 = \frac{20\text{x}5}{25} = 4\,\Omega$$

$$\text{i} = \frac{200}{21+4} = 8\text{ A}$$

$v_1 = 21i = 168$ V, $v_o = 4i = 32$ V

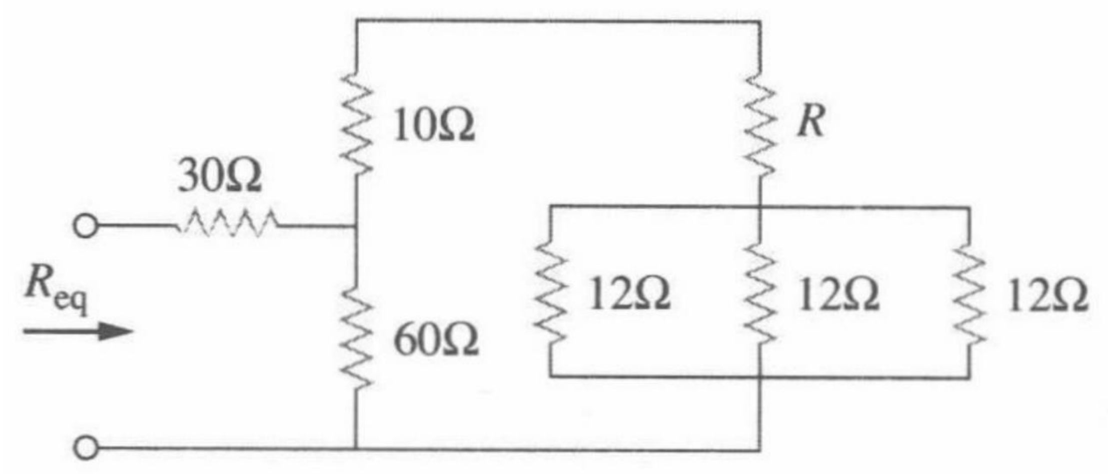
$$i_1 = \frac{V_1}{70} = 2.4\text{ A}, \; i_2 = \frac{V_o}{20} = 1.6\text{ A}$$

根据 KCL：

$i_1 = i_2 + I_o$ $\qquad$ $2.4 = 1.6 + I_o$ $\qquad$ $I_o = 0.8$ A

所以 v_o = **32 V** ， I_o = **800 mA**

2.41 如果下图所示电路中的 R_{eq}=50，求 R



解：

设 R_0 为三个并联 12Ω电阻的等效电阻

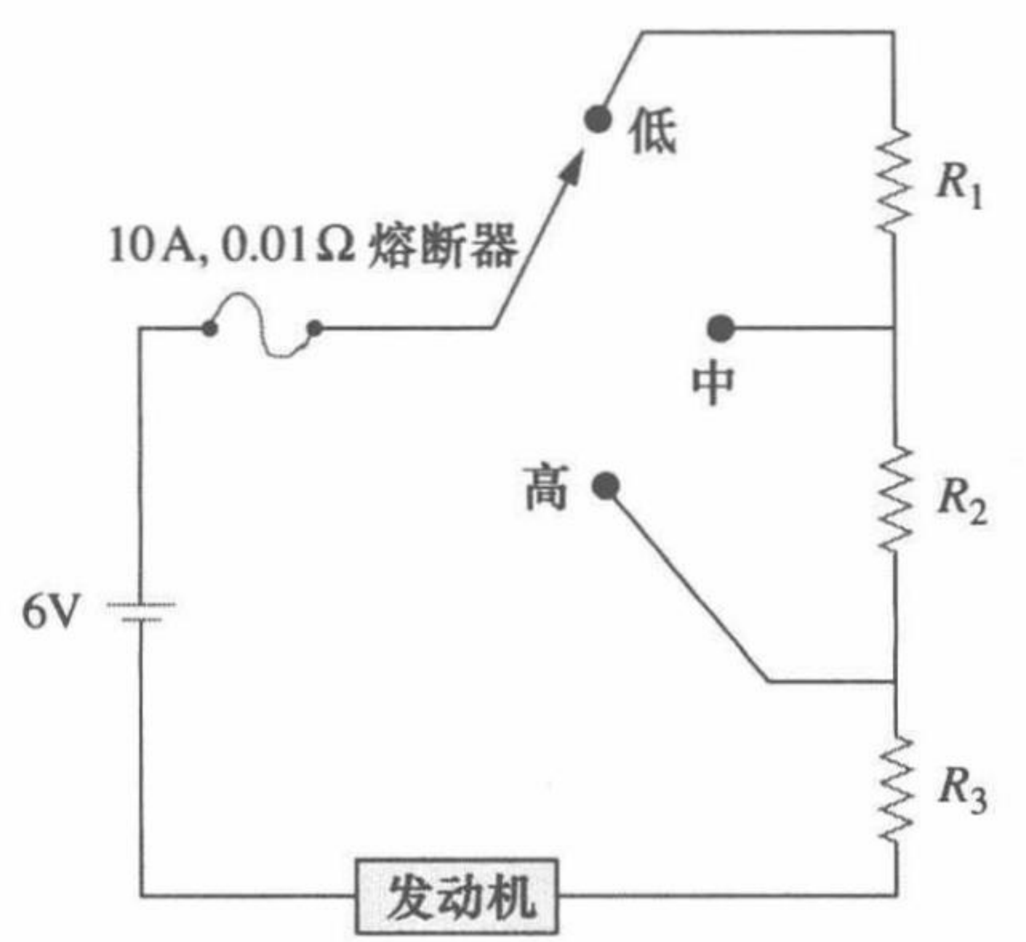
$$\frac{1}{R_o} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} \longrightarrow R_o = 4$$

$$R_{eq} = 30 + 60 \| (10 + R_0 + R) = 30 + 60 \| (14 + R)$$

$$50 = 30 + \frac{60(14 + R)}{74 + R} \longrightarrow 74 + R = 42 + 3R$$

R = **16 Ω**

2.74 下图所示电路用于控制发动机的转速，当开关掷于高、中、低三个不同位置时，发动机电流分别为 5A、3A 和 1A，可以用一个 20mΩ 的负载电阻作为该发动机的电路模型，求串联降压电阻 R_1、R_2、R_3



解：

开关在上面时

$6 = (0.01 + R_3 + 0.02) \times 5$　　　　$R_3 = \mathbf{1.17\ \Omega}$

开关在中间时

$6 = (0.01 + R_2 + R_3 + 0.02) \times 3$　　　　$R_2 + R_3 = 1.97$

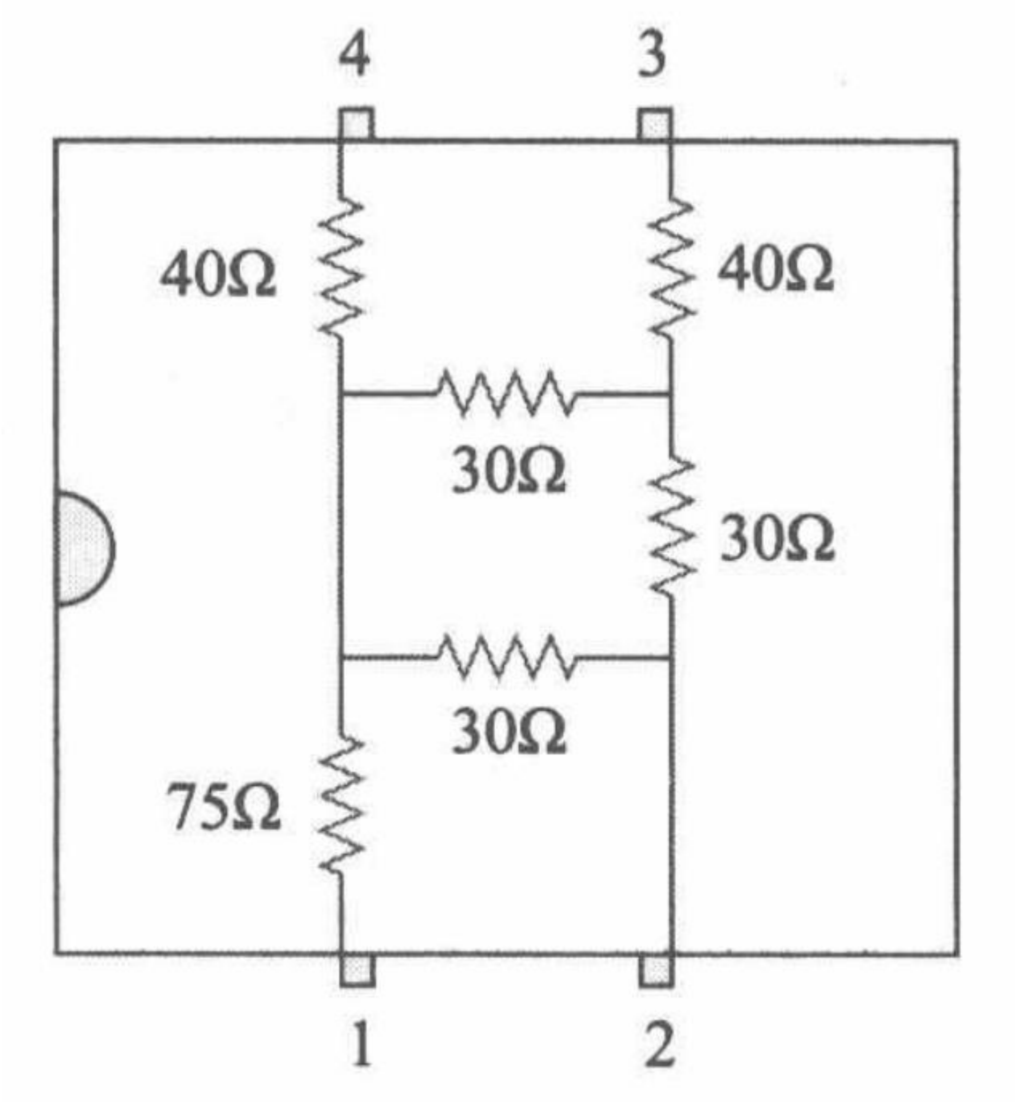
$R_2 = 1.97 - 1.17 = \mathbf{0.8\ \Omega}$

开关在下面时

$6 = (0.01 + R_1 + R_2 + R_3 + 0.02) \times 1$　　　　$R_1 + R_2 + R_3 = 5.97$

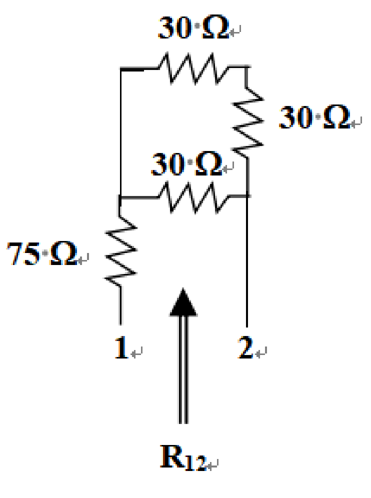
$R_1 = 5.97 - 1.97 = \mathbf{4\ \Omega}$

2.82 某电阻列阵的引脚图如下图所示，求下述引脚之间的等效电阻：（a）1 与 2；（b）1 与 3；（b）1 与 4.



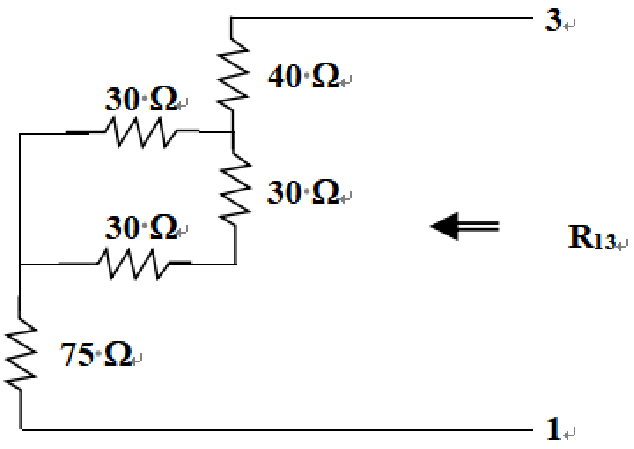
解：

（a）



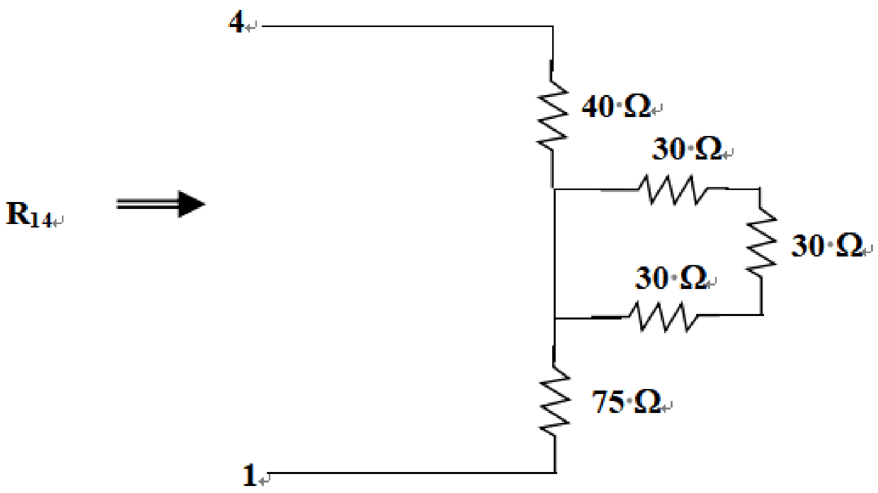
R_{12} = 75 + 30x60/(30+60) = 75+20 = **95 Ω**

（b）



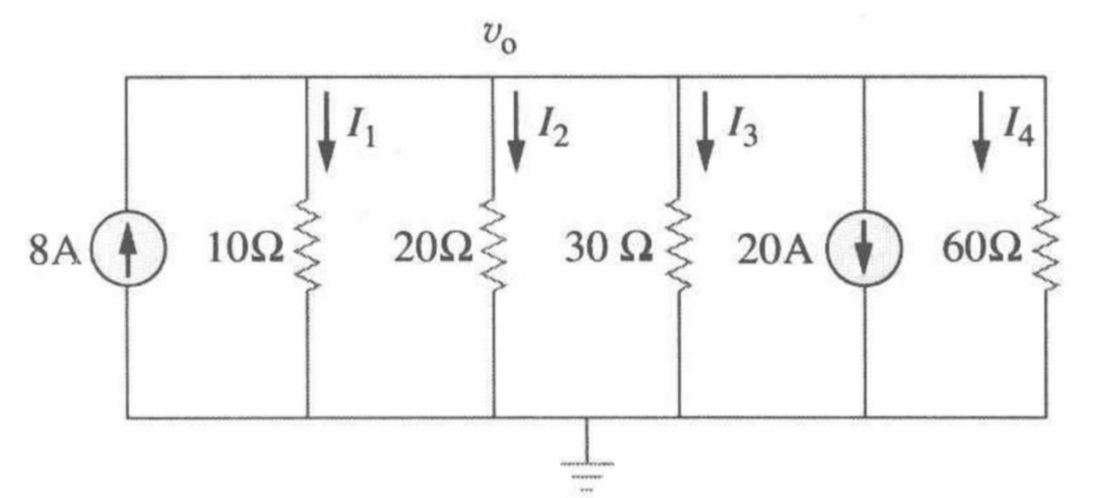
R_{13} = 75 + [30x60/(30+60)] + 40 = 135 Ω

（c）



R_{14} = 40 + 75 = **115 Ω**

3.3 计算下图所示电路中的电流 I_1~I_4 以及电压 v_o



解：

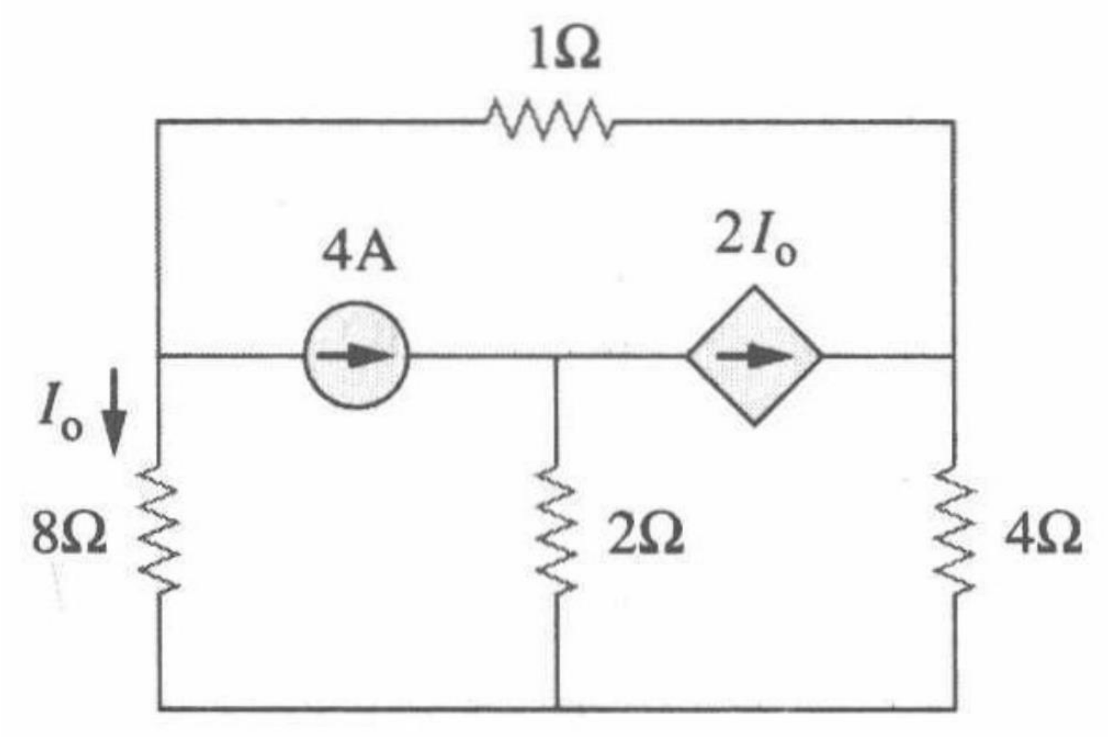
运用 KCL:

$$-8+\frac{v_0}{10}+\frac{v_o}{20}+\frac{v_o}{30}+20+\frac{v_0}{60}=0 \text{ or } v_0 = \mathbf{-60\ V}$$

$i_1 = \dfrac{v_0}{10} =$ **−6 A** , $i_2 = \dfrac{v_0}{20} =$ **−3 A**,

$i_3 = \dfrac{v_0}{30} =$ **−2 A**, $i_4 = \dfrac{v_0}{60} =$ **1 A**.

3.10 计算下图所示电路中的 I_o



解：

在节点 1. $[(v_1–0)/8] + [(v_1–v_3)/1] + 4 = 0$

在节点 2. $–4 + [(v_2–0)/2] + 2i_o = 0$

在节点 3. $–2i_o + [(v_3–0)/4] + [(v_3–v_1)/1] = 0$

可以得到 $i_o = v_1/8$

所以

$$1.125v_1 – v_3 = –4 \quad (1)$$

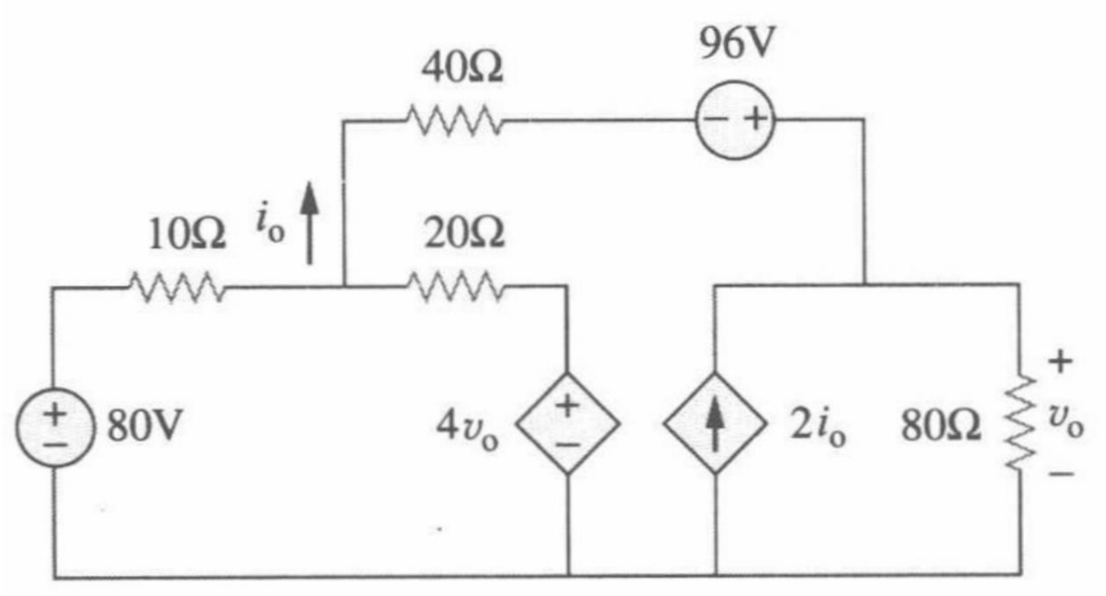
$$0.25v_1 + 0.5v_2 = 4 \quad (2)$$

$$–1.25v_1 + 1.25v_3 = 0 \quad (3)$$

解得：

$i_o = 32/8 =$ **$–4$ amps**.

3.30 利用节点分析法计算下图所示电路中的 v_o 和 i_o



解：

在节点 1,

$[(v_1-80)/10]+[(v_1-4v_o)/20]+[(v_1-(v_o-96))/40] = 0$ or

$(0.1+0.05+0.025)v_1 - (0.2+0.025)v_o =$

$0.175v_1 - 0.225v_o = 8-2.4 = 5.6$ (1)

在节点 2,

$-2\boldsymbol{i_o} + [((v_o-96)-v_1)/40] + [(v_o-0)/80] = 0$ and $\boldsymbol{i_o} = [(v_1-(v_o-96))/40]$

$-2[(v_1-(v_o-96))/40] + [((v_o-96)-v_1)/40] + [(v_o-0)/80] = 0$

$-3[(v_1-(v_o-96))/40] + [(v_o-0)/80] = 0$ or

$-0.0.075v_1 + (0.075+0.0125)v_o = 7.2 =$

$-0.075v_1 + 0.0875v_o = 7.2$ (2)

联立(1) 和 (2) ：

$$\begin{bmatrix} 0.175 & -0.225 \\ -0.075 & 0.0875 \end{bmatrix}\begin{bmatrix} v_1 \\ v_o \end{bmatrix} = \begin{bmatrix} 5.6 \\ 7.2 \end{bmatrix} or$$

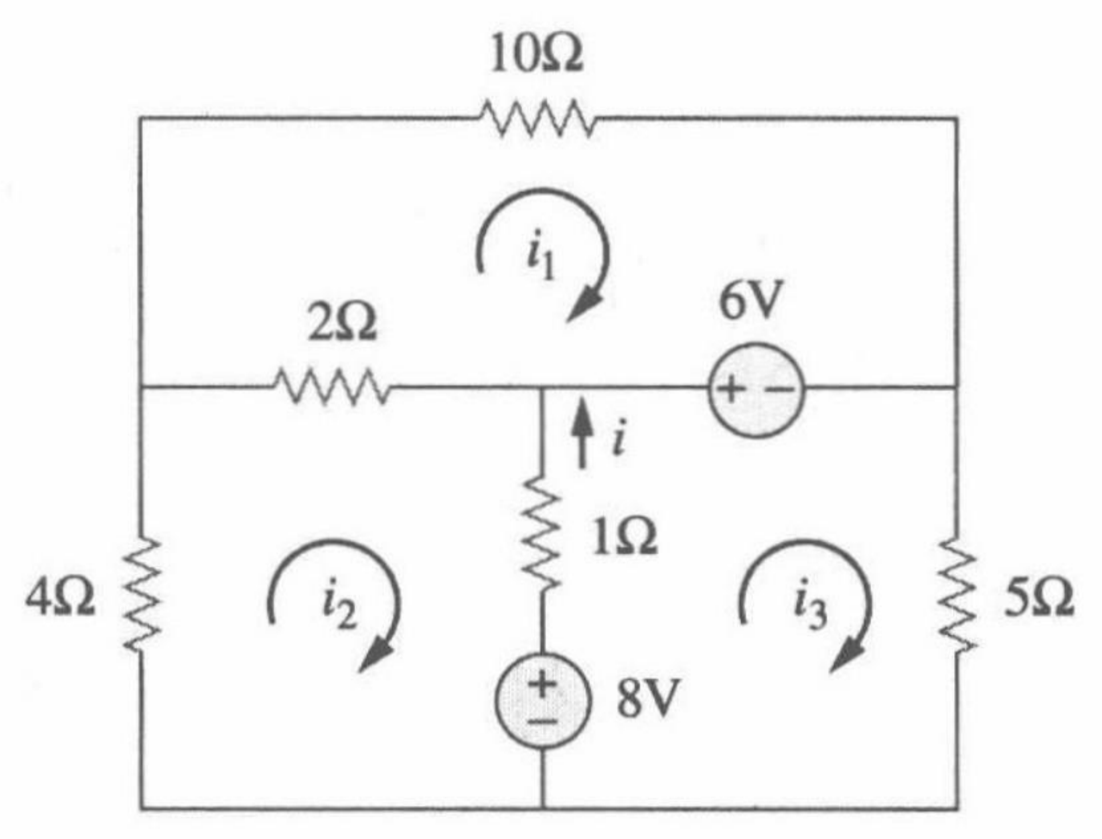
$$\begin{bmatrix} v_1 \\ v_o \end{bmatrix} = \frac{\begin{bmatrix} 0.0875 & 0.225 \\ 0.075 & 0.175 \end{bmatrix}}{0.0153125 - 0.016875}\begin{bmatrix} 5.6 \\ 7.2 \end{bmatrix} = \frac{\begin{bmatrix} 0.0875 & 0.225 \\ 0.075 & 0.175 \end{bmatrix}}{-0.0015625}\begin{bmatrix} 5.6 \\ 7.2 \end{bmatrix}$$

$v_1 = -313.6-1036.8 = -1350.4$

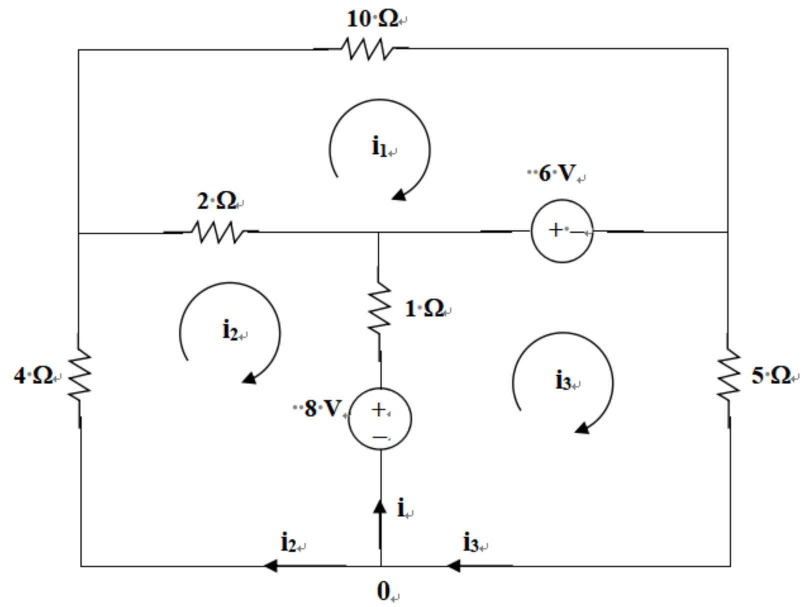
$v_o = -268.8-806.4 =$ **-1.0752 kV**

and $\boldsymbol{i_o} = [(v_1-(v_o-96))/40] = [(-1350.4-(-1075.2-96))/40] =$ **-4.48 A**.

3.41 利用网孔分析法计算下图所示电路中的电流 i



解：



回路 1,

$$6 = 12i_1 - 2i_2 \longrightarrow 3 = 6i_1 - i_2 \qquad (1)$$

回路 2,

$$-8 = -2i_1 + 7i_2 - i_3 \qquad (2)$$

回路 3,

$$-8 + 6 + 6i_3 - i_2 = 0 \longrightarrow 2 = -i_2 + 6i_3 \qquad (3)$$

写成矩阵形式,

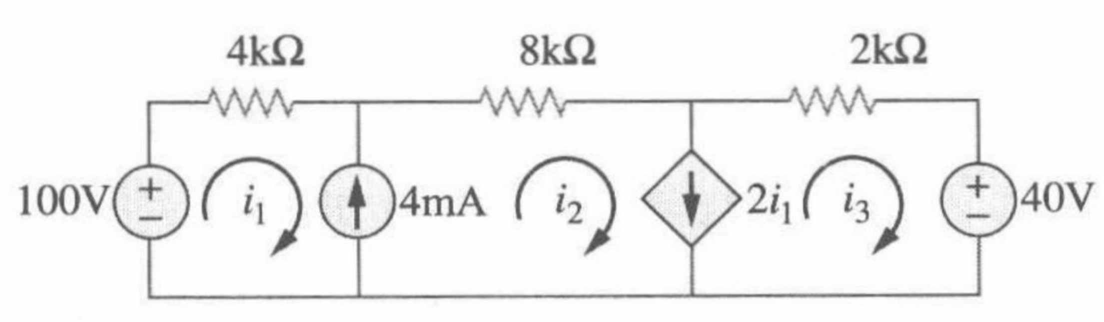
$$\begin{bmatrix} 6 & -1 & 0 \\ 2 & -7 & 1 \\ 0 & -1 & 6 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 3 \\ 8 \\ 2 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 6 & -1 & 0 \\ 2 & -7 & 1 \\ 0 & -1 & 6 \end{vmatrix} = -234, \quad \Delta_2 = \begin{vmatrix} 6 & 3 & 0 \\ 2 & 8 & 1 \\ 0 & 2 & 6 \end{vmatrix} = 240$$

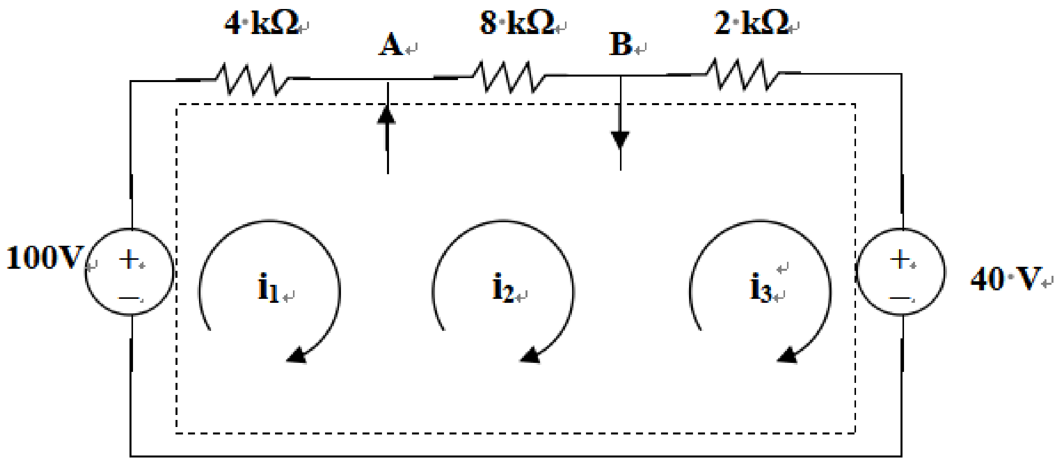
$$\Delta_3 = \begin{vmatrix} 6 & -1 & 3 \\ 2 & -7 & 8 \\ 0 & -1 & 2 \end{vmatrix} = -38$$

$$i = i_3 - i_2 = \frac{\Delta_3 - \Delta_2}{\Delta} = \frac{-38 - 240}{-234} = \mathbf{1.188\ A}$$

3.62 求下图所示电路中的网孔电流 i_1、i_2 和 i_3



解：



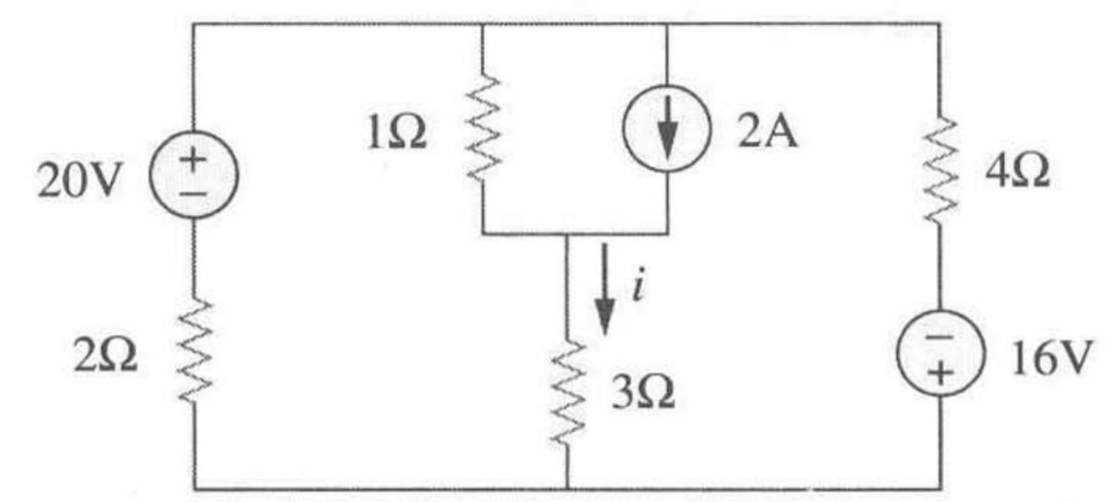
对于超网孔， $-100 + 4i_1 + 8i_2 + 2i_3 + 40 = 0$ or $30 = 2i_1 + 4i_2 + i_3$ (1)

在节点 A, $i_1 + 4 = i_2$ (2)

在节点 B, $i_2 = 2i_1 + i_3$ (3)

解得 $i_1 =$ **2 mA**, $i_2 =$ **6 mA**, ， $i_3 =$ **2 mA**.

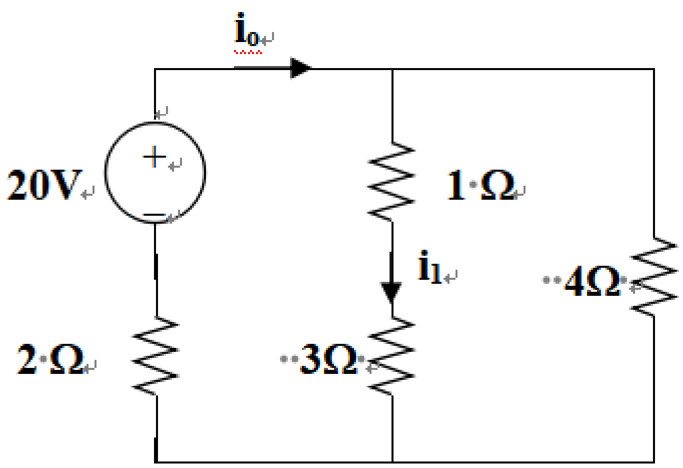
4.15 利用叠加定理确定下图所示电路中的 i，并计算传递给 3Ω 电阻的功率。



解：

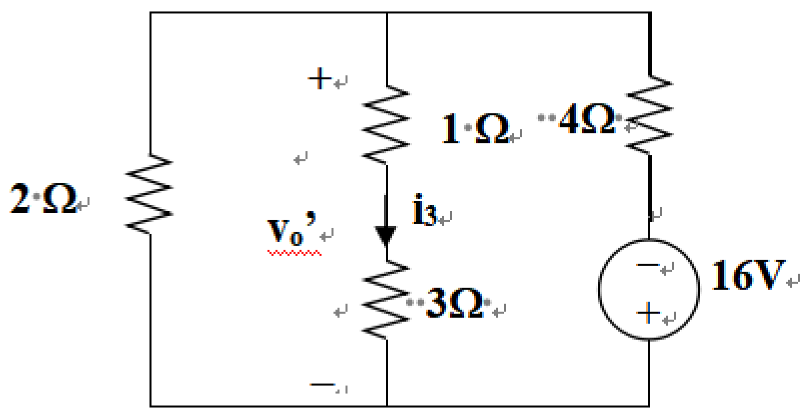
令 $i = i_1 + i_2 + i_3$, i_1, i_2, i_3 是经过 20-V, 2-A, 16-V 电源的电流.

对于 i_1:



$4||(3 + 1) = 2$ ohms, Then $i_o = [20/(2 + 2)] = 5$ A, $i_1 = i_o/2 = 2.5$ A

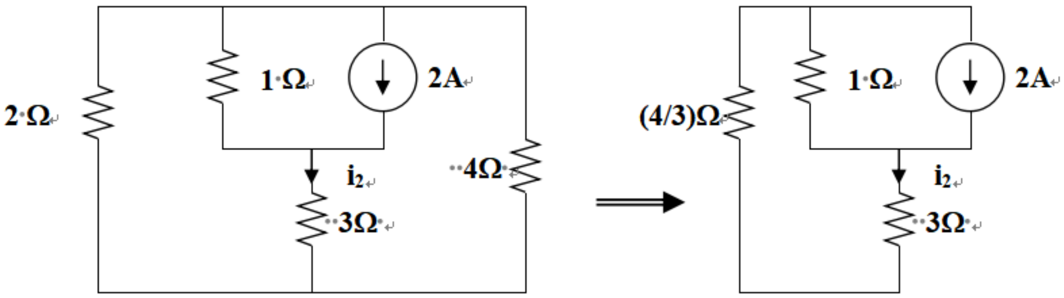
对于 i_3,



$$2||(1+3) = 4/3, \quad v_o' = [(4/3)/((4/3)+4)](-16) = -4$$

$$i_3 = v_o'/4 = -1$$

对于 i_2



$$2||4 = 4/3, \quad 3 + 4/3 = 13/3$$

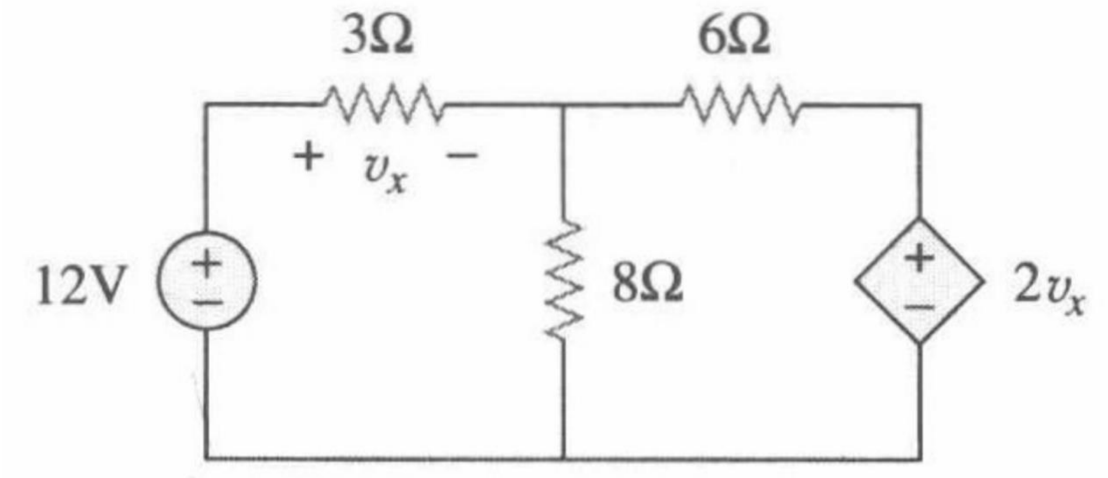
运用分流定理：

$$i_2 = [1/(1 + 13/2)]2 = 3/8 = 0.375$$

$$i = 2.5 + 0.375 - 1 = \mathbf{1.875\ A}$$

$$p = i^2R = (1.875)^2 3 = \mathbf{10.55\ w}$$

4.31 利用电源变换的方法计算下图所示电路中的 v_x

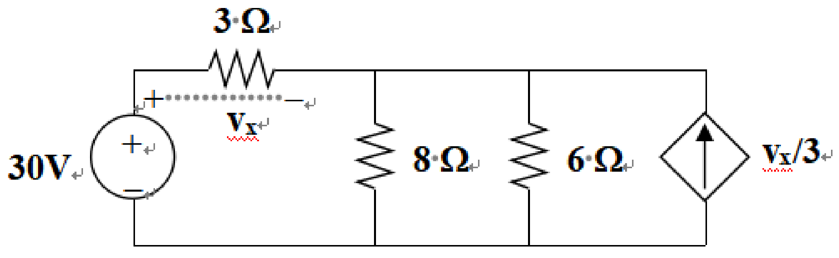


解：

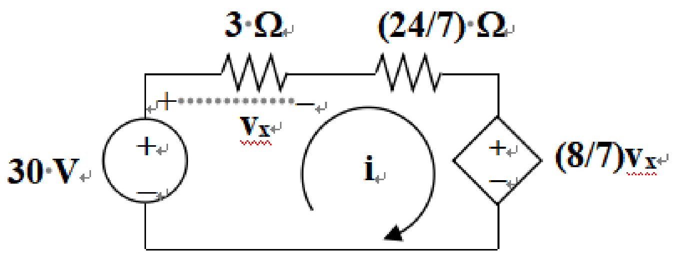
把受控源进行变换可以得到（a）

6||8 = (24/7)Ω

把（a）中受控源再次变换可以得到（b）



(a)



(b)

在（b）

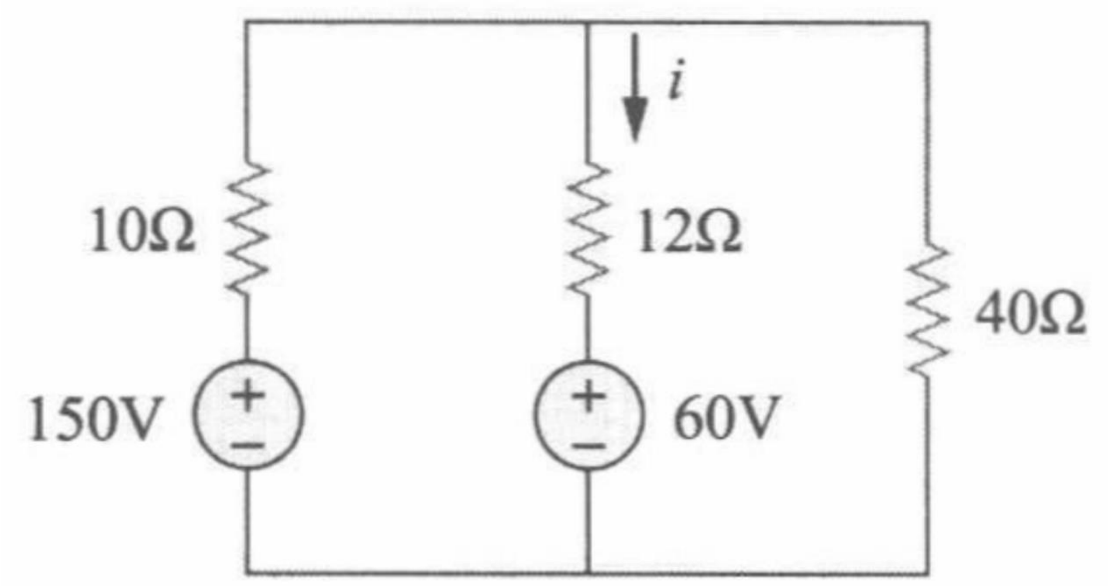
$v_x = 3i$, $i = v_x/3$.

运用 KVL

$-30 + (3 + 24/7)i + (8/7)v_x = 0$

$[(21 + 24)/7]v_x/3 + (8/7)v_x = 30$ leads to $v_x = 30/3.2857 =$ **9.13 V**.

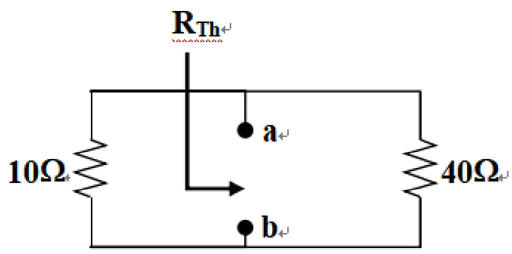
4.36 利用戴维南定理确定下图所示电路中的电流 i（提示：需求出 12Ω 电阻两端的戴维南等效电路）。



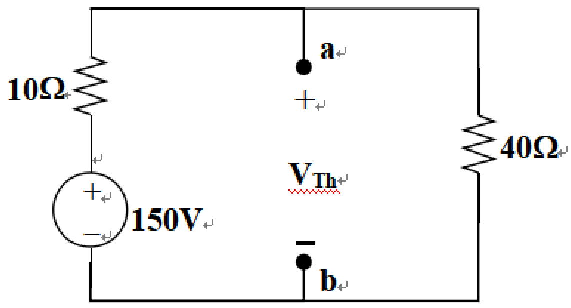
解：

移去 60 V 电压源 和 12 Ω 电阻得到(b)，可知如今的戴维南等效电压比计算出来的电压少60V

把 150 V 电压源 设为 0得到（a）.



(a)

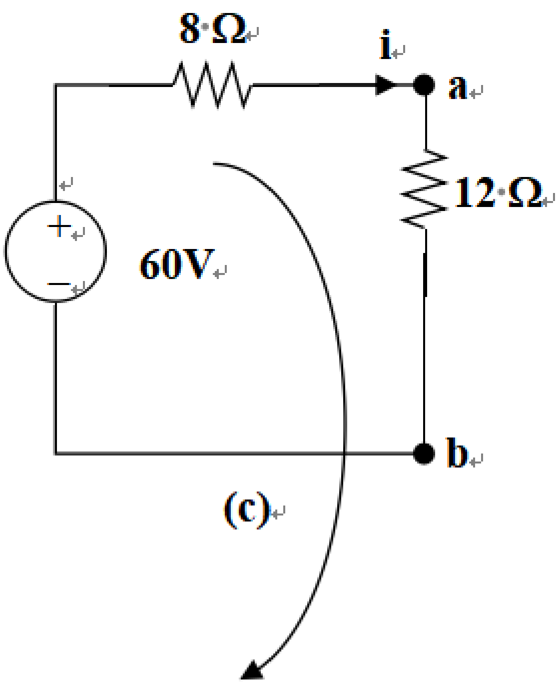


(b)

在(a), $R_{Th} = 10||40 = 8\ \Omega$

在 (b), $V_{Th} = (40/(10+40))150 = 120V$

实际的戴维南电压为：120–60 = 60 V

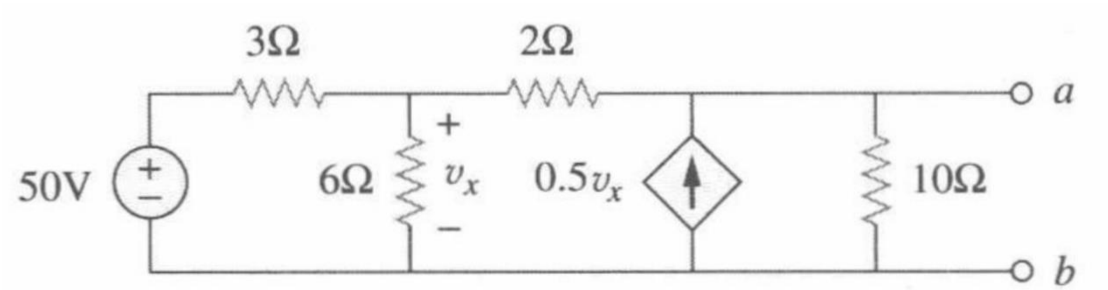


(c)

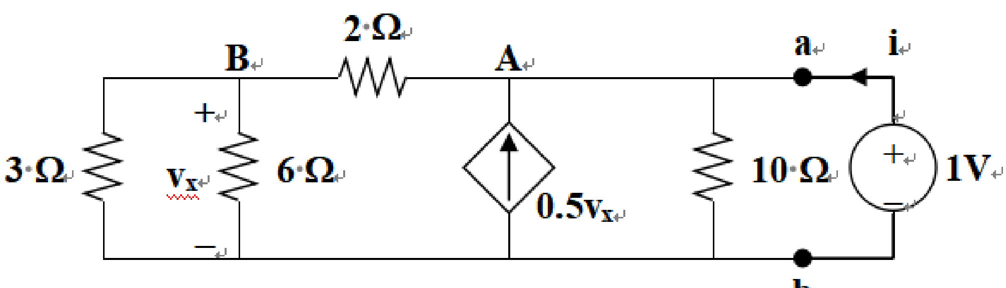
原始电路的等效电路化为 (c). 运用 KVL,

$$-60 + (8 + 12)i = 0$$
$$i = \mathbf{3\ A}.$$

4.57 求下图所示电路在端口 a-b 处的戴维南等效电路与诺顿等效电路。



解：
把 50V 电压源移除，加入一个 1V 电压源可得图（a）



(a)

运用节点分析法，在节点 A

$i + 0.5v_x = (1/10) + (1 - v_x)/2$, or $i + v_x = 0.6$

在节点 B，

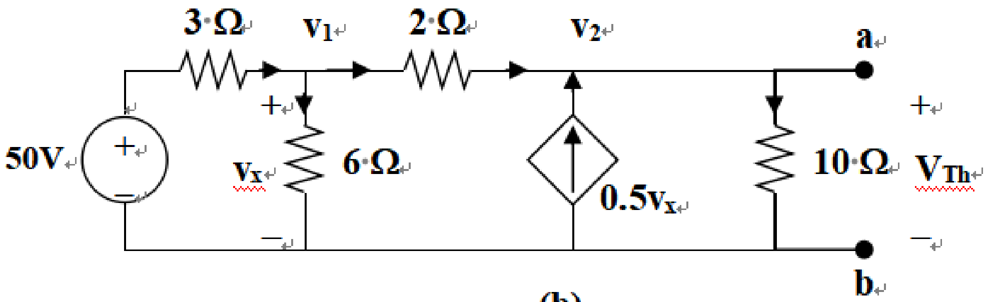
$(1 - v_o)/2 = (v_x/3) + (v_x/6)$, and $v_x = 0.5$

联立解得

$$i = 0.1$$

$$R_{Th} = 1/i = \mathbf{10\Omega}$$

通过图（b）求出 V_{Th}



(b)

在节点 1：

$(50 - v_1)/3 = (v_1/6) + (v_1 - v_2)/2$

$100 = 6v_1 - 3v_2$

在节点 2：

$0.5v_x + (v_1 - v_2)/2 = v_2/10$, $v_x = v_1$, and $v_1 = 0.6v_2$

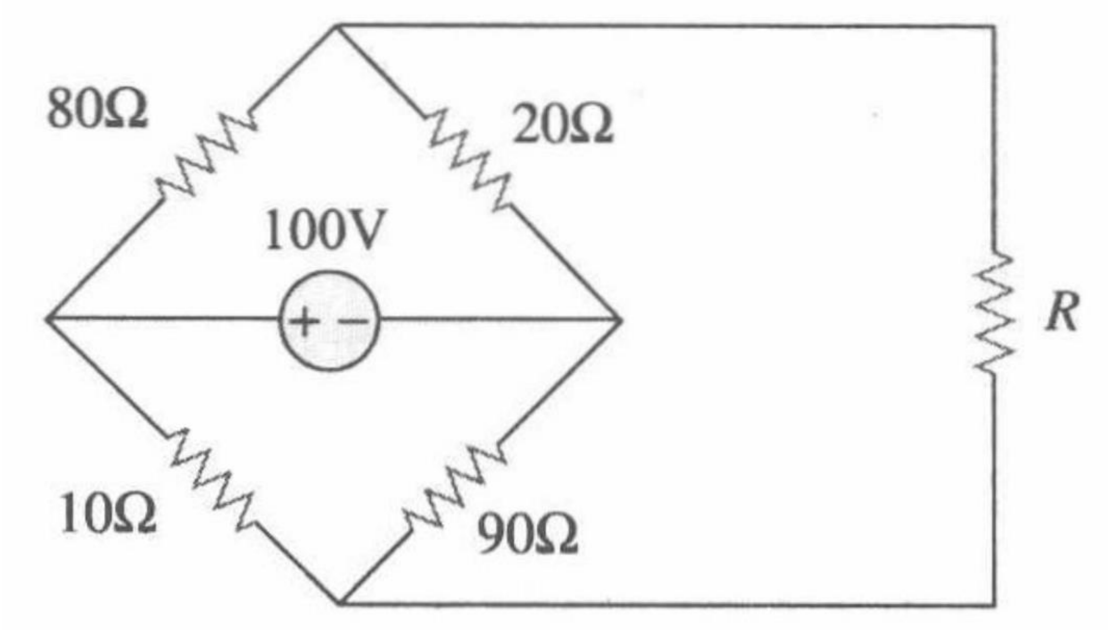
联立解得

$$v_2 = V_{Th} = \mathbf{166.67\ V}$$

$$I_N = V_{Th}/R_{Th} = \mathbf{16.667\ A}$$

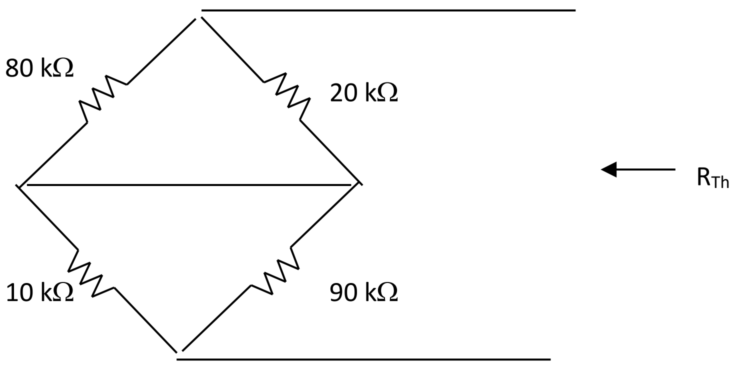
$$R_N = R_{Th} = \mathbf{10\ \Omega}$$

4.67 在下图所示电路中，调节可变电阻 R，直至其从电路中吸收的功率最大。（a）试计算吸收最大功率时电阻 R 的阻值；（b）确定 R 吸收的最大功率的值。



解：

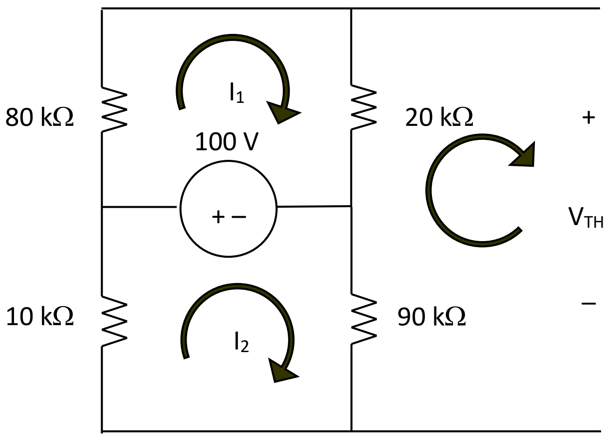
首先得到戴维南等效电路图：



R_{Thev} = [80k20k/(80k+20k)] + [10k90k/(10k+90k)] = [(1600k/100)+(900k/100)]

= 16k+9k = 25 kΩ.

然后在原始电路图中运用网孔分析法



网孔 1, –100 + (80k+20k)I_1 = 0 or I_1 = 100/100k = 1 mA.

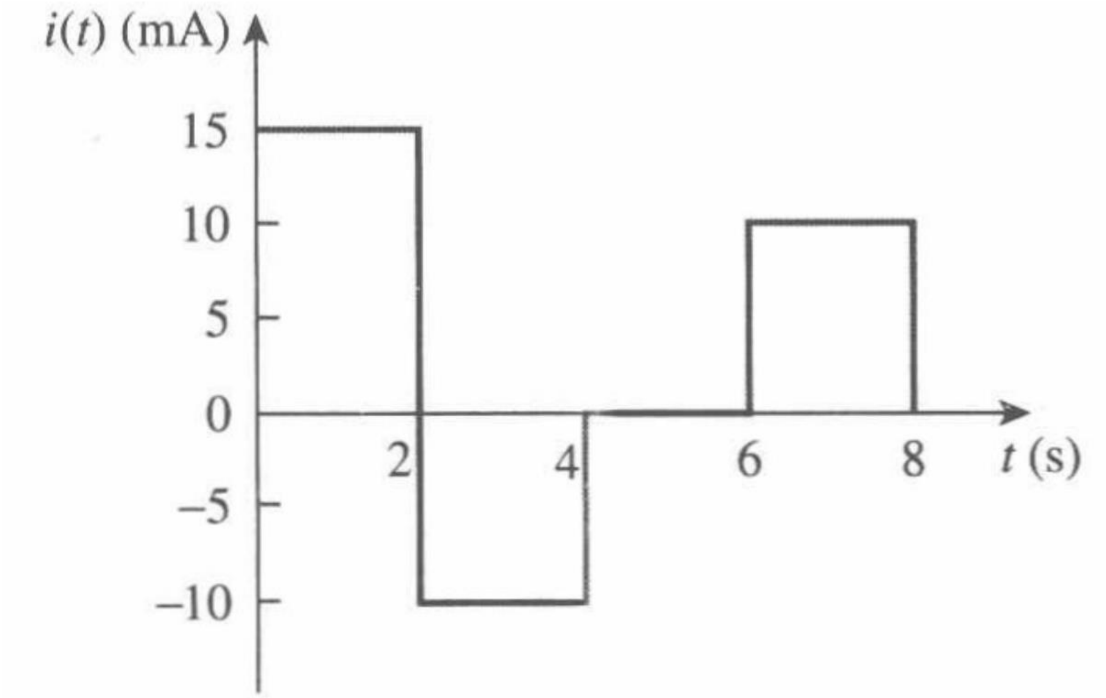
网孔 2, (10k+90k)I_2 +100 = 0 or I_2 = –100/100k = –1 mA.

最终可得, V_{Thev} = 20k(0.001) + 90k(–0.001) = 20–90 = –70 V.

(a) R = R_{Th} = **25 kΩ**

(b) $P_{max} = (V_{Thev})^2/(4R_{Thev}) = (-70)^2/(4x25k)$ = **49 mW**.

6-11 如果通过一个 4mF 电容的电流波形如下图所示，假设 v（0）=10V，画出电压 v（t）的波形。



解：

$$v = \frac{1}{C}\int_0^t i dt + v(0) = 10 + \frac{1}{4x10^{-3}}\int_0^t i(t)dt$$

0<t <2, i(t)=15mA, V(t)= 10+ $v = 10 + \frac{10^3}{4x10^{-3}}\int_0^t 15dt = 10 + 3.76t$

v(2) = 10+7.5 =17.5

2 < t <4, i(t) = –10 mA

$$v(t) = \frac{1}{4x10^{-3}}\int_2^t i(t)dt + v(2) = -\frac{10x10^{-3}}{4x10^{-3}}\int_2^t dt + 17.5 = 22.5 + 2.5t$$

v(4)=22.5-2.5x4 =12.5

4<t<6, i(t) = 0, $v(t)=\frac{1}{4x10^{-3}}\int_{2}^{t}0dt+v(4)=12.5$

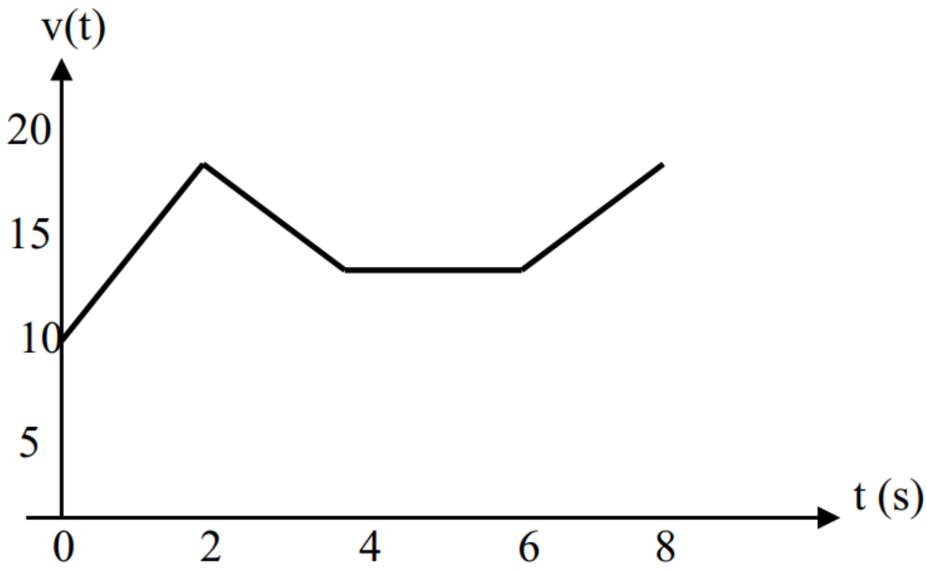
6<t<8, i(t) = 10 mA

$$v(t)=\frac{10x10^{3}}{4x10^{-3}}\int_{4}^{t}dt+v(6)=2.5(t-6)+12.5=2.5t-2.5$$

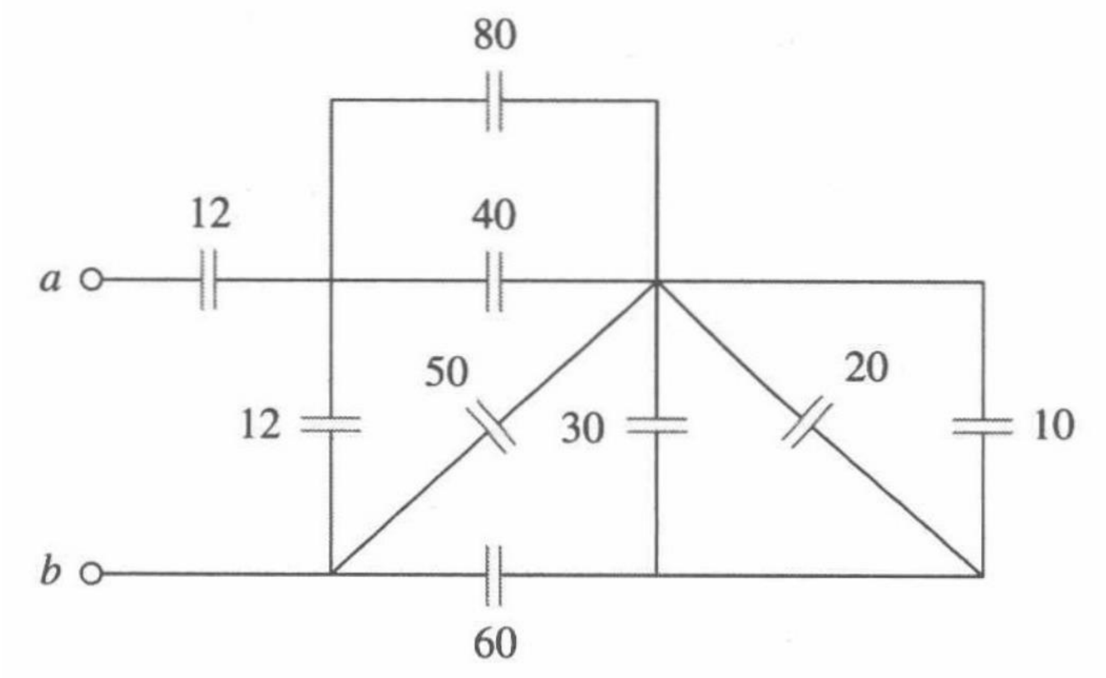
所以,

$$v(t)=\begin{cases}10+3.75tV, & 0<t<2s\\ 22.5-2.5tV, & 2<t<4s\\ 12.5V, & 4<t<6s\\ 2.5t-2.5V, & 6<t<8s\end{cases}$$

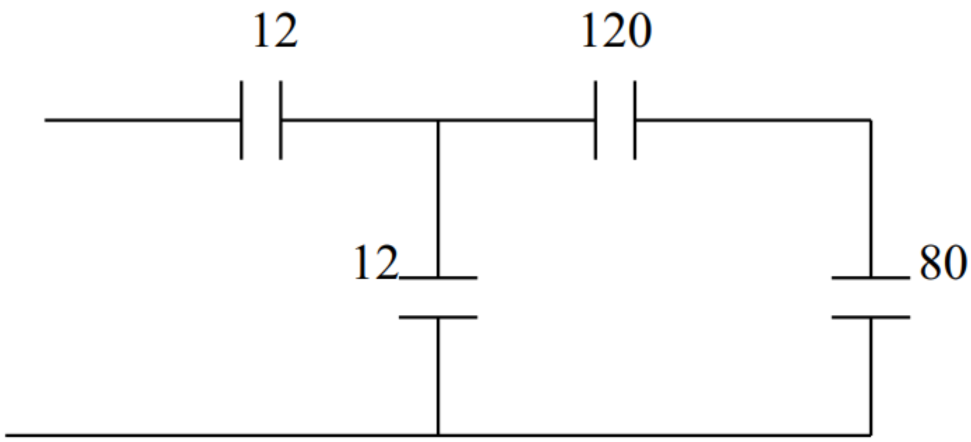
画出图像：



6-19 计算下图所示电路终端 a 和 b 间的等效电容，所有电容单位均为μF。

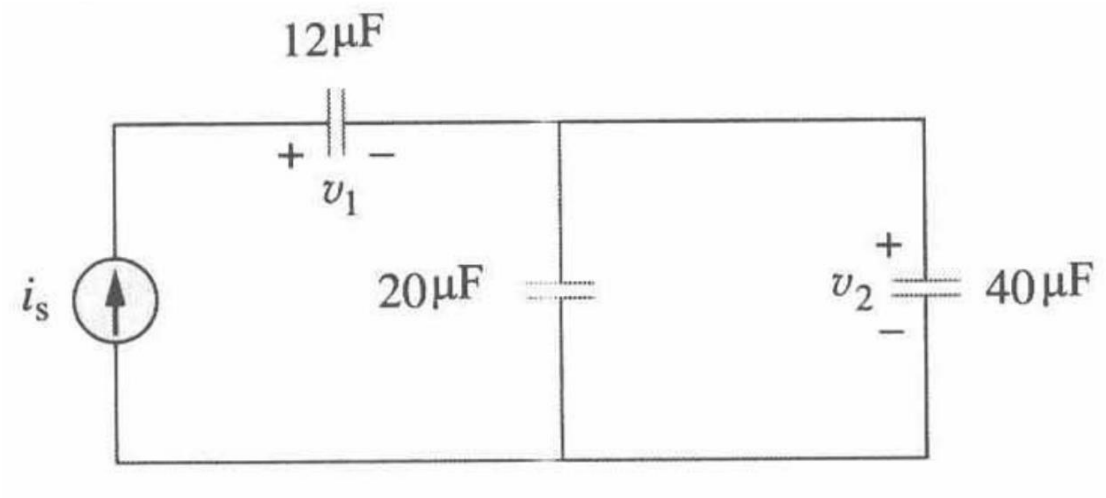


解：
把 10-, 20-, 30- μF 的电容进行平行等效可以得到 60μF. 60 -μF 电容与 60- μF 电容串联等效得到 30 μF.
30 + 50 = 80μF, 80 + 40 = 120 μF
可以得到下面的电路：



120-μF 电容与 80μF 电容进行串联等效(80x120)/200 = 48
48 + 12 = 60
60-μF 电容与 12μF 电容进行串联等效 (60x12)/72 = **10 μF**

6-32 在下图所示电路中，$i_s=4.5e^{-2t}$mA 且当 t=0 时，v_1（0）=0V，v_2（0）=0V。计算：（a）v_1（t），v_2（t）;（b）在 t>0s 时每个电容所存储的能量。



解：
把 20μF 电容与 40μF 电容并联合并可以得到 60μF

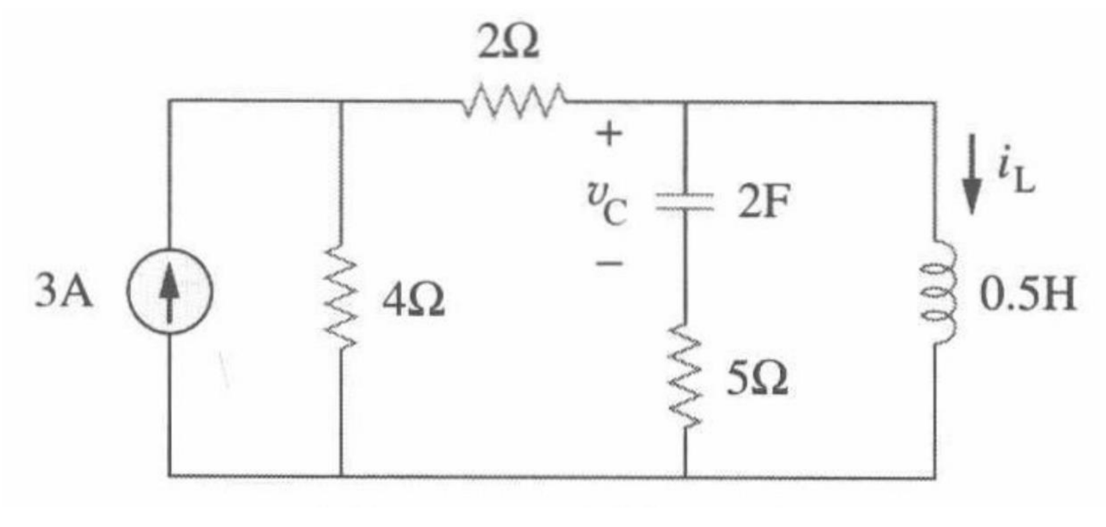
$v_1 = \dfrac{1}{60\mu}\int_0^t 4.5e^{-2\tau} m d\tau$ = **$[37.5 – 37.5e^{-2t}]$ V**

v_2= **$[187.5 – 187.5e^{-2t}]$ V**

$(v_1)^2 = 35156.25[1 – 2e^{-2t} + e^{-4t}]$
$(v_2)^2 = 1406.25[1 – 2e^{-2t} + e^{-4t}]$

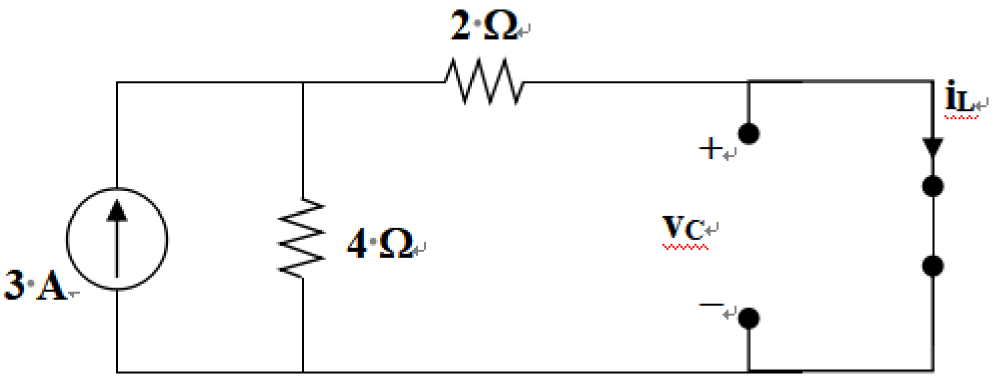
W_1= 0.5x12x10$^{-6}(v_1)^2$ = **$0.211[1 – 2e^{-2t} + e^{-4t}]$ J**
W_2= 0.5x20x10$^{-6}(v2)^2$ =0.01406**$[1 – 2e^{-2t} + e^{-4t}]$ J**
W_3 = 0.5x40x10$^{-6}(v_2)^2$ = **$0.02813[1 – 2e^{-2t} + e^{-4t}]$ J**

6-46 在下图所示直流电路中，计算电容上的电压 v_c，电感上的电流 i_L，以及它们分别所储存的能量。



解：

在直流情况下，电路如下图所示



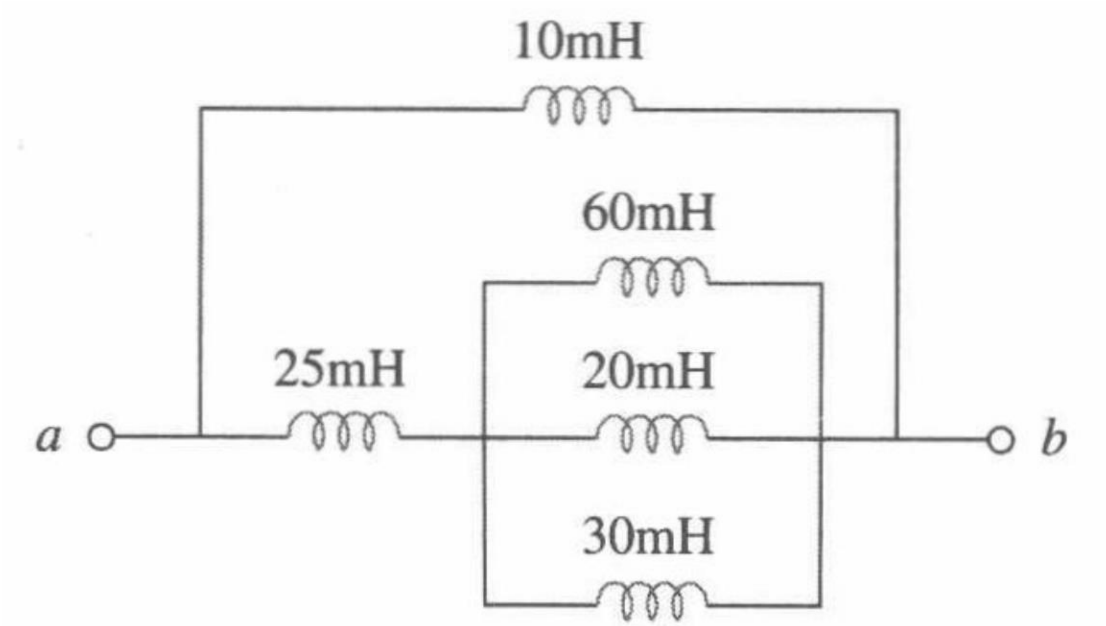
运用分流定理

$$i_L = \frac{4}{4+2}(3) = \textbf{2A}, \quad v_c = \textbf{0V}$$

$$w_L = \frac{1}{2} L\, i_L^2 = \frac{1}{2}\left(\frac{1}{2}\right)(2)^2 = \textbf{1J}$$

$$w_c = \frac{1}{2} C\, v_c^2 = \frac{1}{2}(2)(v) = \textbf{0J}$$

6-51 计算下图所示电路 a-b 终端间的等效电感 L_{eq}。

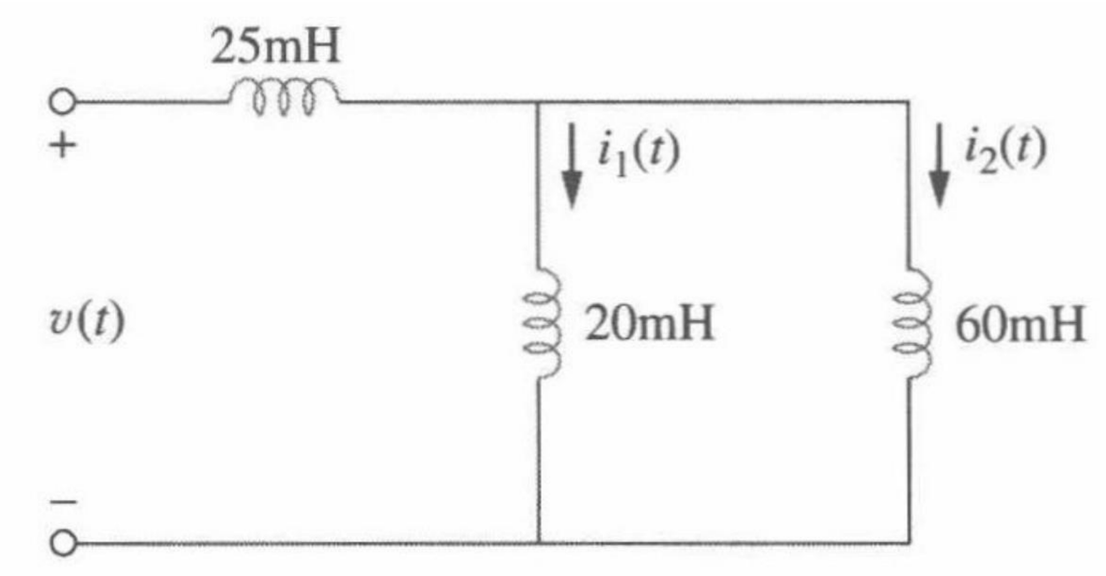


解：

$$\frac{1}{L}=\frac{1}{60}+\frac{1}{20}+\frac{1}{30}=\frac{1}{10}$$ L = 10 mH

$$L_{eq}=10\|(25+10)=\frac{10x35}{45}$$ = **7.778 mH**

6-62 分析下图所示电路，在 t>0、v（t）=12e^{-3t}mV、i_1（0）=-30mA 时，计算：（a）i_2（0）；（b）i_1（t）和 i_2（t）。



解：

(a) $$L_{eq}=25+20\parallel 60=25+\frac{20x60}{80}=40\text{ mH}$$

$$v=L_{eq}\frac{di}{dt}\longrightarrow i=\frac{1}{L_{eq}}\int v(t)dt+i(0)=\frac{10^{-3}}{40x10^{-3}}\int_0^t 12e^{-3t}dt+i(0)=-0.1(e^{-3t}-1)+i(0)$$

运用分流定理

$$i_1=\frac{60}{80}i=\frac{3}{4}i,\qquad i_2=\frac{1}{4}i$$

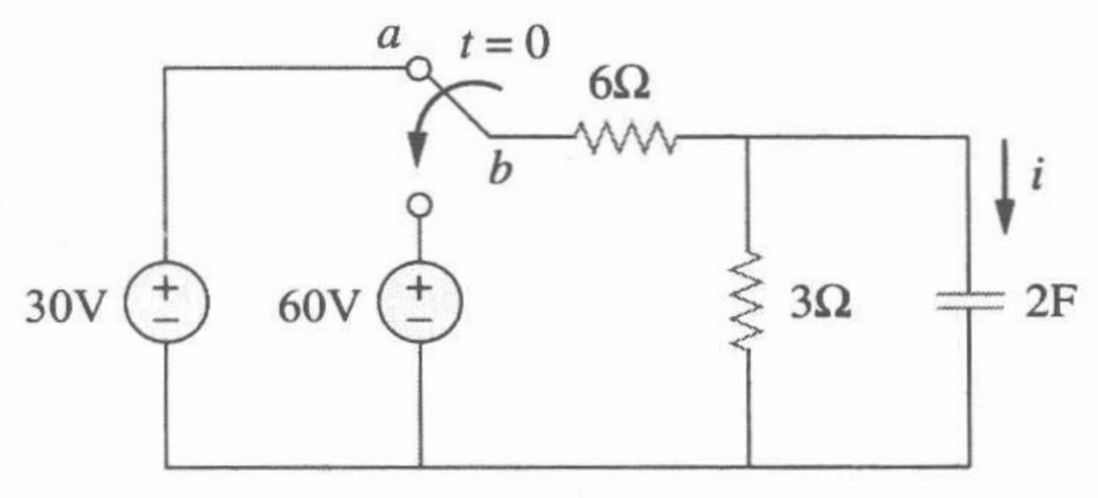
$$i_1(0)=\frac{3}{4}i(0)\longrightarrow 0.75i(0)=-0.03\longrightarrow i(0)=-0.04$$

$$i_2=\frac{1}{4}(-0.1e^{-3t}+0.06)\text{ A}=(-25e^{-3t}+15)\text{ mA}$$

$i_2(0) = -25+15 =$ **−10 mA**.

(b) $i_1(t) = 0.75(-0.1e^{-3t} + 0.06) =$ **$(-75e^{-3t} + 45)$ mA** and $i_2(t) =$ **$(-25e^{-3t} + 15)$ mA**.

7.44 下图所示电路中，开关处于 a 位置且电路已达到稳态，当 t=0 时，开关切换到 b 位置，求 t>0 时的 i（t）。



解：

$$R_{eq} = 6 \| 3 = 2\,\Omega$$

$$\tau = RC = 4$$

$$v(t) = v(\infty) + \left[\, v(0) - v(\infty) \right] e^{-t/\tau}$$

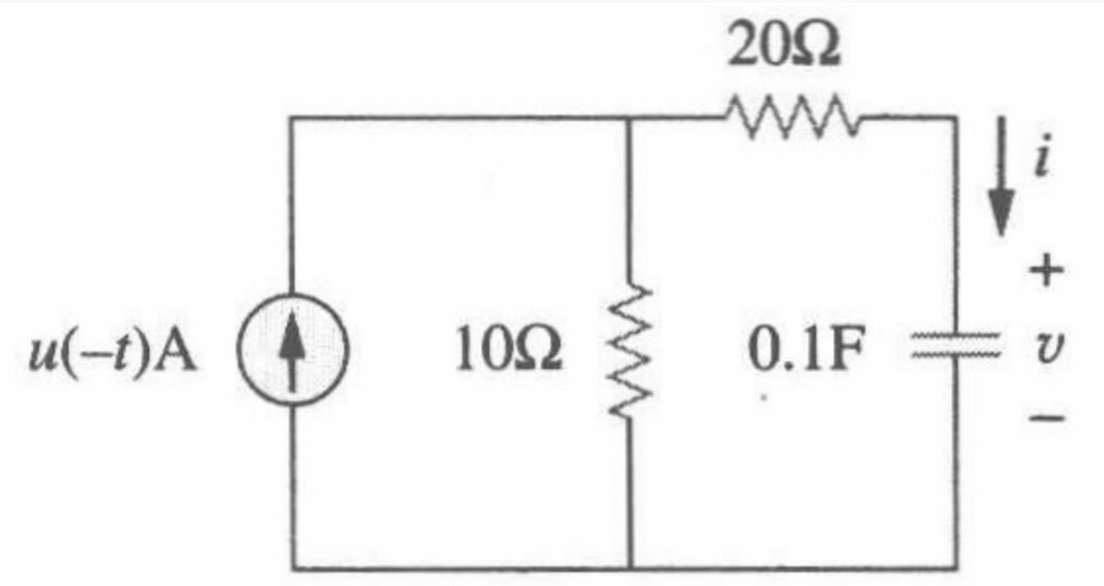
运用分压定理,

$$v(0) = \frac{3}{3+6}(30) = 10\ V\,,\quad v(\infty) = \frac{3}{3+6}(60) = 20\ V$$

$$v(t) = 20 + (10 - 20)\ e^{-t/4} = 20 - 10\ e^{-t/4}$$

$$i(t) = C\frac{dv}{dt} = (2)(-10)\left(-1/4\right)e^{-t/4} = \mathbf{(5e^{-0.25t})u(t)\ A}.$$

7.48 下图所示电路中，求 v（t）和 i（t）



解：

当 $t<0$, $u(-t)=1$,

当 $t>0$, $u(-t)=0$, $v(\infty)=0$

$R_{th}=20+10=30$, $\tau=R_{th}C=(30)(0.1)=3$

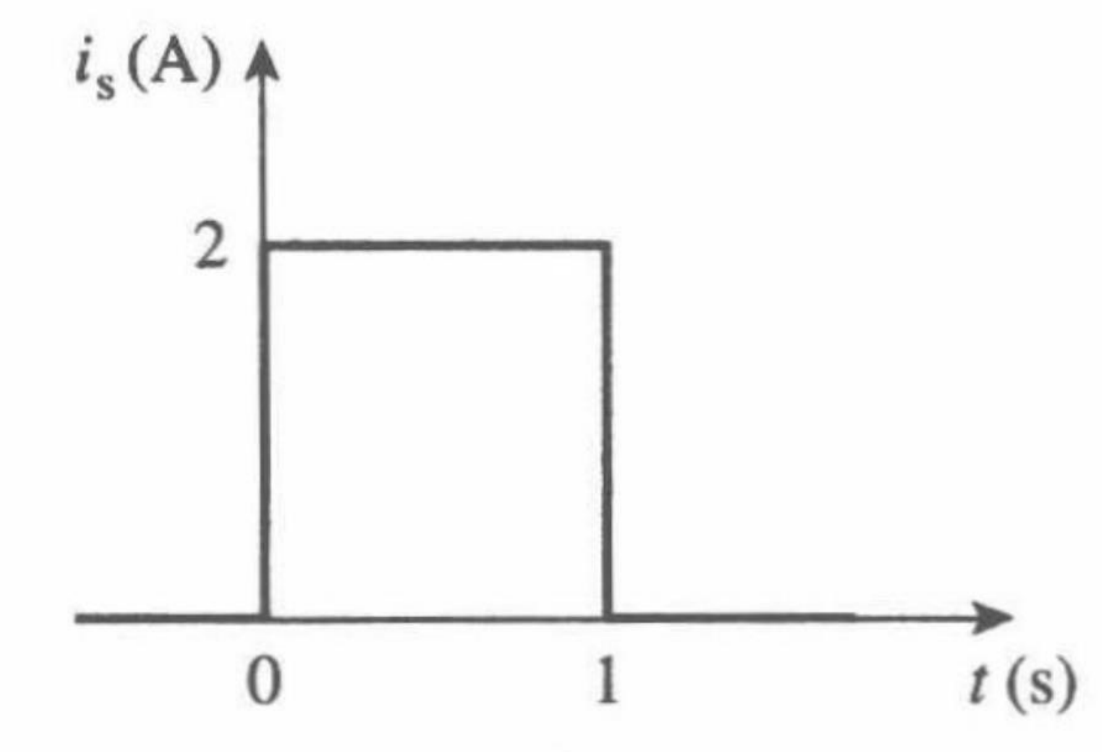
$$v(t)=v(\infty)+\left[v(0)-v(\infty)\right]e^{-t/\tau}$$

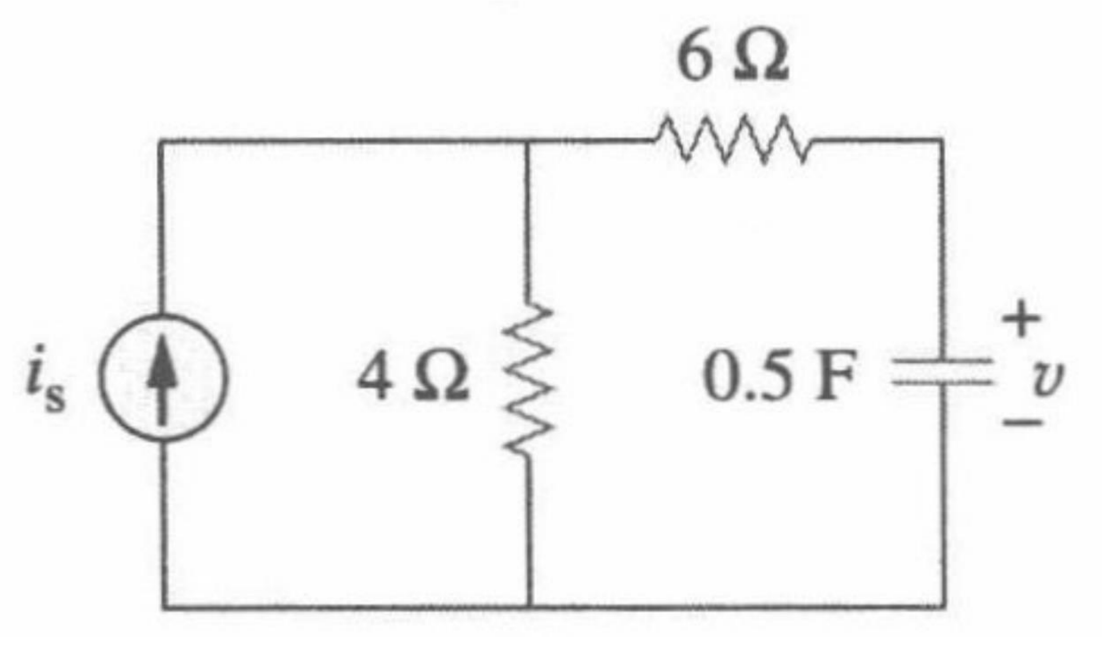
$$v(t)=\mathbf{10e^{-t/3}\ V}$$

$$i(t)=C\frac{dv}{dt}=(0.1)\left(\frac{-1}{3}\right)10e^{-t/3}$$

$$i(t)=\mathbf{\frac{-1}{3}e^{-t/3}\ A}$$

7.49 下图所示波形对应对应下图所示电路，假设 v（0）=0，求 v（t）





解：

当 $0 < t < 1$，　$v(0) = 0$，　$v(\infty) = (2)(4) = 8$

$R_{eq} = 4 + 6 = 10$，$\tau = R_{eq}C = (10)(0.5) = 5$

$$v(t) = v(\infty) + \left[v(0) - v(\infty) \right] e^{-t/\tau}$$

$$v(t) = 8\left(1 - e^{-t/5}\right) V$$

当 $t > 1$，$v(1) = 8\left(1 - e^{-0.2}\right) = 1.45$，$v(\infty) = 0$

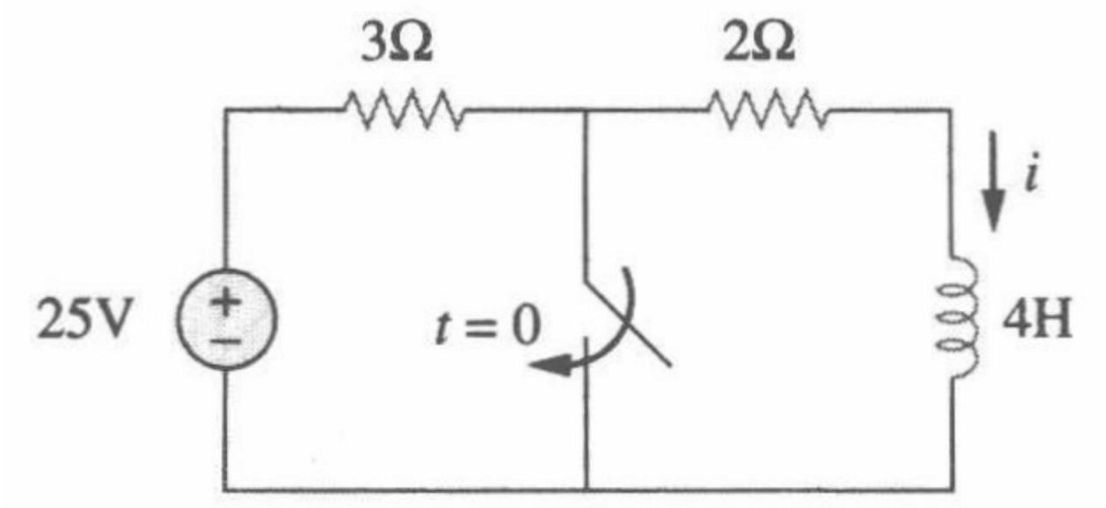
$$v(t) = v(\infty) + \left[v(1) - v(\infty) \right] e^{-(t-1)/\tau}$$

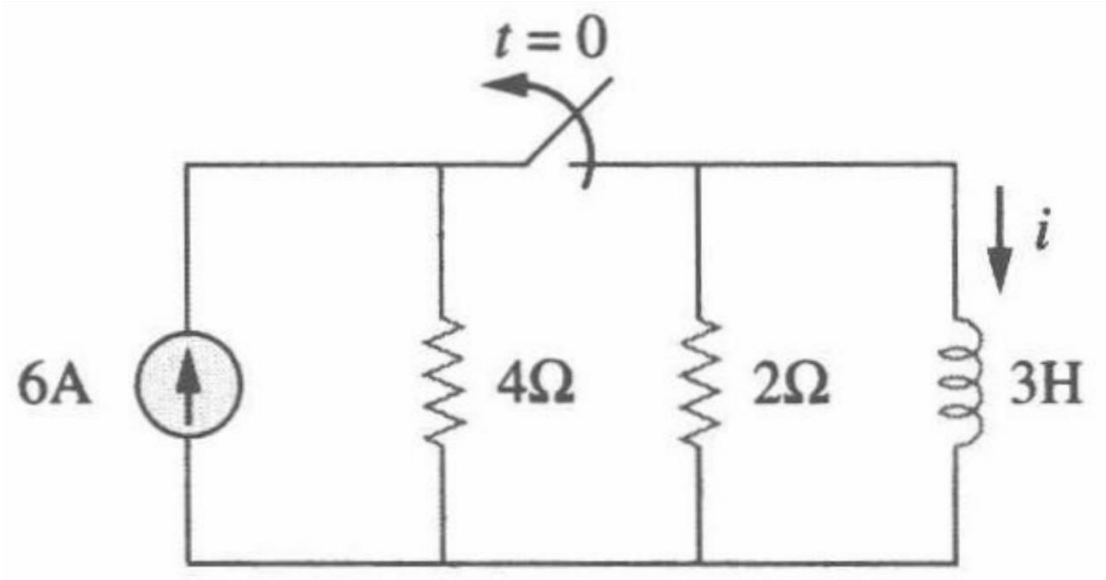
$$v(t) = 1.45\, e^{-(t-1)/5}\ V$$

因此，

$$v(t) = \begin{cases} \mathbf{8\left(1 - e^{-t/5}\right) V,} & \mathbf{0 < t < 1} \\ \mathbf{1.45\, e^{-(t-1)/5}\ V,} & \mathbf{t > 1} \end{cases}$$

7.53 下图中，求每个电路在 t<0 和 t>0 时的电感电流 i（t）。





(a)　t = 0 之前，　$\mathrm{i} = \dfrac{25}{3+2} = \mathbf{5\ A}$

t = 0 之后，$\mathrm{i(t)} = \mathrm{i(0)e^{-t/\tau}}$

$\tau = \dfrac{L}{R} = \dfrac{4}{2} = 2\,,\ \mathrm{i(0)} = 5$

$\mathrm{i(t)} = \boldsymbol{5e^{-t/2}\ u(t)A}$

（b）t = 0 之前，

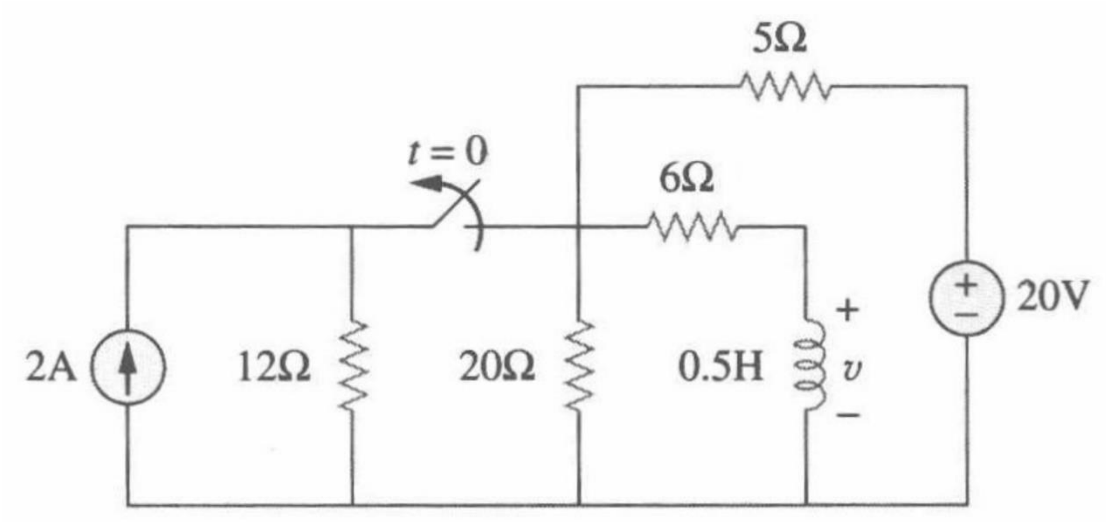
$\mathrm{i(t)} = \mathbf{6\ A}$

t = 0 之后，

$\mathrm{i(t)} = \mathrm{i(0)e^{-t/\tau}}\,,\qquad \tau = \dfrac{L}{R} = \dfrac{3}{2}$

$\mathrm{i(t)} = \boldsymbol{6e^{-2t/3}\ u(t)A}$

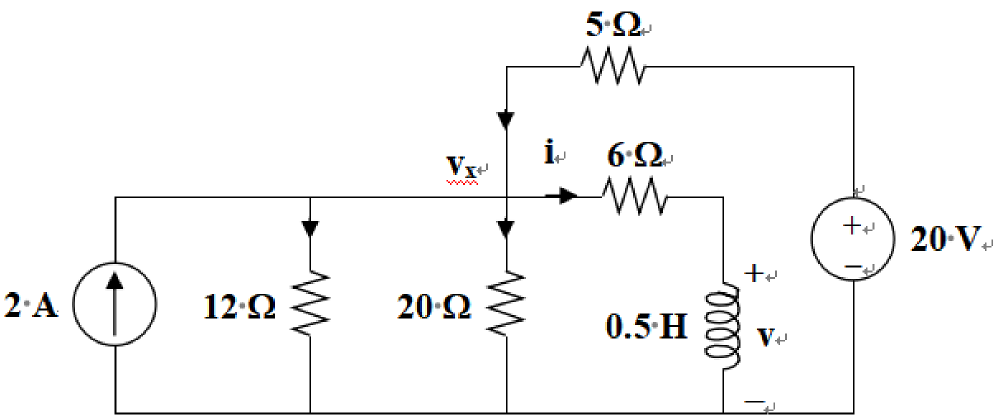
7.56 在下图所示网络中，求当 t>0 时的 v（t）。



解：

$$R_{eq} = 6 + 20 \parallel 5 = 10\,\Omega, \quad \tau = \frac{L}{R} = 0.05$$

$$i(t) = i(\infty) + \left[\, i(0) - i(\infty)\right] e^{-t/\tau}$$



$$2 + \frac{20 - v_x}{5} = \frac{v_x}{12} + \frac{v_x}{20} + \frac{v_x}{6} \longrightarrow v_x = 12$$

$$i(0) = \frac{v_x}{6} = 2\text{ A}$$

因为 $20 \parallel 5 = 4$，

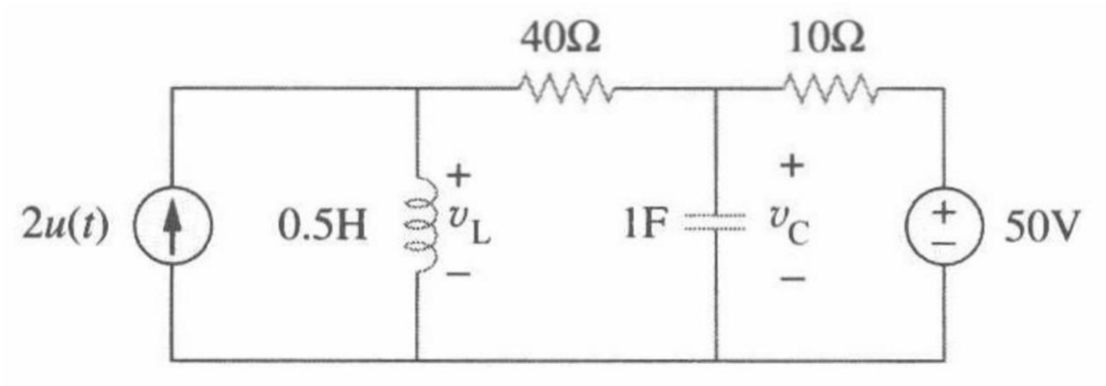
$$i(\infty) = \frac{4}{4+6}(4) = 1.6$$

$$i(t) = 1.6 + (2 - 1.6)e^{-t/0.05} = 1.6 + 0.4e^{-20t}$$

$$v(t) = L\frac{di}{dt} = \frac{1}{2}(0.4)(-20)\,e^{-20t}$$

$$v(t) = \mathbf{-4e^{-20t}\ V}$$

8.31 对于下图所示电路，计算 v_L（0^+）以及 v_C（0^+）。



解：

在 t = 0-, 可以得到电路图 (a). 在 t = 0+, 可以得到电路图 (b). 运用 KVL,

$$v(0+) = v(0-) = 40, \quad i(0+) = i(0-) = 1$$

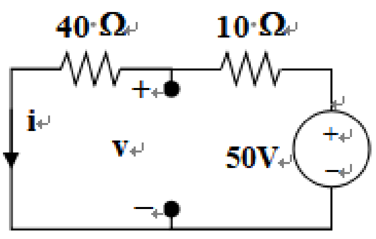
运用 KCL, $2 = i(0+) + i_1 = 1 + i_1$

$i_1 = 1.$

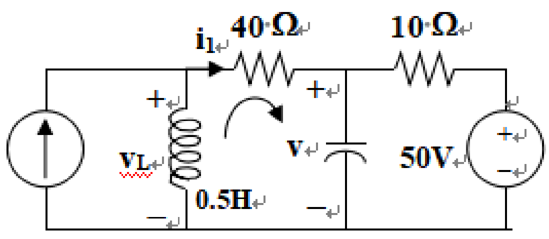
运用 KVL, $-v_L + 40i_1 + v(0+) = 0$

$v_L(0+) = 40x1 + 40 = 80$

$$v_L(0+) = \mathbf{80\ V}, \qquad v_C(0+) = \mathbf{40\ V}$$

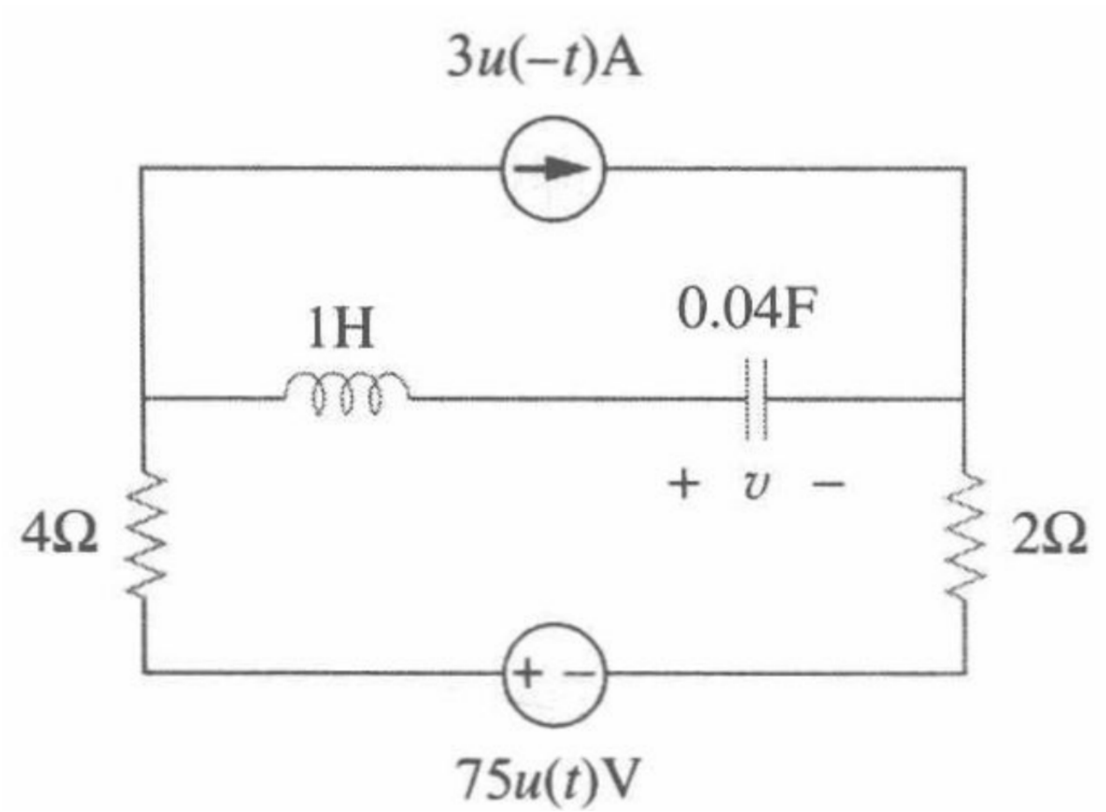


(a)



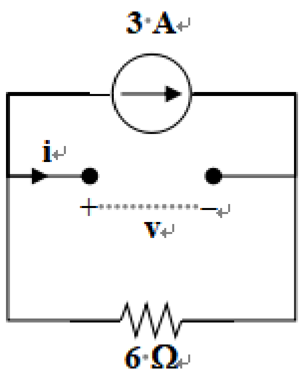
(b)

8.32 对于下图所示电路，计算 t>0 时的 v（t）



解：

在 t = 0–，等效电路图为：



$$i(0^-) = 0, \quad v(0^-) = -3x6 = -18\ V$$

在 t > 0,

$$\alpha = R/(2L) = 6/2 = 3, \quad \omega_o = 1/\sqrt{LC} = 1/\sqrt{0.04}$$

$$s_{1,2} = -3 \pm \sqrt{9-25} = -3 \pm j4$$

因此， $v(t) = Vs + [(A\cos4t + B\sin4t)e{-3t}]$

$$Vs = 75\text{ V}$$

$$v(t) = 75 + [(A\cos 4t + B\sin 4t)e{-}3t]$$

$v(0) = -18 = 75 + A$ 得到 $A = -93.$

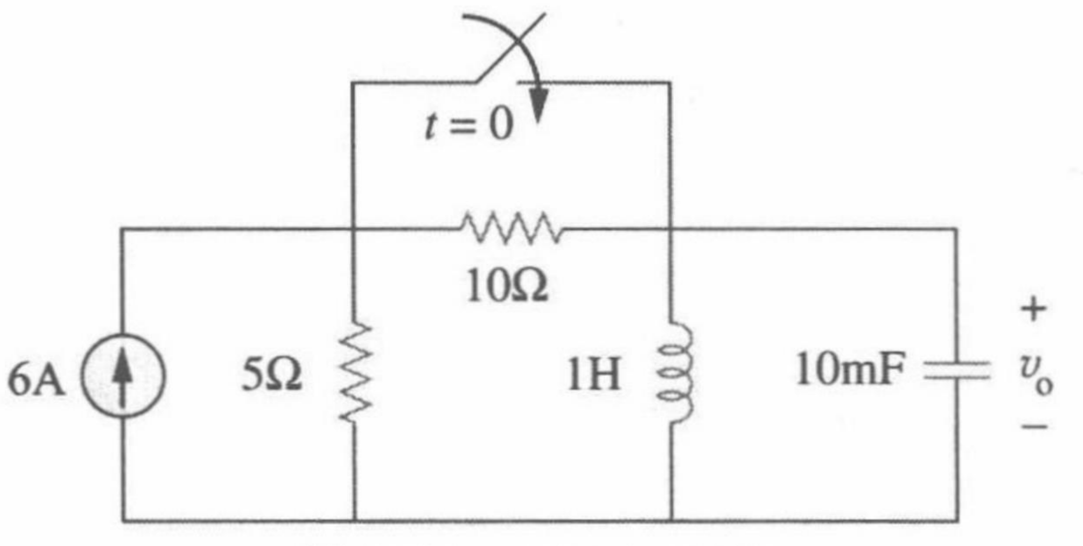
$i(0) = 0 = Cdv(0)/dt$

$dv/dt = [-3(A\cos 4t + B\sin 4t)e^{-3t}] + [4(-A\sin 4t + B\cos 4t)e^{-3t}]$

$0 = dv(0)/dt = -3A + 4B$ or $B = (3/4)A = -69.75$

$v(t) =$ **$\{75 + [(-93\cos 4t - 69.75\sin 4t)e^{-3t}]\}$ V， $t > 0$.**

8.47 计算下图所示电路的输出电压 v_o（t）



解：

在 $t = 0^-$, $i_L(0) = 6x5/(10 + 5) = 2$ A, $v_o(0) = 0.$

在 $t > 0$,

$$\alpha = 1/(2RC) = (1)/(2x5x0.01) = 10$$

$$\omega_o = 1/\sqrt{LC} = 1/\sqrt{1x0.01} = 10$$

因为 $\alpha = \omega_o$,

$$s_{1,2} = -10$$

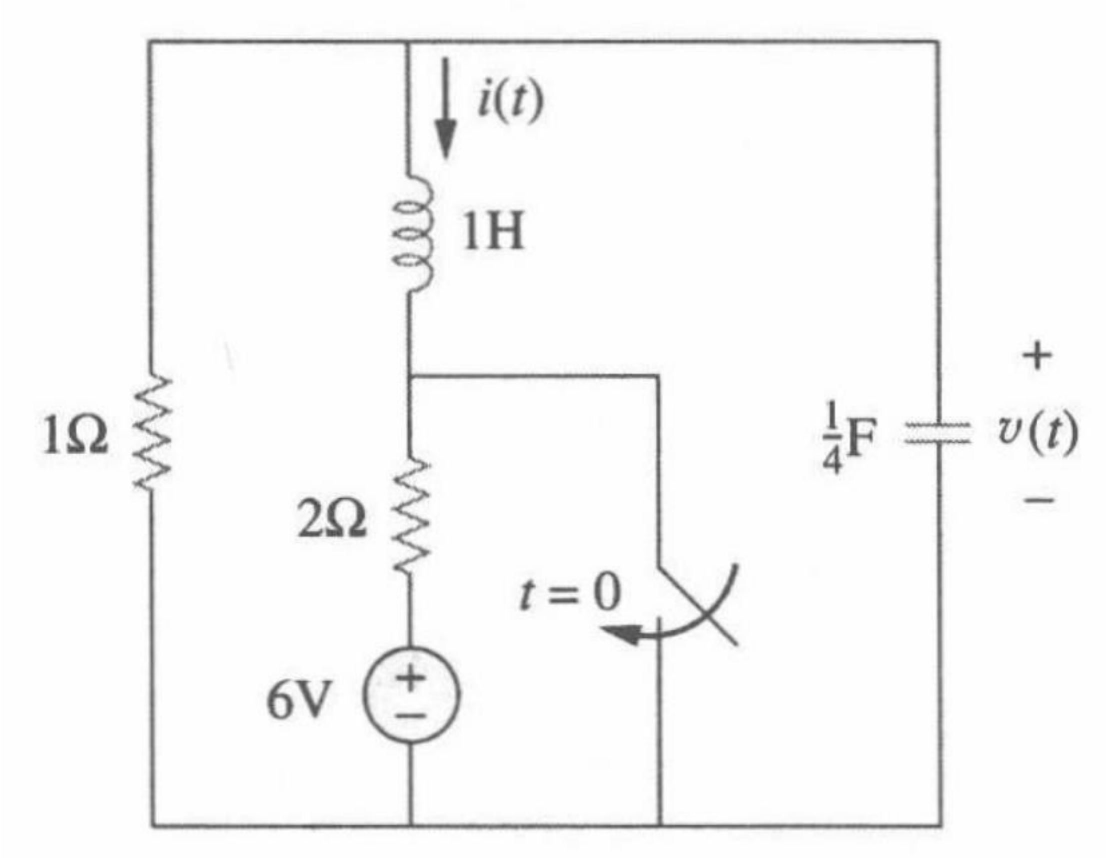
因此 $i(t) = I_{ss} + [(A + Bt)e^{-10t}]$, $I_{ss} = 6$, $i(0) = 2 = 6 + A$ ， $A = -4$

$$v_o = Ldi/dt = [Be^{-10t}] + [-10(A + Bt)e^{-10t}]$$

$$v_o(0) = 0 = B - 10A \quad , \quad B = -40$$

因此, $v_o(t) = \mathbf{(400te^{-10t})\ V}$.

8.48 对于下图所示电路，计算 t>0 时的 v（t）和 i（t）。



解：

在 $t = 0^-$, $i(0) = -6/(1+2) = -2$ ， $v(0) = 2x1 = 2$.

在 $t > 0$,

$$\alpha = 1/(2RC) = (1)/(2x1x0.25) = 2$$

$$\omega_o = 1/\sqrt{LC} = 1/\sqrt{1x0.25} = 2$$

因为 $\alpha = \omega_o$,

$$s_{1,2} = -2$$

因此, $i(t) = [(A + Bt)e^{-2t}]$, $i(0) = -2 = A$

$$v = Ldi/dt = [Be^{-2t}] + [-2(-2 + Bt)e^{-2t}]$$

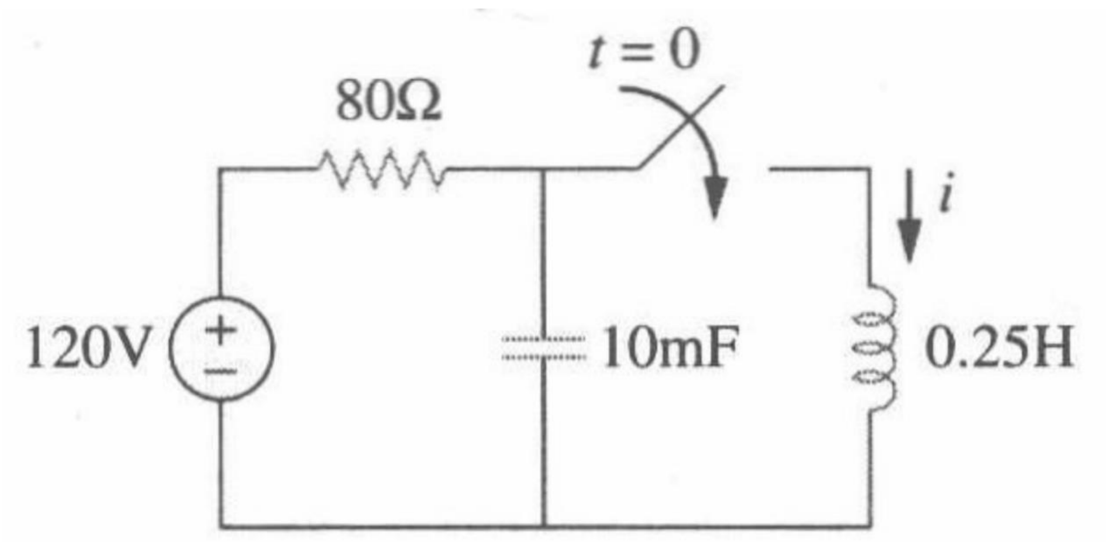
$$v_o(0) = 2 = B + 4 \quad \text{or} \quad B = -2$$

因此,

$$i(t) = \mathbf{[(-2 - 2t)e^{-2t}]\ A}$$

$$v(t) = \mathbf{[(2 + 4t)e^{-2t}]\ V}$$

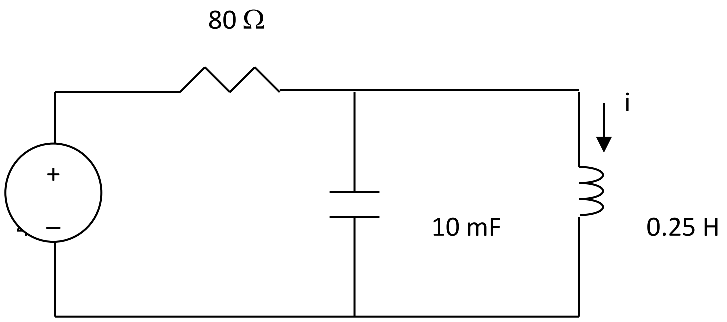
8.53 下图所示电路中，已断开一天的开关在 t=0 时闭合。计算 t>0 时 i（t）的差分方程。



解：

当 $t < 0$, $i(0) = 0$ ， $v_C(0) = 40$.

当 $t > 0$,



$[(40 – v_C)/80] = 0.01[dv_C/dt] + i$ ， $40 = v_C + 0.8[dv_C/dt] + 80i$.

$$\mathbf{(d^2i/dt^2) + 1.25(di/dt) + 400i = 200}.$$

9.5 已知 v1=45sin（ωt+30°）V 和 v2=50cos（ωt-30°）V，计算这两个正弦信号之间的相位角，并指出哪一个是滞后的。

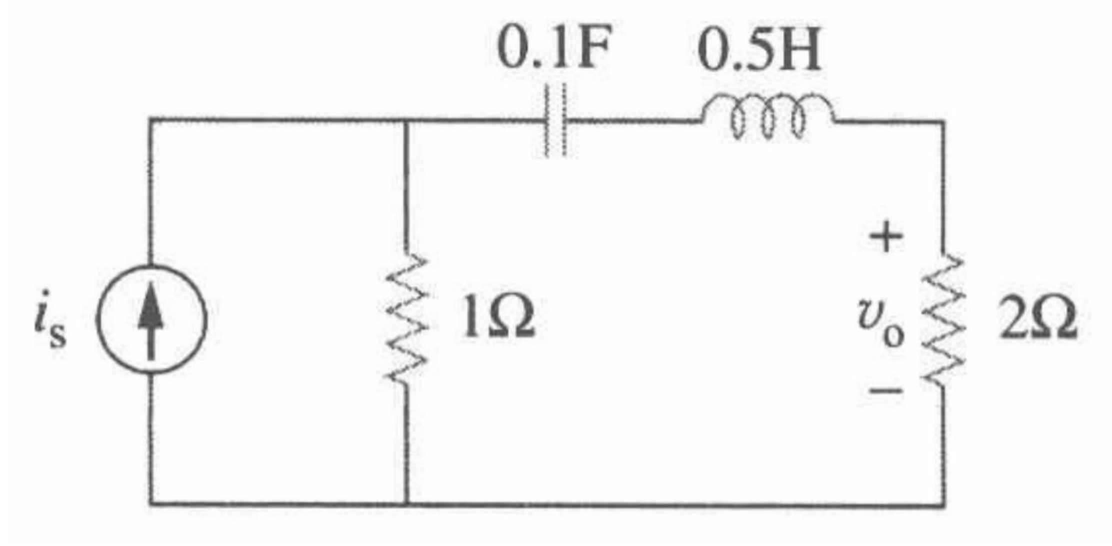
解：

$v_1 = 45 \sin(\omega t + 30°)$ V = $45 \cos(\omega t + 30° – 90°)$ = $45 \cos(\omega t – 60°)$ V

$v_2 = 50 \cos(\omega t – 30°)$ V

相位角为 **30°** ， $\boldsymbol{v_1}$ **滞后于** $\boldsymbol{v_2}$.

9.51 如果下图所示电路中 2Ω 电阻两端的电压 v_o 为 90cos2tV，试求 i_s



解：

$$0.1\,\text{F} \longrightarrow \frac{1}{\text{j}\omega\text{C}} = \frac{1}{\text{j}(2)(0.1)} = \text{-j5}$$

$$0.5\,\text{H} \longrightarrow \text{j}\omega\text{L} = \text{j}(2)(0.5) = \text{j}$$

2-Ω 电阻的电路为

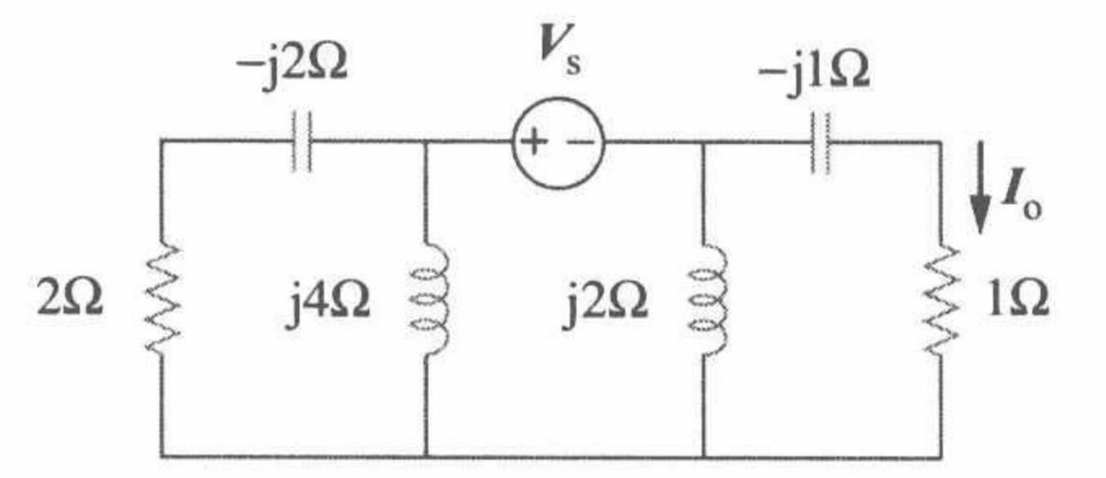
$$\mathbf{I} = \frac{1}{1 - \text{j5} + \text{j} + 2}\mathbf{I}_s = \frac{\mathbf{I}_s}{3 - \text{j4}}, \qquad \mathbf{I} = \frac{90}{2}\angle 0° = 45$$

$$\mathbf{I}_s = (45)(3 - j4) = 225\angle\text{-}53.13°$$

因此,

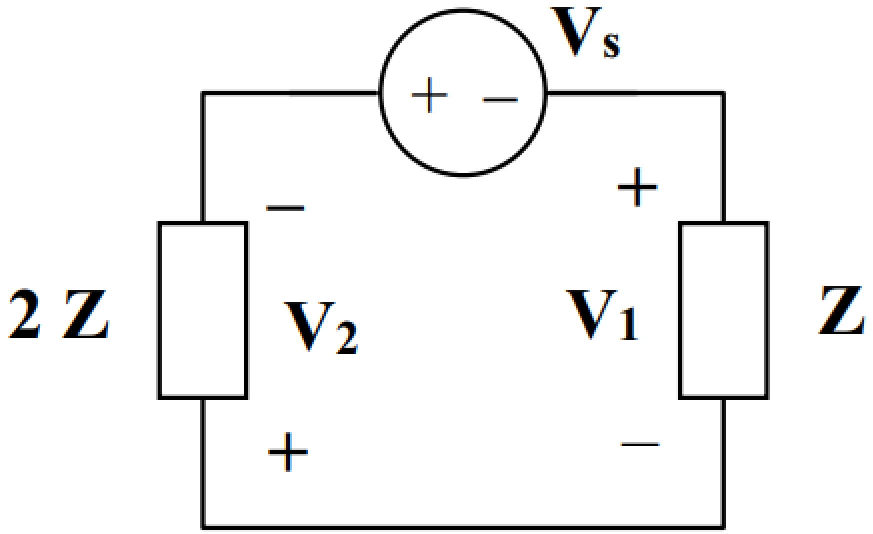
$$\text{i}_s(\text{t}) = \mathbf{225cos(2t – 53.13°)\ A}$$

9.54 在下图所示电路中，$\mathbf{I}_o = 30\angle 0°\text{A}$,试求 $\mathbf{V}_s$。



解：

等效电路如图：



$$\mathbf{V}_1 = \mathbf{I}_o(1-j) = 30(1-j)$$

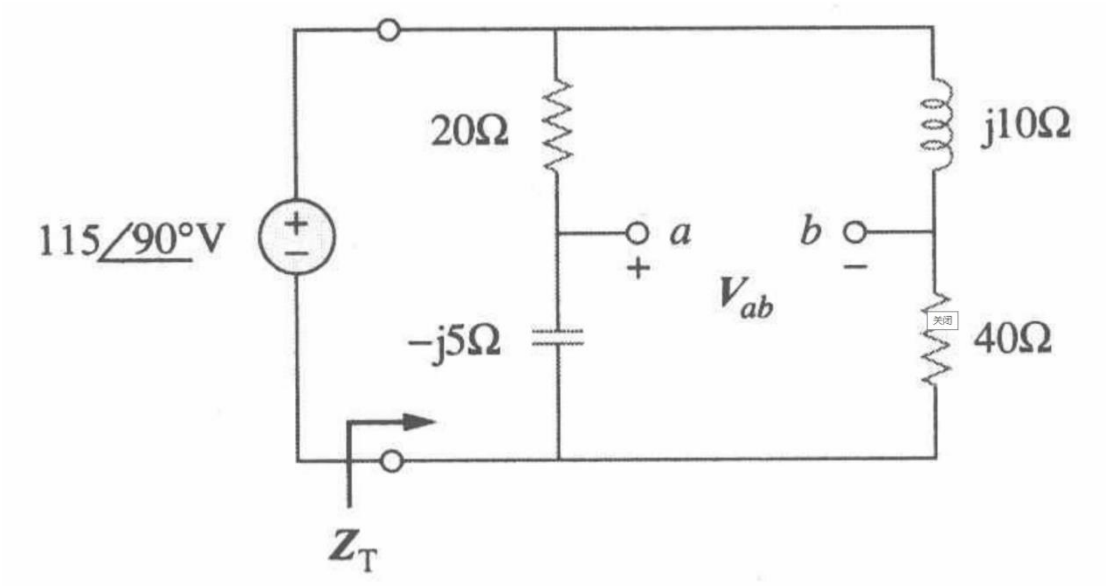
$$\mathbf{V}_2 = 2\mathbf{V}_1 = 60(1-j)$$

$\mathbf{V_2} + \mathbf{V_s} + \mathbf{V_1} = 0$ or

$$\mathbf{V}_s = -\mathbf{V}_1 - \mathbf{V}_2 = -90(1-j) = (90\angle 180°)(1.4142\angle -45°)$$

$$\mathbf{V}_s = \mathbf{127.28\angle 135°\ V}$$

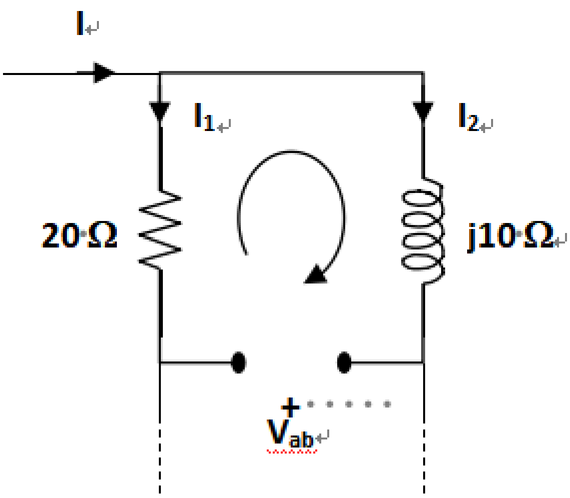
9.66 计算下图所示电路中的 $\mathbf{Z_T}$ 和 $\mathbf{V_{ab}}$



解：

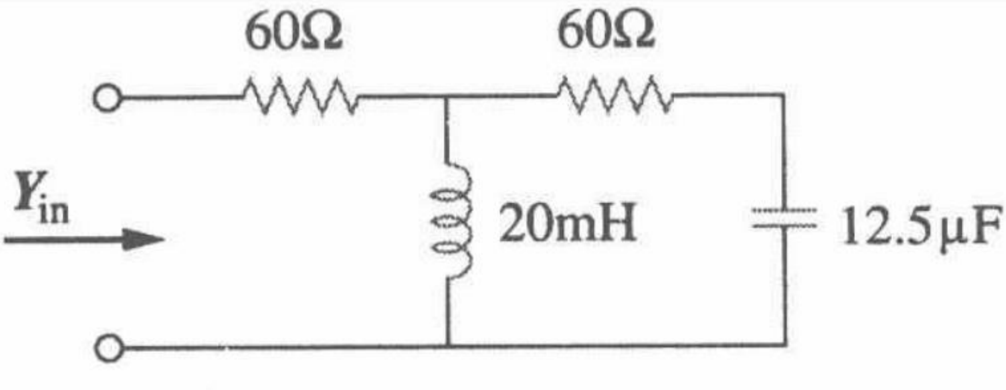
$$\mathbf{Z}_{\mathrm{T}} = (20-\mathrm{j}5) \parallel (40+\mathrm{j}10) = \frac{(20-\mathrm{j}5)(40+\mathrm{j}10)}{60+\mathrm{j}5} = \frac{170}{145}(12-\mathrm{j})$$

$\mathbf{Z}_{\mathrm{T}}$ = **14.069 – j1.172 Ω = 14.118∠-4.76° Ω**

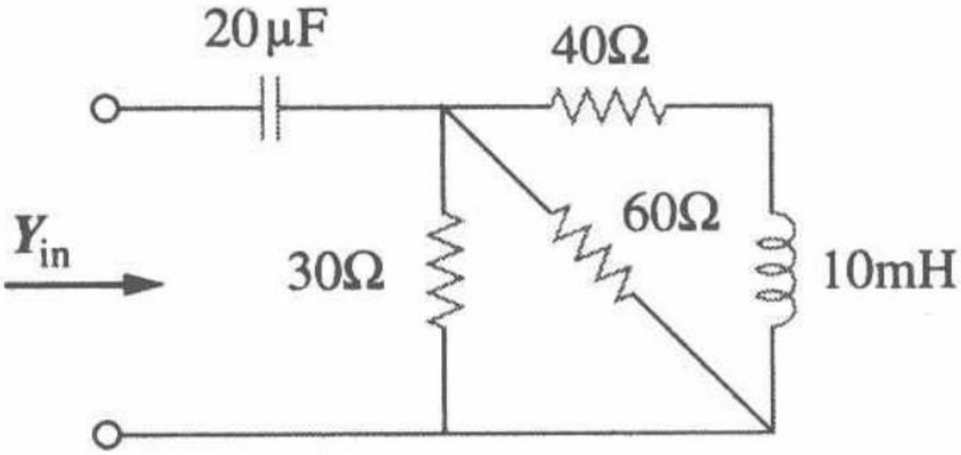


$$\mathbf{I} = \frac{\mathbf{V}}{\mathbf{Z}_T} = \frac{115\angle 90°}{14.118\angle -4.76°} = 8.1456\angle 94.76°$$

9.67 计算下图所示各电路在ω $= 10^3$ rad/s 时的输入导纳。



a)



b)

解：

(a) $20\text{ mH} \longrightarrow \quad j\omega L = j(10^3)(20\times10^{-3}) = j20$

$12.5\ \mu\text{F} \longrightarrow \quad \dfrac{1}{j\omega C} = \dfrac{1}{j(10^3)(12.5\times10^{-6})} = -j80$

$$\mathbf{Z}_{in} = 60 + j20 \,\|\, (60 - j80)$$

$$\mathbf{Z}_{in} = 60 + \frac{(j20)(60 - j80)}{60 - j60}$$

$$\mathbf{Z}_{in} = 63.33 + j23.33 = 67.494\angle 20.22°$$

$$\mathbf{Y}_{in} = \frac{1}{\mathbf{Z}_{in}} = \mathbf{14.8\angle\text{-}20.22°\ mS}$$

(b) $10\text{ mH} \longrightarrow \quad j\omega L = j(10^3)(10\times 10^{-3}) = j10$

$$20\ \mu F \longrightarrow \quad \frac{1}{j\omega C} = \frac{1}{j(10^3)(20\times 10^{-6})} = -j50$$

$$30\,||\,60 = 20$$

$$\mathbf{Z}_{in} = -j50 + 20\,||\,(40 + j10)$$

$$\mathbf{Z}_{in} = -j50 + \frac{(20)(40+j10)}{60+j10} = -j50 + 20(41.231\angle 14.036°)/(60.828\angle 9.462°)$$

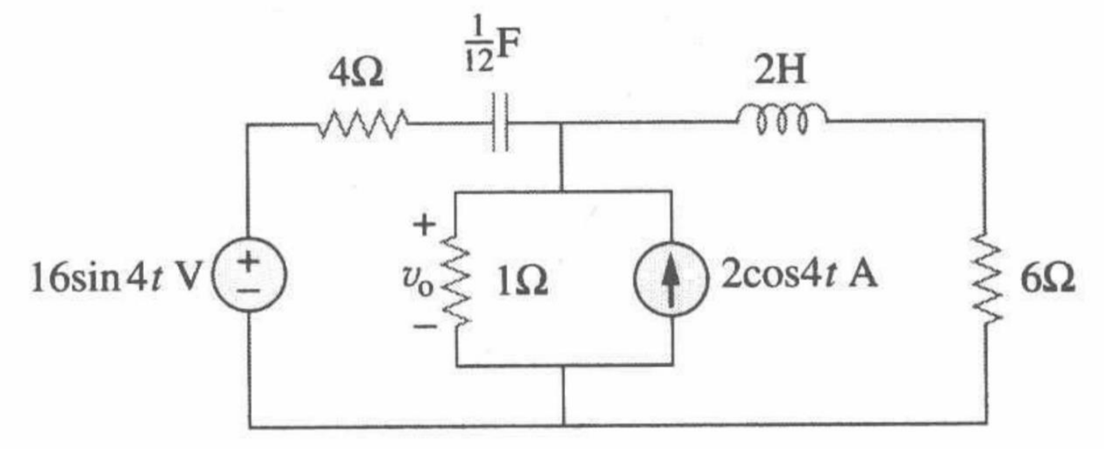
$= -j50 + (13.5566\angle 4.574° = -j50 + 13.51342 + j1.08109$

$= 13.51342 - j48.9189 = 50.751\angle -74.56°$

$$\mathbf{Z}_{in} = 13.5 - j48.92 = 50.75\angle -74.56°$$

$$\mathbf{Y}_{in} = \frac{1}{\mathbf{Z}_{in}} = \mathbf{19.704\angle 74.56°\ mS} \quad = \quad 5.246 + j18.993\ \text{mS}$$

10.3 计算下图所示电路中的 v_o



解：

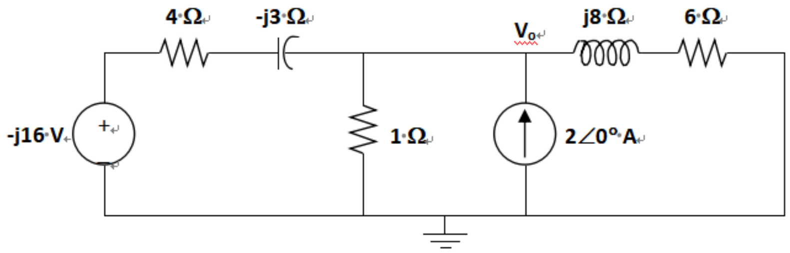
$$\omega = 4$$

$$2\cos(4t) \longrightarrow 2\angle 0°$$

$$16\sin(4t) \longrightarrow 16\angle -90° = -j16$$

$$2\text{ H} \longrightarrow j\omega L = j8$$

$$1/12\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(4)(1/12)} = -j3$$



运用节点分析法,

$$\frac{-j16-\mathbf{V}_o}{4-j3}+2=\frac{\mathbf{V}_o}{1}+\frac{\mathbf{V}_o}{6+j8}$$

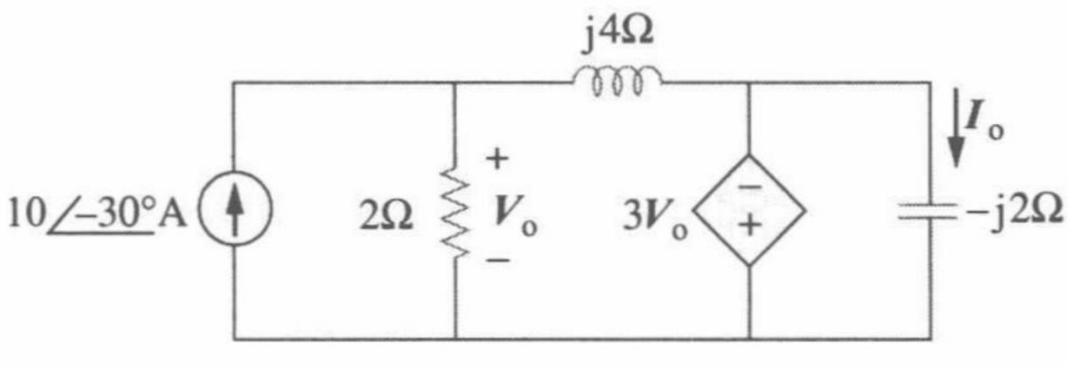
$$\frac{-j16}{4-j3}+2=\left(1+\frac{1}{4-j3}+\frac{1}{6+j8}\right)\mathbf{V}_o$$

$$\mathbf{V}_o=\frac{3.92-j2.56}{1.22+j0.04}=\frac{4.682\angle -33.15°}{1.2207\angle 1.88°}=3.835\angle -35.02°$$

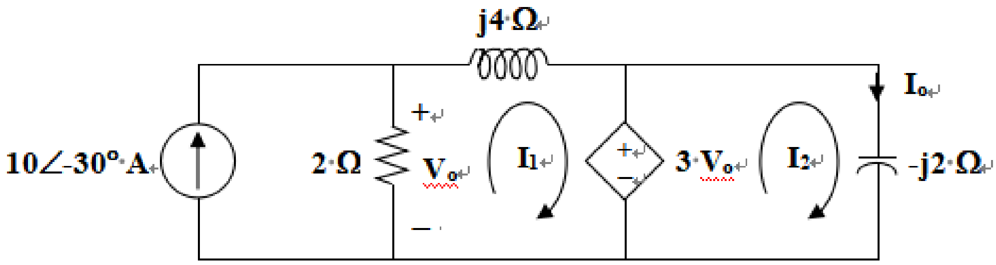
Therefore,

$$v_o(t) = \mathbf{3.835cos(4t – 35.02°) V}$$

10.32 利用网孔分析法计算下图所示电路中的 $\mathbf{V}_o$ 和 $\mathbf{I}_o$



解：



网孔 1,

$$(2+j4)\mathbf{I}_1-2(10\angle\text{-}30°)+3\mathbf{V}_o=0$$

$$\mathbf{V}_o=2(10\angle\text{-}30°-\mathbf{I}_1)$$

因此,

$$(2+j4)\mathbf{I}_1-20\angle\text{-}30°+6(10\angle\text{-}30°-\mathbf{I}_1)=0$$

$$10\angle\text{-}30°=(1-j)\mathbf{I}_1$$

$$\mathbf{I}_1=25\sqrt{2}\angle 15°$$

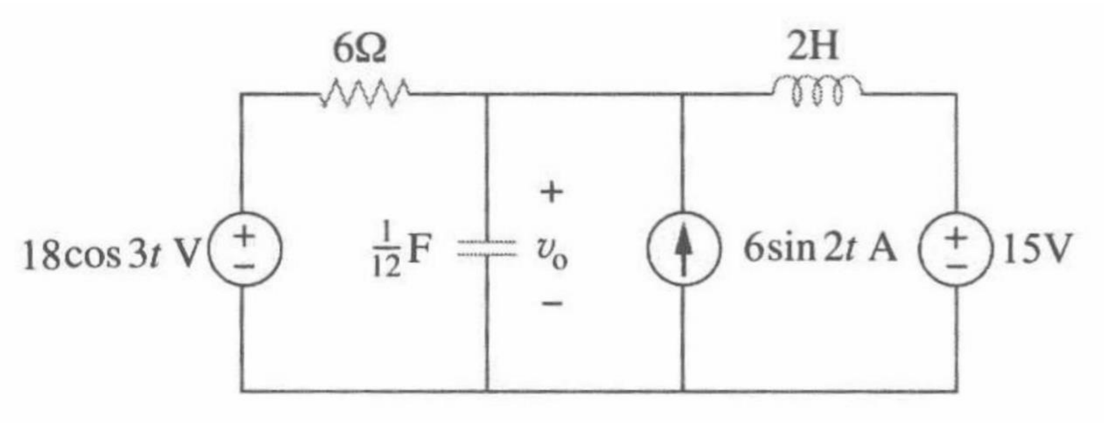
$$\mathbf{I}_o=\frac{3\mathbf{V}_o}{\text{-}j2}=\frac{3}{\text{-}j2}(2)(10\angle\text{-}30°-\mathbf{I}_1)$$

$$\mathbf{I}_o=j3(10\angle\text{-}30°-5\sqrt{2}\angle 15°)$$

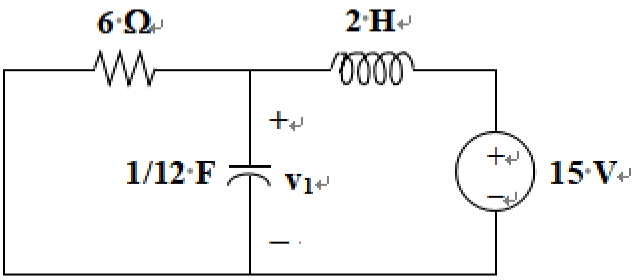
$$\mathbf{I}_o=\ \mathbf{21.21\angle 15°\ A}$$

$$\mathbf{V}_o=\frac{\text{-}\,\mathrm{j}2\mathbf{I}_o}{3}=\ \mathbf{5.657\angle\text{-}75°\ V}$$

10.46 利用叠加定理计算下图所示电路中的 $v_o(t)$

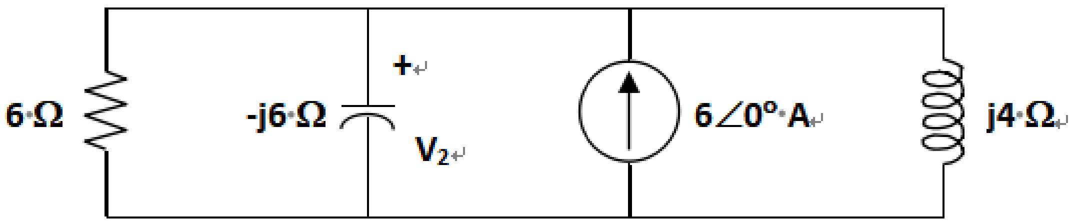


解：



(a)

$$v_1 = 15V$$



(b)

$$\omega = 2$$

$$2\text{ H} \longrightarrow j\omega L = j4$$

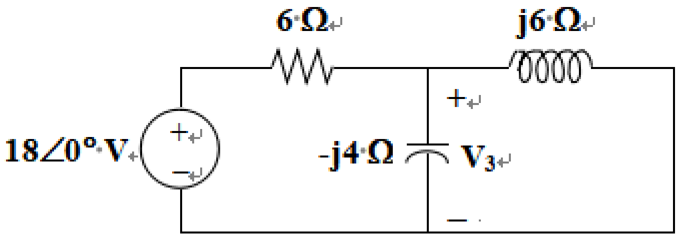
$$\frac{1}{12}\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(2)(1/12)} = -j6$$

运用节点分析法,

$$6 = \frac{\mathbf{V}_2}{6} + \frac{\mathbf{V}_2}{-j6} + \frac{\mathbf{V}_2}{j4} = \left(\frac{1}{6} + \frac{j}{6} - \frac{j}{4}\right)\mathbf{V}_2$$

$$\mathbf{V}_2 = \frac{36}{1 - j0.5} = 32.18\angle 26.57°$$

因此, $v_2 = 32.18\sin(2t + 26.57°)\,V$



(c)

$$\omega = 3$$

$$2\text{ H} \longrightarrow j\omega L = j6$$

$$\frac{1}{12}\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(3)(1/12)} = -j4$$

$$\frac{18 - \mathbf{V}_3}{6} = \frac{\mathbf{V}_3}{-j4} + \frac{\mathbf{V}_3}{j6}$$

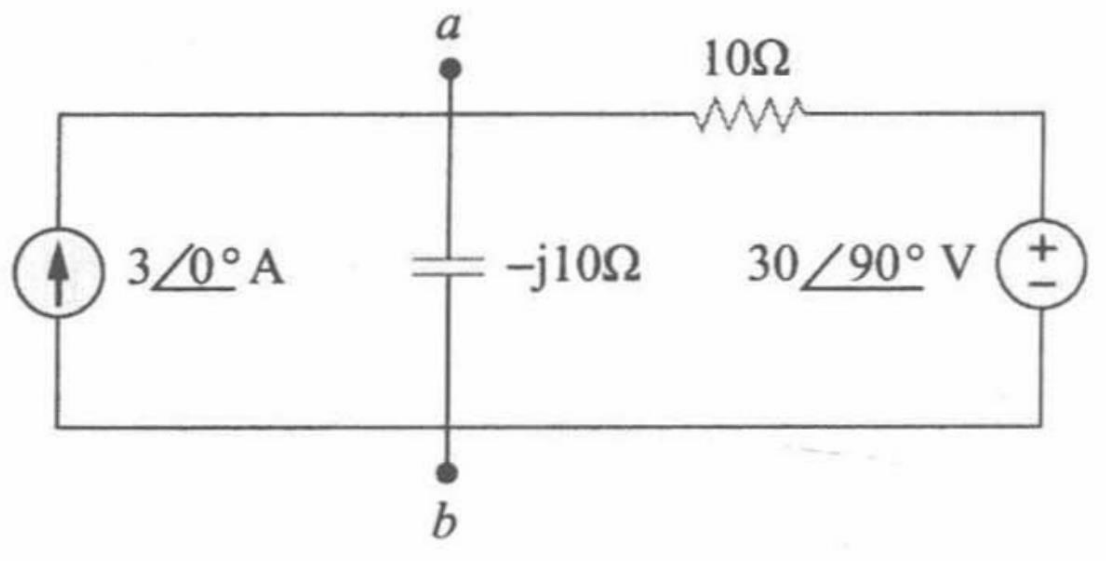
$$\mathbf{V}_3 = \frac{18}{1 + j0.5} = 16.1\angle -26.57°$$

因此, $v_3 = 16.1\cos(3t - 26.57°)\,V$

最后,

$v_o(t)$ = **[15+32.18sin(2t+26.57°)+16.1cos(3t–26.57°)] V**

10.58 求下图所示各电路在端口 a-b 处的诺顿等效电路。



解：

$\mathbf{V_{oc}} = \mathbf{V_{ab}}$. $-3 + [(\mathbf{V_{ab}}-0)/(-j10)] + [(V_{ab}-j30)/10] = 0$

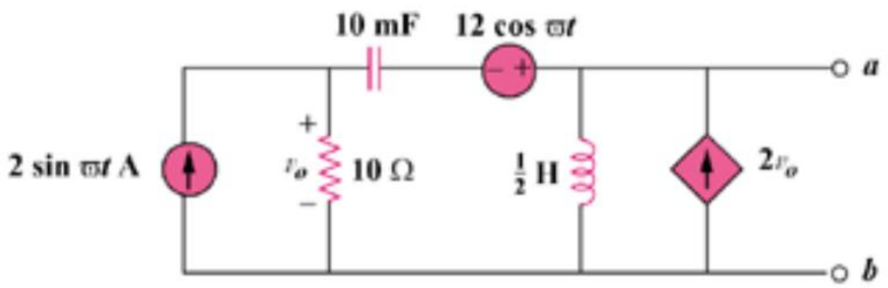
$(0.1+j0.1)\mathbf{V_{ab}} = 3+j3$

$\mathbf{V_{oc}} = \mathbf{V_{Thev}} = 3(1+j)/[0.1(1+j)] = \mathbf{30\ V}$.

$I_{sc} = 3 + [(j30)/10] = 3+j3$.

$\mathbf{Z_{eq}} = \mathbf{V_{Thev}/I_{sc}} = 30/[3(1+j)] = \mathbf{(5-j5)\ \Omega}$.

10.66 求下图所示电路在端口 a-b 处的戴维南等效电路与诺顿等效电路，假设 $\omega = 10$ rad/s



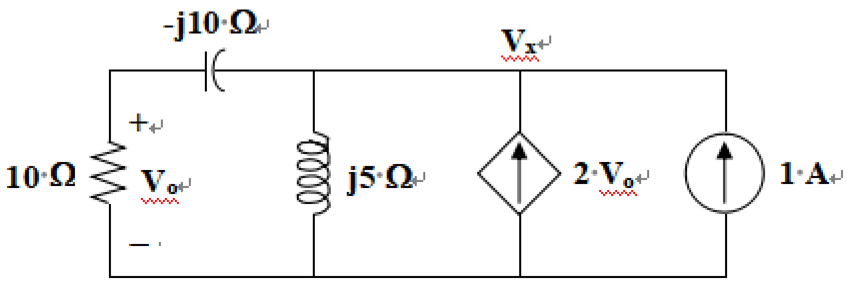
解：

$$\omega = 10$$

$$0.5\ \text{H} \longrightarrow j\omega L = j(10)(0.5) = j5$$

$$10\ mF \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(10)(10\times10^{-3})} = -j10$$

To find $\mathbf{Z}_{th}$,

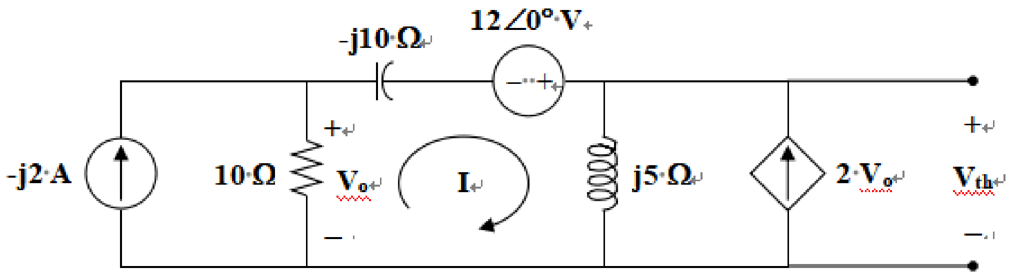


(a)

$$1 + 2\mathbf{V}_o = \frac{\mathbf{V}_x}{j5} + \frac{\mathbf{V}_x}{10 - j10}, \quad , \quad \mathbf{V}_o = \frac{10\mathbf{V}_x}{10 - j10}$$

$$1 + \frac{19\mathbf{V}_x}{10 - j10} = \frac{\mathbf{V}_x}{j5} \longrightarrow \mathbf{V}_x = \frac{-10 + j10}{21 + j2}$$

$$\mathbf{Z}_N = \mathbf{Z}_{th} = \frac{\mathbf{V}_x}{1} = \frac{14.142\angle 135°}{21.095\angle 5.44°} = \mathbf{670\angle 129.56°\ m\Omega}$$



(b)

$$(10 - j10 + j5)\mathbf{I} - (10)(-j2) + j5(2\mathbf{V}_o) - 12 = 0$$

$$\mathbf{V}_o = (10)(-j2 - \mathbf{I})$$

因此,

$$(10 - j105)\mathbf{I} = -188 - j20$$

$$\mathbf{I} = \frac{188 + j20}{-10 + j105}$$

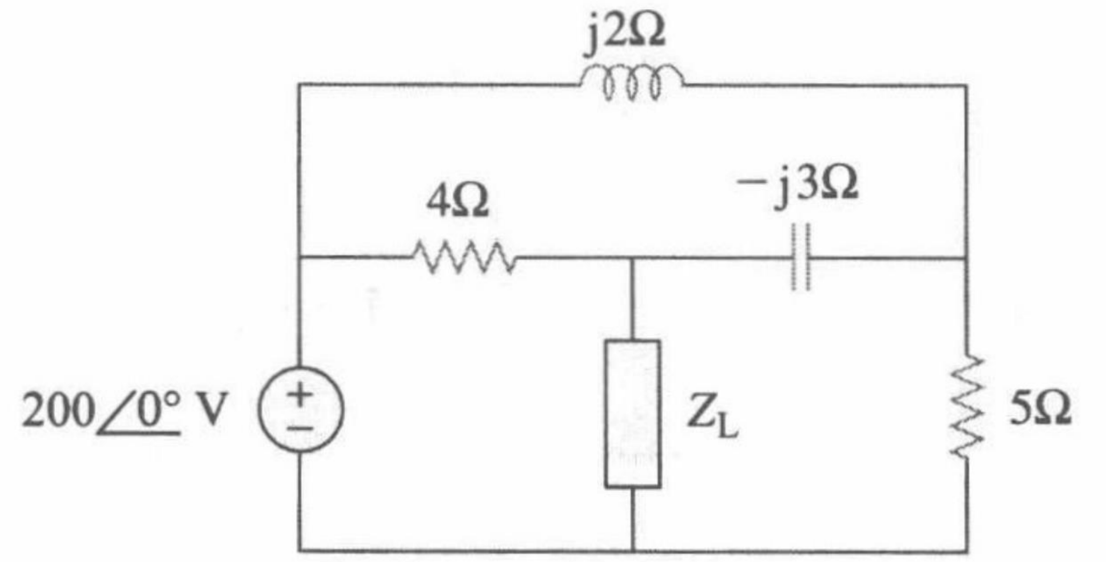
$$\mathbf{V}_{th} = j5(\mathbf{I} + 2\mathbf{V}_o) = j5(-19\mathbf{I} - j40) = -j95\mathbf{I} + 200$$

$$\mathbf{V}_{th} = \frac{-j95(188+j20)}{-10+j105} + 200 = \frac{(95\angle-90°)(189.06\angle 6.07°)}{105.48\angle 95.44} + 200$$
$$= 170.28\angle -179.37° + 200 = -170.27 - j1.8723 + 200 = 29.73 - j1.8723$$

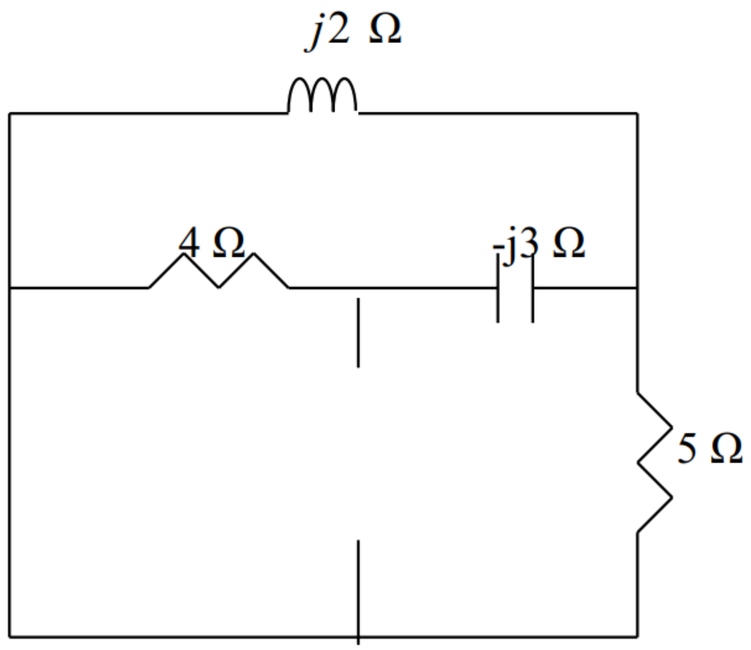
$\mathbf{V}_{\mathrm{th}} =$ **29.79∠–3.6° V**

$\mathbf{I}_N = \frac{\mathbf{V}_{th}}{\mathbf{Z}_{th}} = \frac{29.79\angle -3.6°}{0.67\angle 129.56°} =$ **44.46∠–133.16° A**

11.12 对于下图所示电路，试确定实现最大功率传输（对于 ZL）时的负载阻抗 ZL，并计算负载吸收的最大功率值。

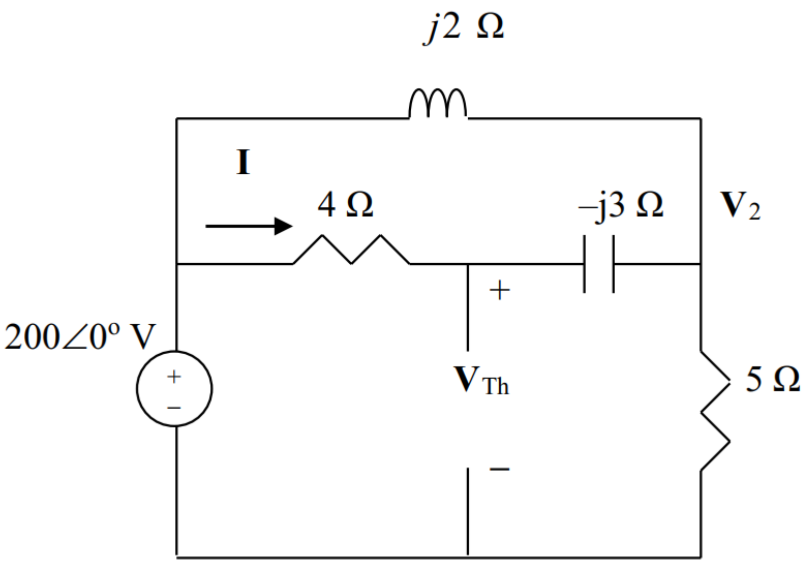


解：



$$Z_{Thev} = \frac{4\left(-j3+\frac{5xj2}{5+j2}\right)}{4-j3+\frac{5xj2}{5+j2}} = \frac{4(0.6896-j1.2758)}{4.69-j1.2758} = \frac{4(1.4502\angle -61.61°)}{4.86\angle -15.22°}$$
$$= 1.1936\angle -46.39°$$

Z_{Thev} = 0.8233 – j0.8642 or **Z_L = [823.3 + j864.2] mΩ**.



$$\frac{\mathbf{V}_2-200}{4-\mathbf{j}3}+\frac{\mathbf{V}_2-200}{\mathbf{j}2}+\frac{\mathbf{V}_2-0}{5}=0$$
$$(0.16+\mathbf{j}0.12-\mathbf{j}0.5+0.2)\mathbf{V}_2=(0.16+\mathbf{j}0.12-\mathbf{j}0.5)200$$
$$(0.5235\angle -46.55°)\mathbf{V}_2=(0.4123\angle -67.17°)200=82.46\angle -67.17°$$

Thus, $\mathbf{V_2} = 157.52\angle{-20.62°}\text{V} = 147.43–j55.473$

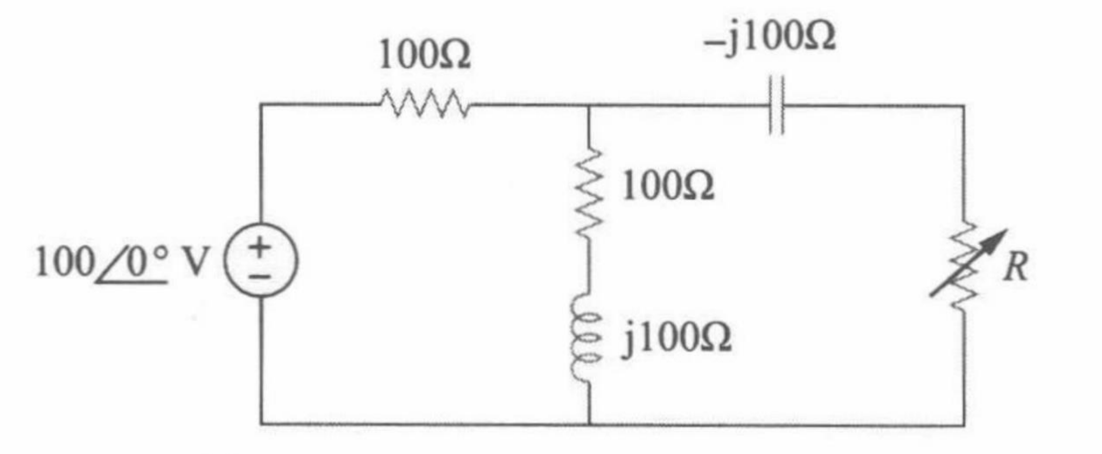
$\mathbf{I} = (200 – V_2)/(4 – j3) = (200 – 147.43 + j55.473)/(4 – j3)$
$= (52.57+j55.473)/(4–j3) = (76.426\angle 46.54°)/(5\angle{–36.87°}$
$= 15.285\angle 83.41° = 1.7542+j15.184$

$\mathbf{V_{Thev}} = 200 – 4\mathbf{I} = 200 – 7.0168 – j60.736 = [192.983 – j60.736]$ V
$= 202.31\angle{–17.47°}\text{V}$

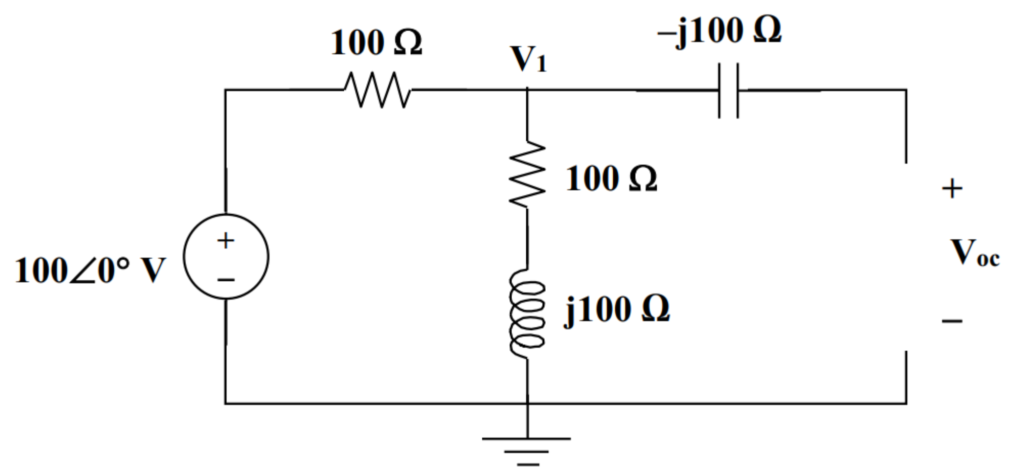
$|\mathbf{I_L}| = (202.31/(2\text{x}0.8233)) = 122.865$ A

$P_{avg} = [(|\mathbf{I_L}|)^2 0.8233]/2 =$ **6.214 kW**.

11.19 调节下图所示电路中的可变电阻 R 使其吸收最大的平均功率，试求该电阻值以及所吸收的最大平均功率。



解：



$\mathbf{Z_{eq}} = –j100 + 100(100+j100)/(100+100+j100)$.
$[(V_1–100)/100] + [(V_1–0)/(100+j100)] + 0 = 0$ ， $\mathbf{V_{oc}} = \mathbf{V_{Thev}} = \mathbf{V_1}$.

$\mathbf{Z_{eq}}$ = –j100+100(1.4142∠45°)/(2.2361∠26.57°) = –j100+63.244∠18.43°

= –j100 + 60 + j20 = (60 – j80) Ω = 100∠–53.13° Ω.

(0.01+0.005–j0.005)$\mathbf{V_1}$ = 1 = 0.0158114∠–18.43°$\mathbf{V_1}$， $\mathbf{V_1}$ = 63.246∠18.43°.

因此

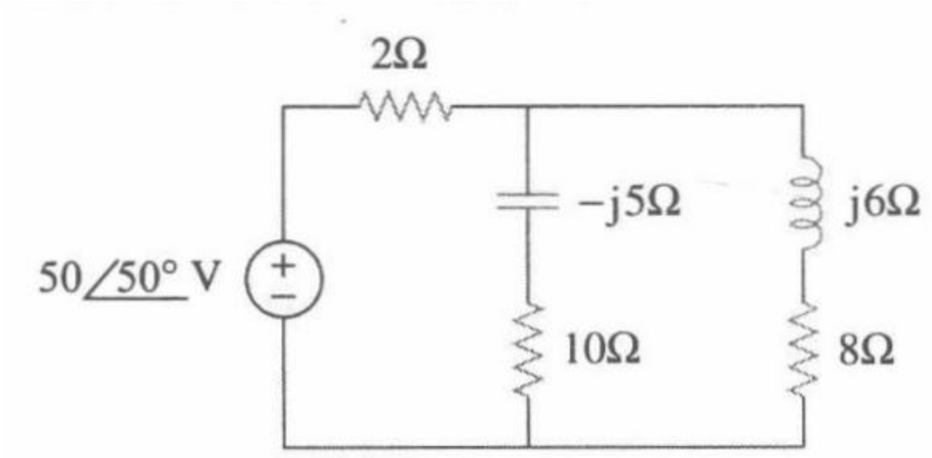
R = **100 Ω**

|**I**| = 63.246/|60–j80+100| = 63.246/178.885 = 0.353557 A

P_{avg} = [(0.353557)^2/2]100 = **6.25 W**.

11.51 对于下图所示的电路，试计算：（a）功率因数；（b）电源传递的平均功率；（c）无功功率；

（d）视在功率；（e）复功率。



解：

(a) $\mathbf{Z}_T = 2 + (10 - j5)\,||\,(8 + j6)$

$$\mathbf{Z}_T = 2 + \frac{(10 - j5)(8 + j6)}{18 + j} = 2 + \frac{110 + j20}{18 + j}$$

$$\mathbf{Z}_T = 8.152 + j0.768 = 8.188\angle 5.382°$$

$$\text{pf} = \cos(5.382°) = \mathbf{0.9956} \quad \textbf{(lagging)}$$

(b) $$\mathbf{S} = \mathbf{V}\,\mathbf{I}^* = \frac{|\mathbf{V}|^2}{(\mathbf{Z_T})^*} = \frac{(50)^2}{(8.188\angle\mathbf{-5.382}°)}$$

$$\mathbf{S} = 305.325\angle 5.382°$$

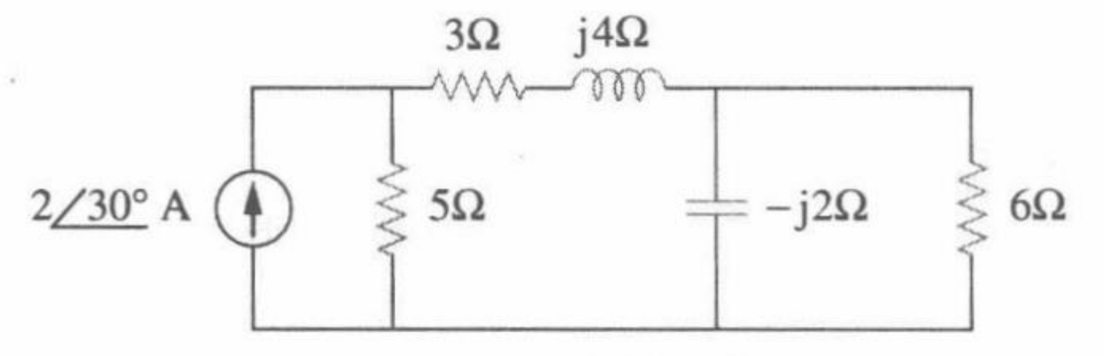
$\mathrm{P} = \mathrm{S}\cos\theta =$ **304 W**

(c) $\mathrm{Q} = \mathrm{S}\sin\theta =$ **28.64 VAR**

(d) $\mathrm{S} = \left|\mathbf{S}\right| =$ **305.3 VA**

(e) $\mathbf{S} = 305.325\angle 5.382° =$ **(304+j28.64) VA**

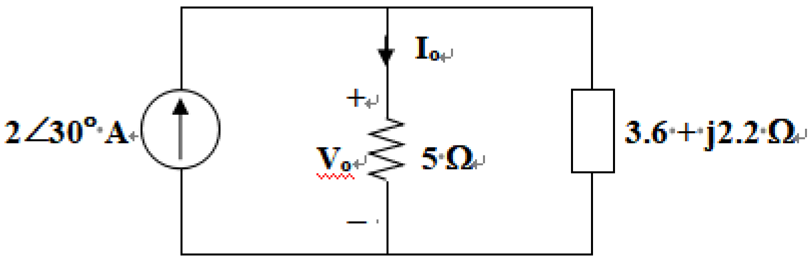
11.56 确定下图所示电路中的电源传递的复功率。



解：

$$-j2 \,||\, 6 = \frac{(6)(-j2)}{6 - j2} = \frac{12\angle -90°}{6.32456\angle -18.435°} = 1.897365\angle -71.565° = 0.6 - j1.8$$

$$3 + j4 + [(-j2) \,||\, 6] = 3.6 + j2.2$$



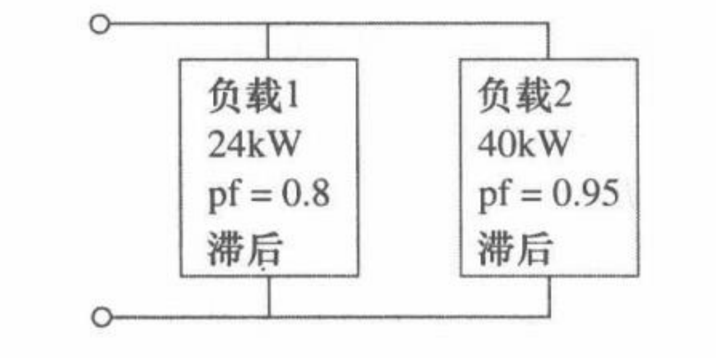
$$\mathbf{I}_o = \frac{3.6 + j2.2}{8.6 + j2.2}(2\angle 30°) = \frac{4.219\angle 31.4296°}{8.87694\angle 14.3493°}(2\angle 30°) = 0.95055\angle 47.08°$$

$$\mathbf{V}_o = 5\mathbf{I}_o = 4.75275\angle 47.08°$$

$$\mathbf{S} = \mathbf{V}_o \mathbf{I}_s^* = (4.75275\angle 47.08°)(2\angle -30°)$$

$$\mathbf{S} = 9.5055\angle 17.08° = \textbf{(9.086+j2.792) VA}$$

11.74 某 120Vrms、60Hz 电源给两个相互并联的负载供电，如下图所示。（a）试求该并联负载的功率因数；（b）试计算将功率因数提高到 1，所需并联的电容值。



解：

(a) $\theta_1 = \cos^{-1}(0.8) = 36.87°$

$$S_1 = \frac{P_1}{\cos\theta_1} = \frac{24}{0.8} = 30\ \text{kVA}$$

$$Q_1 = S_1 \sin\theta_1 = (30)(0.6) = 18\ \text{kVAR}$$

$$\mathbf{S}_1 = 24 + j18\ \text{kVA}$$

$$\theta_2 = \cos^{-1}(0.95) = 18.19°$$

$$S_2 = \frac{P_2}{\cos\theta_2} = \frac{40}{0.95} = 42.105\ \text{kVA}$$

$$Q_2 = S_2 \sin\theta_2 = 13.144\ \text{kVAR}$$

$$\mathbf{S}_2 = 40 + j13.144\ \text{kVA}$$

$$\mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 = 64 + j31.144\ \text{kVA}$$

$$\theta = \tan^{-1}\left(\frac{31.144}{64}\right) = 25.95°$$

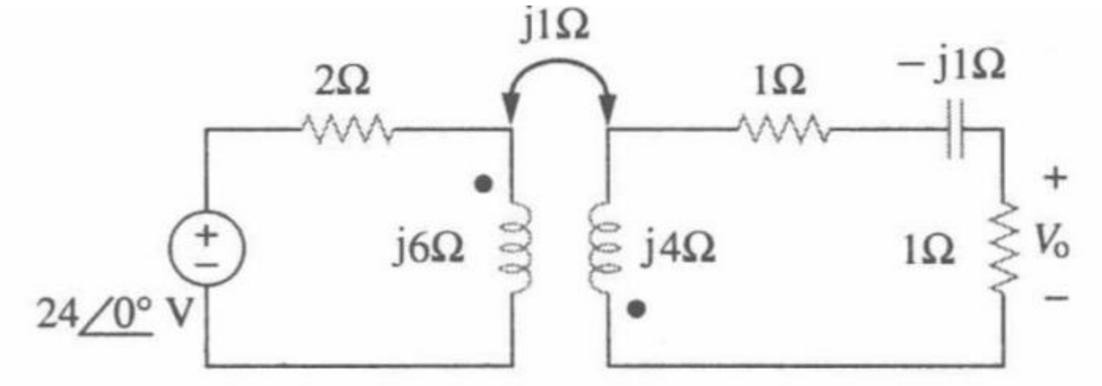
$$\text{pf} = \cos\theta = \mathbf{0.8992}$$

(b) $\theta_2 = 25.95°$, $\theta_1 = 0°$

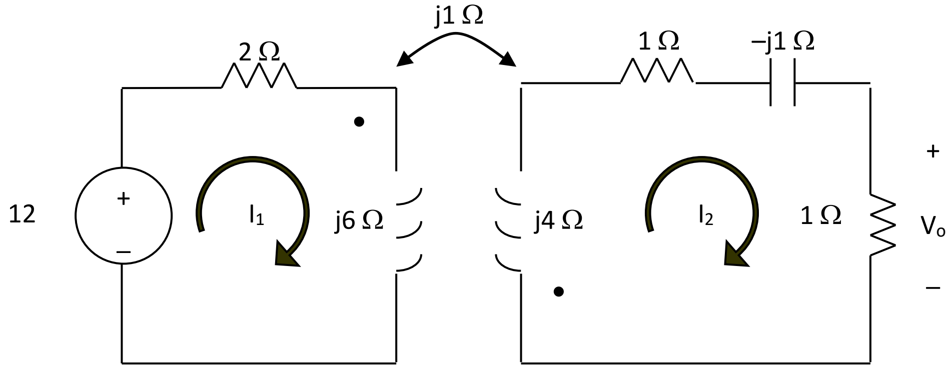
$$Q_c = P[\tan\theta_2 - \tan\theta_1] = 64[\tan(25.95°) - 0] = 31.144 \text{ kVAR}$$

$$C = \frac{Q_c}{\omega V_{rms}^2} = \frac{31{,}144}{(2\pi)(60)(120)^2} = \mathbf{5.74\ mF}$$

13.7 计算下图所示电路中的 V_o



解：
运用网孔分析法：



对于网孔 1，

$(2+j6)I_1 + jI_2 = 24$

对于网孔 2，

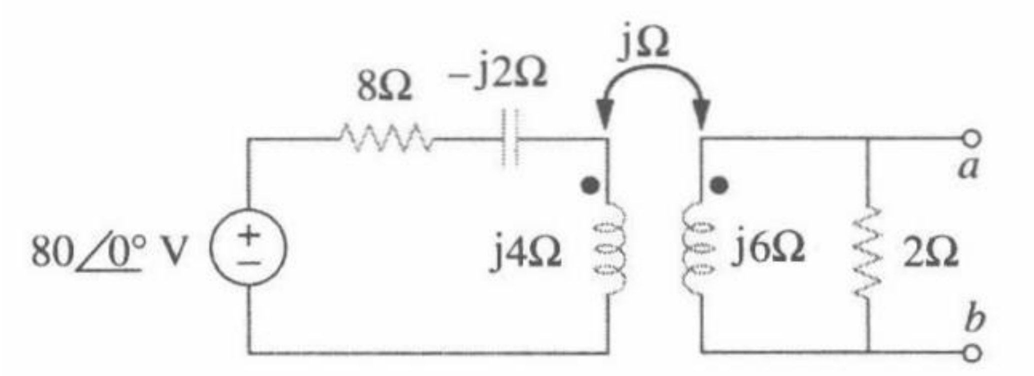
$jI_1 + (2-j+j4)I_2 = jI_1 + (2+j3)I_2 = 0$ or $I_1 = (-3+j2)I_2$

解得

$I_2 = (-0.8762+j0.6328)$ A.

$V_o = I_2 x1 = \mathbf{1.081\angle 144.16^\circ V}$.

13.11 利用网孔分析法求解下图所示电路中的 i_x 其中：is=4cos600t A，vs=110cos（600t+30°）V



解：

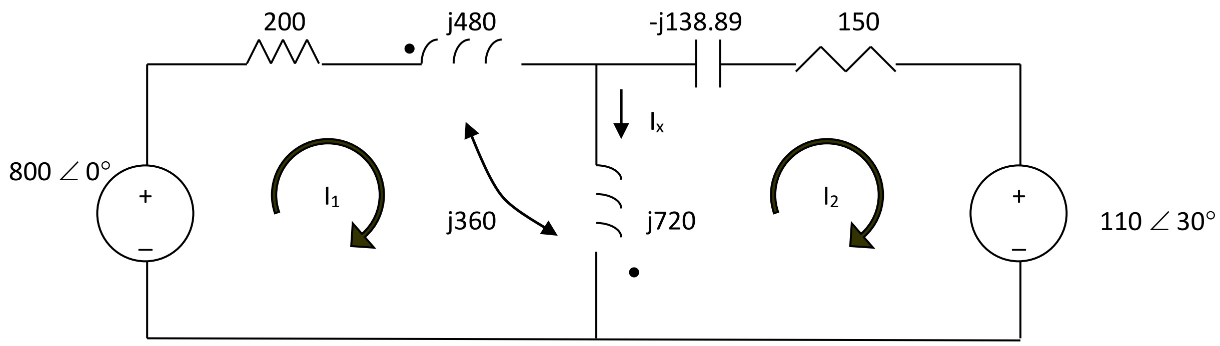
$$800mH \longrightarrow j\omega L = j600x800x10^{-3} = j480$$

$$600mH \longrightarrow j\omega L = j600x600x10^{-3} = j360$$

$$1200mH \longrightarrow j\omega L = j600x1200x10^{-3} = j720$$

$$12\mu F \rightarrow \frac{1}{j\omega C} = \frac{-j}{600x12x10^{-6}} = -j138.89$$

把电流源变换为电压源，



对于网孔 1，

$$800 = (200 + j480 + j720)I_1 + j360I_2 - j720I_2 \quad \text{or}$$

$$800 = (200 + j1200)I_1 - j360I_2$$

对于网孔 2，

$110\angle 30^\circ + 150 - j138.89 + j720)I_2 + j360I_1 = 0$ or

$$-95.2628 - j55 = -j360I_1 + (150 + j581.1)I_2$$

写成矩阵形式

$$\begin{bmatrix} 800 \\ -95.2628 - j55 \end{bmatrix} = \begin{bmatrix} 200 + j1200 & -j360 \\ -j360 & 150 + j581.1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

解得

I =

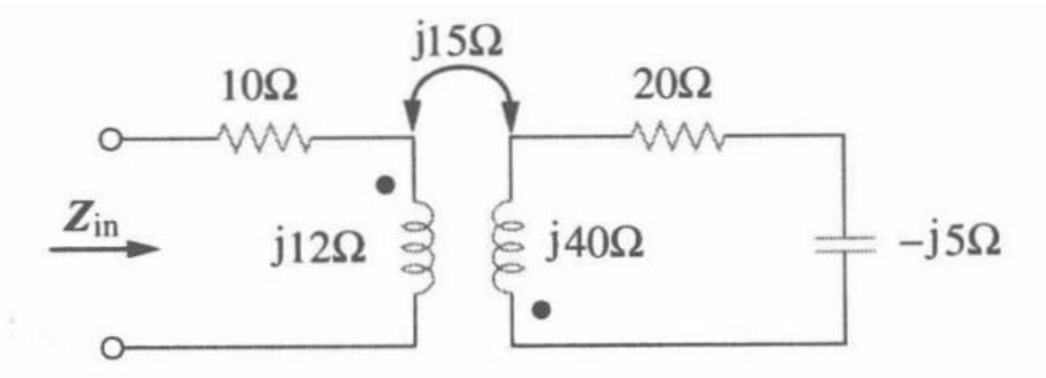
0.1390 - 0.7242i

0.0609 - 0.2690i

$I_x = I_1 - I_2 = 0.0781 - j0.4552 = 0.4619\angle -80.26^\circ$

因此，$i_x(t) =$ **$461.9\cos(600t - 80.26^\circ)$ mA**.

13.33 计算下图所示空心变压器电路的输入阻抗。



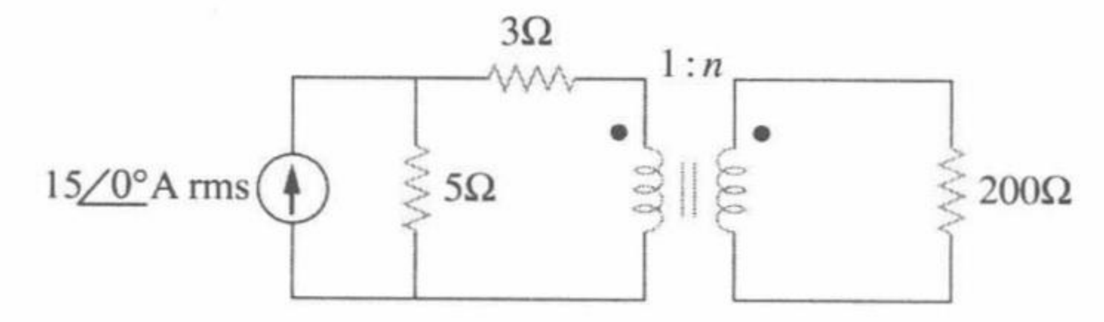
解：

$Z_{in} = 10 + j12 + (15)^2/(20 + j40 - j5) = 10 + j12 + 225/(20 + j35)$

$= 10 + j12 + 225(20 - j35)/(400 + 1225)$

$= (12.769 + j7.154)\ \Omega$

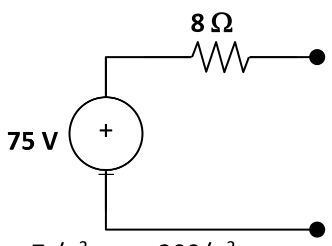
13.53 对于下图所示网络：(a)试求传递给 200Ω 负载功率最大时的匝数比 n；(b)如果 n=10，计算 200Ω 负载的功率。



解：

（a）

变压器左边的戴维南等效电路为：



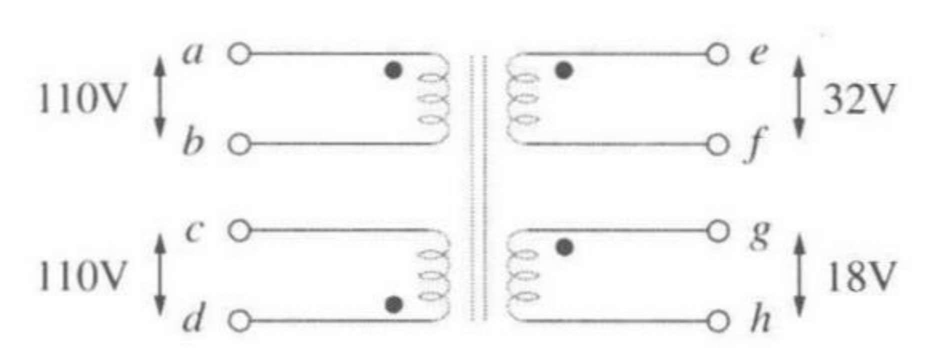
$\mathbf{Z_L}' = \mathbf{Z_L}/n^2 = 200/n^2$

$8 = 200/n^2$ ， $n = \mathbf{5}$.

(b) If $n = 10$, $\mathbf{Z_L}' = 200/100 = 2\ \Omega$ and $I = 75/(8 + 2) = 7.5$ A

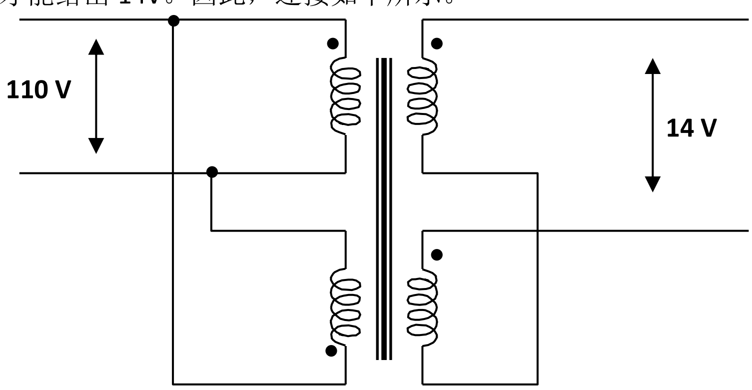
$$p = I^2\mathbf{Z_L}' = (7.5)^2(2) = \mathbf{112.5\ W}.$$

13.93 下图所示的四绕组变压器通常用在既可以在110V电压下工作又可以在220V电压下工作的设备（如计算机、录像机等）中，这就使得这类设备既可以在国内使用，也可以在国外使用，试说明提供如下电压所需的变压器连接方式：（a）输入 1100V 时，输出 14V；（b）输入 220V 时，输出 50V。

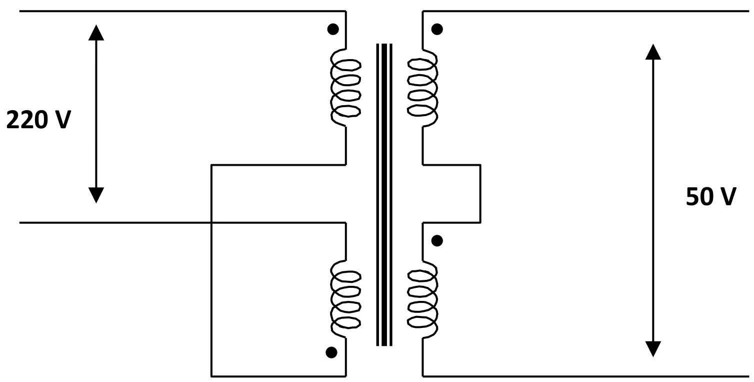


解：

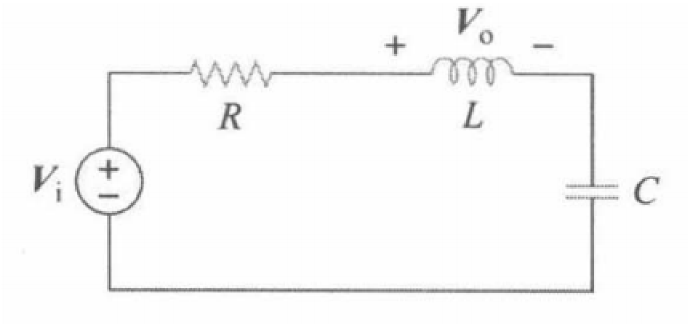
（a）对于 110V 的输入，初级绕组必须平行连接，次级上有串联辅助。 线圈必须是相反的串联才能给出 14V。因此，连接如下所示。



（b）为了在一次侧得到 220V，线圈是串联串联辅助在二次侧。 线圈必须连接串联，以提供 50V。因此，连接如下所示

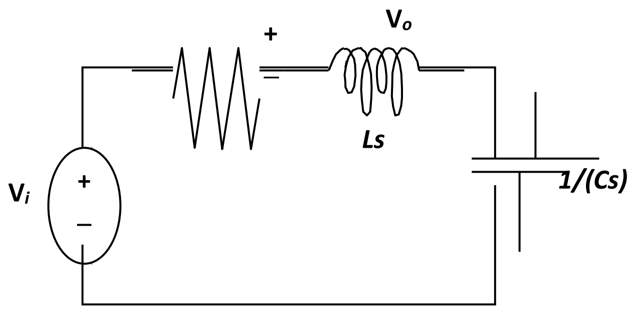


14.4 求下图所示电路的传递函数 H（s）=Vo/Vi



解：

把电路转为到 s 域



$-\mathbf{V_i} + R\mathbf{I} + Ls\mathbf{I} + [1/(Cs)]\mathbf{I} = 0$ ， $\mathbf{V_o} = Ls\mathbf{I}$

$[R+Ls+1/(Cs)]\mathbf{I} = \mathbf{V_i}$ or $\mathbf{I} = [Cs/(CLs^2+CRs+1)]\mathbf{V_i}$.

$\mathbf{V_o} = Ls\mathbf{I}$ ，

$$\mathbf{H(s) = V_o/V_i = LCs^2/(CLs^2+CRs+1)}.$$

14.30 电路由电感值为 10mH、电阻值为 20Ω 的线圈，电容器和电压均值为 120V 的信号发生器串联组成。试求：（a）使电路在 15kHz 时发生谐振的电容值；（b）谐振时通过线圈的电流；（c）电路的 Q 值。

解：

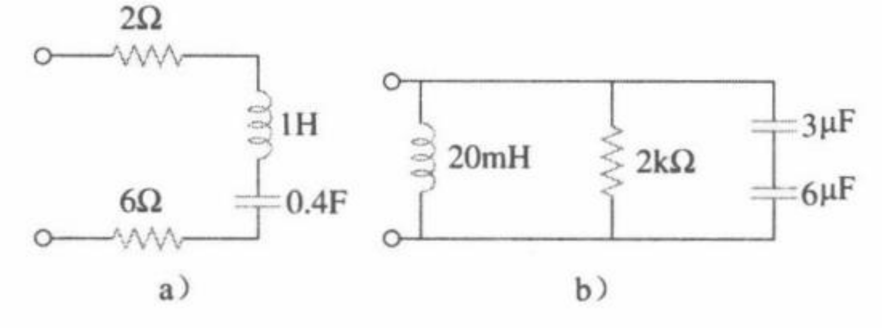
(a) f_o = 15,000 Hz leads to $\omega_o = 2\pi f_o = 94.25$ krad/s $= 1/(LC)^{0.5}$

$LC = 1/8.883\times10^9$ or $C = 1/(8.883\times10^9\times10^{-2}) = 11.257\times10^{-9}$ F = **11.257 pF**.

(b) I = 120/20 = **6 A**.

(c) $Q = \omega_o L/R = 94.25\text{x}10^3(0.01)/20 =$ **47.12**.

14.42 对于下图所示电路，求谐振频率ω_0、品质因数 Q 及带宽 B。



解：

(a)

$$R = 2 + 6 = 8\,\Omega,\ L = 1\,H, \qquad C = 0.4\,F$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.4}} = \mathbf{1.5811\,rad/s}$$

$$Q = \frac{\omega_0 L}{R} = \frac{1.5811}{8} = \mathbf{0.1976}$$

$$B = \frac{R}{L} = \mathbf{8\,rad/s}$$

(b)

$$3\ \mu F \text{ and } 6\ \mu F \longrightarrow \frac{(3)(6)}{3+6} = 2\ \mu F$$

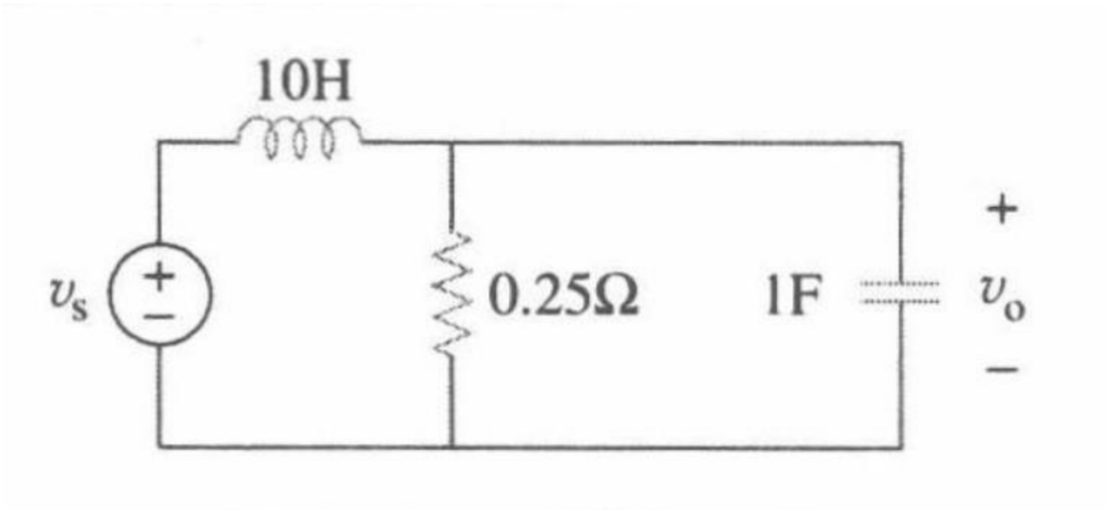
$$C = 2\ \mu F, \quad R = 2\ k\Omega, \quad L = 20\ mH$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(2\times 10^{-6})(20\times 10^{-3})}} = \mathbf{5\,krad/s}$$

$$Q = \frac{R}{\omega_0 L} = \frac{2\times 10^3}{(5\times 10^3)(20\times 10^{-3})} = \mathbf{20}$$

$$B = \frac{1}{RC} = \frac{1}{(2\times 10^3)(2\times 10^{-6})} = \textbf{250 rad/s}$$

14.48 求下图所示电路的传递函数 V_O/V_S，并证明该电路为低通滤波器



解：

$$\mathbf{H}(\omega) = \frac{R \parallel \frac{1}{j\omega C}}{j\omega L + R \parallel \frac{1}{j\omega C}}$$

$$\mathbf{H}(\omega) = \frac{\frac{R/j\omega C}{R + 1/j\omega C}}{j\omega L + \frac{R/j\omega C}{R+1/j\omega C}} = \frac{\frac{R}{1+j\omega RC}}{j\omega L + \frac{R}{1+j\omega RC}} = \frac{R}{R + j\omega L + \frac{R/j\omega C}{R+1/j\omega C}}$$

$$\mathbf{H}(\omega) = \frac{0.25}{(0.25 - \omega^2 2.5) + j\omega 10}$$

$H(0) = 1$ and $H(\infty) = 0$ 所以是低通滤波器.

14.55 确定 R=10Ω，L=25mH，C=0.4μF 的 RLC 串联带通滤波器的频率范围，并计算其品质因数。

解：

$$\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(25\times10^{-3})(0.4\times10^{-6})}} = 10\ \text{krad/s}$$

$$B = \frac{R}{L} = \frac{10}{25\times10^{-3}} = 0.4\ \text{krad/s}$$

$$Q = \frac{10}{0.4} = \mathbf{25}$$

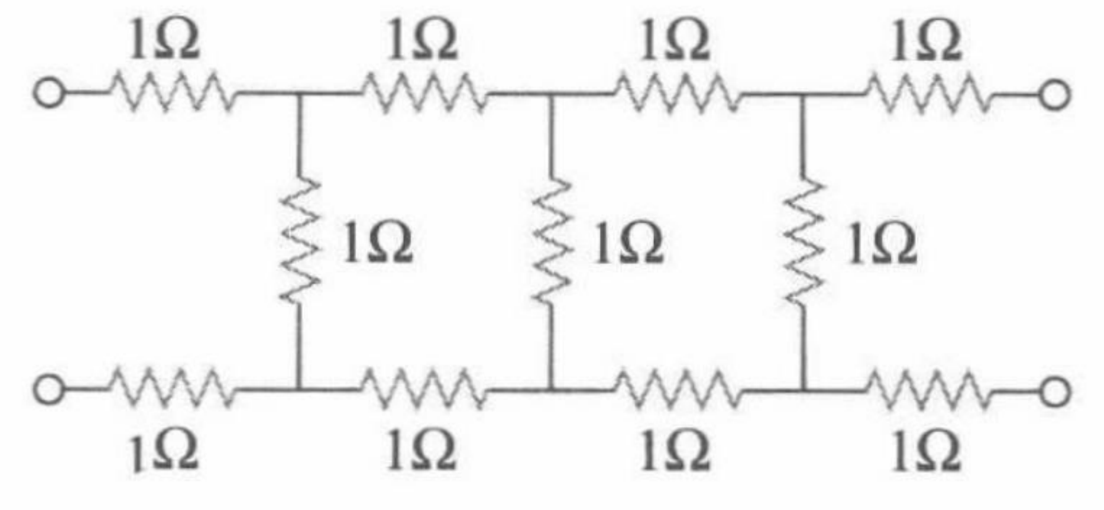
$$\omega_1 = \omega_o - B/2 = 10 - 0.2 = 9.8\ \text{krad/s} \quad \text{or} \quad f_1 = \frac{9.8}{2\pi} = 1.56\ \text{kHz}$$

$$\omega_2 = \omega_o + B/2 = 10 + 0.2 = 10.2\ \text{krad/s} \quad \text{or} \quad f_2 = \frac{10.2}{2\pi} = 1.62\ \text{kHz}$$

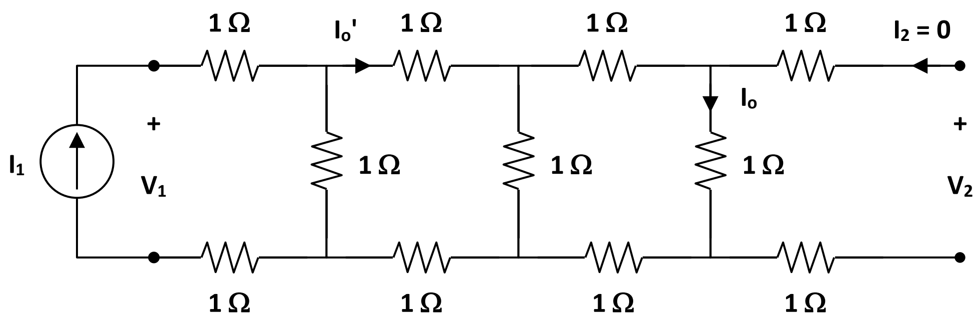
因此,

$$\mathbf{1.56\ kHz < f < 1.62\ kHz}$$

19.2 求下图所示网络的等效阻抗参数。



解：



(a)

$$\mathbf{z}_{11} = \frac{\mathbf{V}_1}{\mathbf{I}_1} = 2 + 1 \,||\, [\,2 + 1 \,||\, (2+1)\,]$$

$$\mathbf{z}_{11} = 2 + 1 \,||\left(2 + \frac{3}{4}\right) = 2 + \frac{(1)(11/4)}{1 + 11/4} = 2 + \frac{11}{15} = 2.733$$

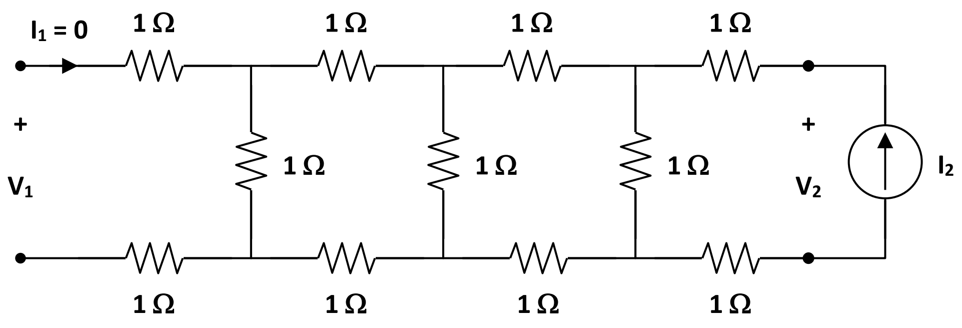
$$\mathbf{I}_o = \frac{1}{1+3}\mathbf{I}_o' = \frac{1}{4}\mathbf{I}_o'$$

$$\mathbf{I}_o' = \frac{1}{1 + 11/4}\mathbf{I}_1 = \frac{4}{15}\mathbf{I}_1$$

$$\mathbf{I}_o = \frac{1}{4}\cdot\frac{4}{15}\mathbf{I}_1 = \frac{1}{15}\mathbf{I}_1$$

$$\mathbf{V}_2 = \mathbf{I}_o = \frac{1}{15}\mathbf{I}_1$$

$$\mathbf{z}_{21} = \frac{\mathbf{V}_2}{\mathbf{I}_1} = \frac{1}{15} = \mathbf{z}_{12} = 0.06667$$



(b)

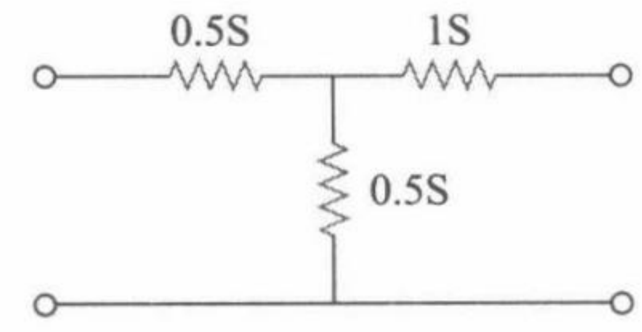
$$\mathbf{z}_{22} = \frac{\mathbf{V}_2}{\mathbf{I}_2} = 2 + 1 \,||\, (2 + 1 \,||\, 3) = \mathbf{z}_{11} = 2.733$$

因此,

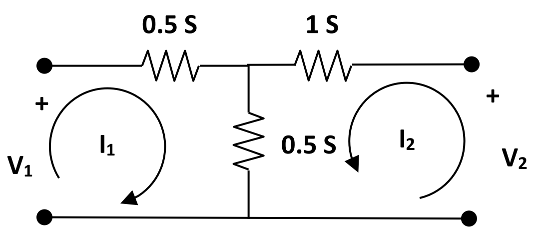
$$[\mathbf{z}] = \begin{bmatrix} \mathbf{2.733} & \mathbf{0.06667} \\ \mathbf{0.06667} & \mathbf{2.733} \end{bmatrix} \mathbf{\Omega}$$

$$\mathbf{z}_{11} = \frac{\mathbf{V}_1}{\mathbf{I}_1} = 2 + 1 \| [2 + 1 \| (2+1)]$$

19.18 求下图所示二端口电路的 y 参数



解：



$I_1 = y_{11}V_1 + y_{12}V_2$

$I_2 = y_{21}V_1 + y_{22}V_2$

令 $V_1 = 1$ V ， $V_2 = 0$ ， $V_1 = 0$， $V_2 = 1$ V.

$I_1 = 1/[(1/0.5)+(1/1.5)] = 1/(2+0.66667) = 0.375$ A

$I_2 = –0.375(2/3) = –0.25$ A.

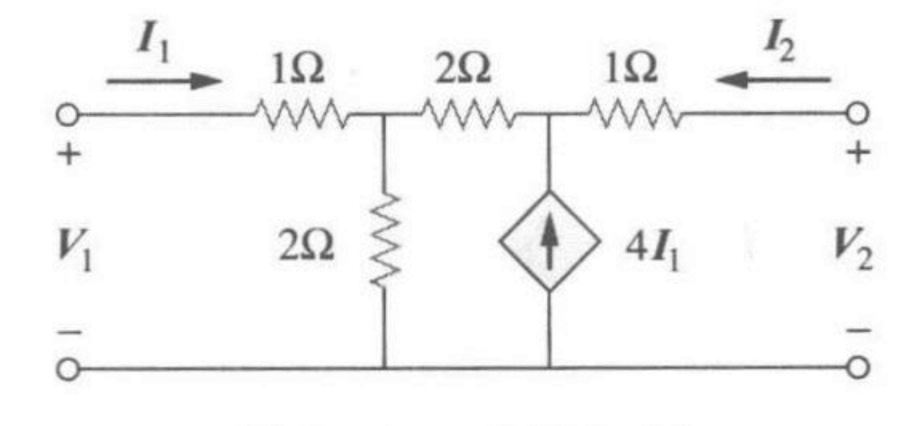
$y_{11} = 0.375/1 =$ **0.375 S** ， $y_{21} =$ **–0.25 S**.

$I_2 = 1/[(1/1)+(1/(0.5+0.5))] = 0.5$ A

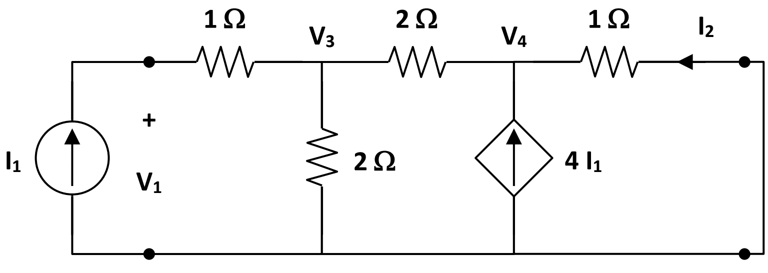
$I_1 = –0.5(1/2) =$ **–0.25 A**.

$y_{12} = –0.25$ S and $y_{22} =$ **0.5 S**.

19.31 求下图所示电路的混合参数



解：



(a)

在节点 1：

$$\mathbf{I}_1 = \frac{\mathbf{V}_3}{2} + \frac{\mathbf{V}_3 - \mathbf{V}_4}{2} \longrightarrow 2\mathbf{I}_1 = 2\mathbf{V}_3 - \mathbf{V}_4$$

在节点 2：

$$\frac{\mathbf{V}_3 - \mathbf{V}_4}{2} + 4\mathbf{I}_1 = \frac{\mathbf{V}_4}{1}$$

$$8\mathbf{I}_1 = \text{-}\mathbf{V}_3 + 3\mathbf{V}_4 \longrightarrow 16\mathbf{I}_1 = \text{-}2\mathbf{V}_3 + 6\mathbf{V}_4$$

联立：

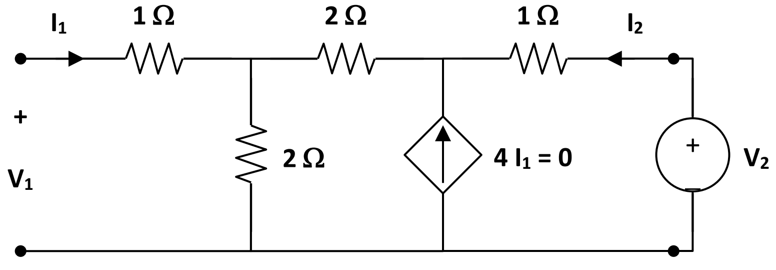
$$18\mathbf{I}_1 = 5\mathbf{V}_4 \longrightarrow \mathbf{V}_4 = 3.6\mathbf{I}_1$$

$$\mathbf{V}_3 = 3\mathbf{V}_4 - 8\mathbf{I}_1 = 2.8\mathbf{I}_1$$

$$\mathbf{V}_1 = \mathbf{V}_3 + \mathbf{I}_1 = 3.8\mathbf{I}_1$$

$$\mathbf{h}_{11} = \frac{\mathbf{V}_1}{\mathbf{I}_1} = 3.8\,\Omega$$

$$\mathbf{I}_2 = \frac{\text{-}\mathbf{V}_4}{1} = \text{-}3.6\,\mathbf{I}_1 \longrightarrow \mathbf{h}_{21} = \frac{\mathbf{I}_2}{\mathbf{I}_1} = \text{-}3.6$$



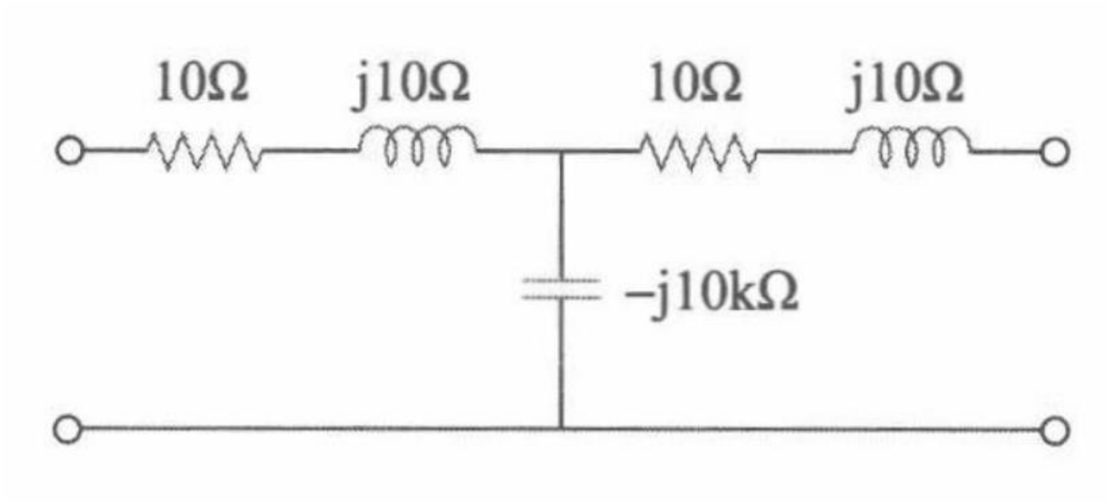
(b)

$$\mathbf{V}_1 = \frac{2}{2+2+1}\mathbf{V}_2 = \frac{2}{5}\mathbf{V}_2 \longrightarrow \mathbf{h}_{12} = \frac{\mathbf{V}_1}{\mathbf{V}_2} = 0.4$$

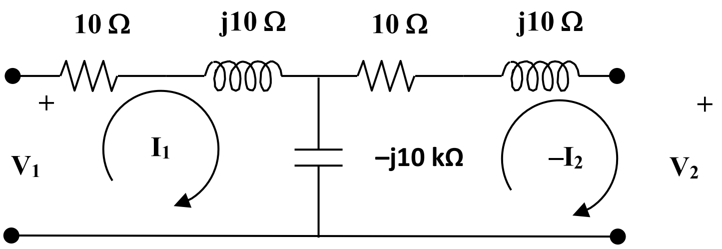
$$\mathbf{I}_2 = \frac{\mathbf{V}_2}{2+2+1} = \frac{\mathbf{V}_2}{5} \longrightarrow \mathbf{h}_{22} = \frac{\mathbf{I}_2}{\mathbf{V}_2} = \frac{1}{5} = 0.2\ \mathrm{S}$$

$$[\mathbf{h}] = \begin{bmatrix} \mathbf{38\,\Omega} & \mathbf{0.4} \\ \mathbf{-3.6} & \mathbf{0.2\ S} \end{bmatrix}$$

19.45 求下图所示电路的 ABCD 参数



解：



$V_1 = AV_2 - BI_2$ ， $I_1 = CV_2 - DI_2$.

令 $I_1 = 1$ A， $I_2 = 0$ ， $I_1 = 1$ A ， $V_2 = 0$.

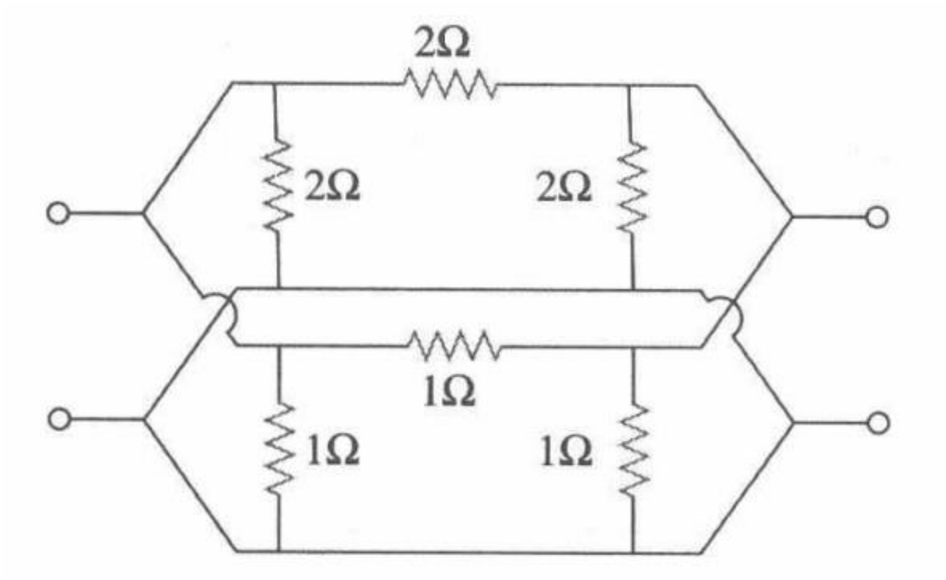
$V_1 = (10+j10)1 - j10{,}000x1 \approx -j10$ kV and $V_2 = -j10$ kV

A = **1** ， C = 1/(–j10k) = **j100 μS**.

$V_1 \approx (10+j10+10+j10)1 = (20+j20)$ V ， $I_2 \approx -1$ A which leads to

B = **(20+j20) Ω** ， D = **1**.

19.68 求下图所示网络的 h 参数



解：

对于上面的网络 N_a， $[\mathbf{y}_a]=\begin{bmatrix} 4 & -2 \\ -2 & 4 \end{bmatrix}$

对于下面的网络 N_b， $[\mathbf{y}_b]=\begin{bmatrix} 2 & -1 \\ 1 & 2 \end{bmatrix}$

对于总网络,

$$[\mathbf{y}]=[\mathbf{y}_a]+[\mathbf{y}_b]=\begin{bmatrix} 6 & -3 \\ -3 & 6 \end{bmatrix}$$

$$\Delta_y = 36 - 9 = 27$$

$$[\mathbf{h}] = \begin{bmatrix} \dfrac{1}{\mathbf{y}_{11}} & \dfrac{-\mathbf{y}_{12}}{\mathbf{y}_{11}} \\ \dfrac{\mathbf{y}_{21}}{\mathbf{y}_{11}} & \dfrac{\Delta_{\mathrm{y}}}{\mathbf{y}_{11}} \end{bmatrix} = \begin{bmatrix} \mathbf{\dfrac{1}{6}\,\Omega} & \mathbf{\dfrac{1}{2}} \\ \mathbf{\dfrac{1}{2}} & \mathbf{\dfrac{9}{2}\,S} \end{bmatrix}$$