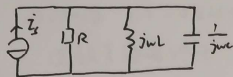


1. 解:



$$Y_{eq} = \frac{1}{R} + \frac{1}{j\omega L} + j\omega C$$

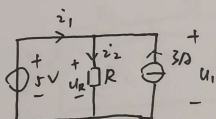
$$= \frac{1}{R} - j\frac{1}{\omega L} + j\omega C$$

发生并联谐振时.

$$-j\frac{1}{\omega L} + j\omega C = 0$$

$$\omega_0 = \sqrt{\frac{1}{LC}}$$

2. 解:



由KCL和KVL得:

$$i_1 + 3 = i_2$$

$$5 = i_2 R = (i_1 + 3)R$$

当 $i_1 > 0$ 时, 电压源发出功率

$$\text{即 } i_1 = \frac{5}{R} - 3 > 0$$

 $R < \frac{5}{3}\Omega$ 时, 电压源发出功率 $R > \frac{5}{3}\Omega$ 时, 电压源吸收功率 \therefore 5V电压源不确定是吸收还是发出功率

$$u_R = i_2 R = (i_1 + 3)R$$

电阻恒为吸收功率.

可知 $u_1 = u_R$

$$\text{当 } u_R = (i_1 + 3)R > 0$$

$$\text{即 } i_1 + 3 > 0$$

$$i_1 > -3\text{A 时}$$

电流源发出功率

~~电压源发出功率~~~~电压源发出功率~~~~电压源的功率情况不确定~~

$$\text{即 } i_1 = \frac{5}{R} - 3 > -3$$

$$\text{又 } \because \frac{5}{R} > 0, \text{ 恒成立}$$

 \therefore 电流源是发出功率.

结论: 5V电压源功率情况不确定

电阻R吸收功率

3A电流源发出功率.

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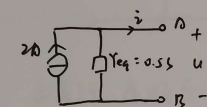
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3. 解: 由已知 $i = -0.5U + 2$

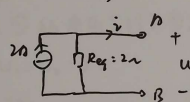
\therefore 诺顿等效电路为

$$i_{sc} = 2A, Y_{eq} = -0.5S$$

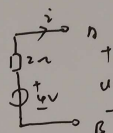
如图所示



等效为



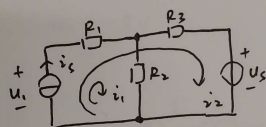
\therefore 其戴维宁等效电路为



$$\therefore U_{oc} = 4V$$

$$R_i = 2\Omega$$

4. 解:



$$\begin{cases} (R_1 + R_2) i_1 + R_1 i_2 = U_1 \\ (R_1 + R_3) i_2 + R_1 i_1 = U_1 - U_2 \\ i_1 + i_2 = i_3 \end{cases}$$

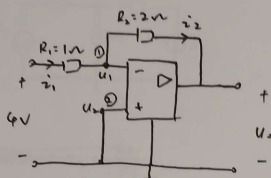
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5. 解:



由虚短、虚断可得

经①处电压与经②处电压相等

$$U_1 = U_2 = 0V$$

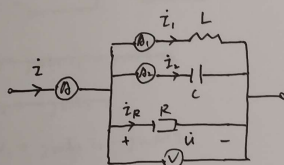
$$i_1 = i_2$$

$$i_1 = \frac{4 - U_1}{R_1} \quad i_2 = \frac{U_1 - U_o}{R_2}$$

$$\frac{4 - 0}{1} = \frac{0 - U_o}{2}$$

$$U_o = -8V$$

6. 解:



$$\therefore U_R = 220V \quad R = 550\Omega$$

$$\therefore I_R = \frac{2}{5}A$$

$$\text{设 } i_R = \frac{2}{5} \angle 0^\circ A$$

$$U = 220 \angle 0^\circ V$$

$$\therefore i_C = j\omega C U_C$$

$$U_C = j\omega L i_L, i_L = -j \frac{1}{\omega L} U_C$$

$$\therefore i_L = 1 \angle 90^\circ A$$

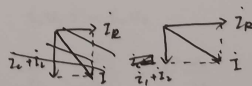
$$U_C = U_L$$

$$\therefore \omega L < \frac{1}{\omega C}$$

$$\therefore \frac{1}{\omega L} > \omega C, i_L = i_1, i_C = i_2$$

$$\therefore \omega C - \frac{1}{\omega L} < 0$$

$$\therefore i_C + i_L = U(j\omega C - \frac{1}{\omega L})$$



$$i = i_C + i_L + i_R = i_1 + i_2 + i_R$$

由图可知

$$\therefore i_C + i_L = 0.3 \angle 90^\circ A$$

$$\therefore i_L = i_1 = 1.3 \angle 90^\circ A$$

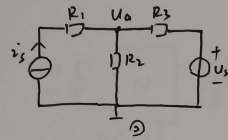
$$\therefore I_1 = 1.3A$$

$$\therefore I_1 = I_2 = 1.3A$$

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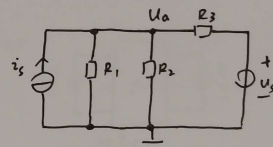
7. 解: (a)



$$(R_2 + R_3)U_a = i_s + \frac{U_s}{R_3}$$

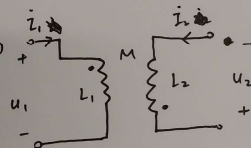
$$\left(\frac{1}{R_2} + \frac{1}{R_3}\right)U_a = i_s + \frac{U_s}{R_3}$$

(b)



$$\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)U_a = i_s + \frac{U_s}{R_3}$$

8. 解: (a)



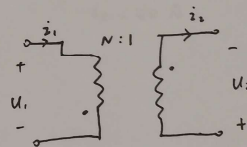
$$U_1 = j\omega L_1 i_1 - j\omega M i_2$$

$$U_2 = -j\omega L_2 i_2$$

$$U_1 = j\omega L_1 i_1 - j\omega M i_2$$

$$U_2 = -j\omega L_2 i_2 + j\omega M i_1$$

(b)



由图可知

$$\frac{U_1}{U_2} = \frac{N}{1} = N$$

$$\frac{i_1}{i_2} = -\frac{1}{N}$$

$$\therefore \frac{i_1}{i_2} = -\frac{1}{N} = -\frac{U_2}{U_1}$$

$$i_1 U_1 = -i_2 U_2$$

$$\frac{U_1}{i_1} = \frac{N U_2}{-\frac{1}{N} i_2} = -N^2 \frac{U_2}{i_2}$$

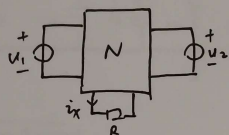
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9. 解: (a)



由线性特性知:

$$\begin{cases} 2a+3b=20 \\ -2a+b=0 \end{cases}$$

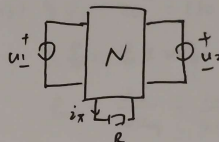
解得: $a=2.5, b=5$

$$\therefore 5a+5b=37.5$$

即 $u_1=u_2=5V$ 时

$$i_x=37.5A$$

(b)



由线性特性知:

$$\begin{cases} 2a+3b+c=20 \\ -2a+b+c=0 \\ c=-10 \end{cases}$$

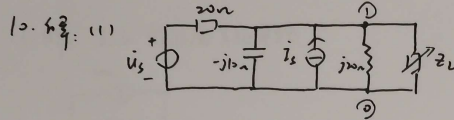
解得: $a=0, b=10, c=-10$

$$\therefore 5a+5b+c=40$$

即 $u_1=u_2=5V$ 时

$$i_x=40A$$

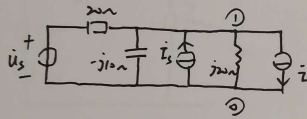
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$$\left(\frac{1}{20} + \frac{1}{-j10} + \frac{1}{j20} + \frac{1}{Z_L} \right) \dot{U}_1 = \frac{\dot{U}_s}{20} + \dot{I}_s$$

$$\left(\frac{1}{20} + \frac{1}{-j10} + \frac{1}{j20} + \frac{1}{Z_L} \right) \dot{U}_1 = \frac{\dot{U}_s}{20} + \dot{I}_s$$

(2) 将 Z_L 替换成电流为 \dot{I} 的电压源
得到电路:



对结点 ① 列 KCL 电压方程:

$$\left(\frac{1}{20} + \frac{1}{-j10} + \frac{1}{j20} \right) \dot{U}_1 = \frac{\dot{U}_s}{20} + \dot{I}_s - \dot{I}$$

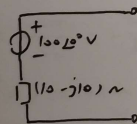
$$\dot{U}_1 = 100 - (10 - j10) \dot{I}$$

\therefore 戴维宁等效电路中

$$\dot{U}_{oc} = 100 \angle 0^\circ \text{ V}$$

$$\dot{Z}_{eq} = (10 - j10) \Omega$$

\therefore 从 Z_L 看进去的戴维南等效电路为

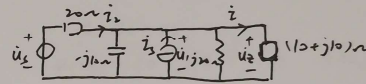


13) 当 $Z_L = Z_{eq}^* = (10 + j10) \Omega$ 时.

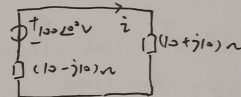
Z_L 获得最大功率

$$P_{max} = \frac{U_{oc}^2}{4R_{eq}} = \frac{100^2}{4 \times 10} \text{ W} = 250 \text{ W}$$

14) 当 Z_L 获得最大功率时, $Z_L = (10 + j10) \Omega$



电路的戴维南等效电路为



$$\dot{I} = \frac{100}{20} \text{ A} = 5 \angle 0^\circ \text{ A}$$

$$\therefore \dot{U}_1 = \dot{U}_2 = \dot{I} Z_L = (50 + j50) \text{ V}$$

\therefore 电压源发出的复功率 \bar{S}_1

$$\bar{S}_1 = \dot{U}_1 \dot{I}_s^* = (250 + j250) \text{ V} \cdot \text{A}$$

$$\dot{I}_2 = \frac{\dot{U}_2 - \dot{U}_1}{20} = (-2.5 + j2.5) \text{ A}$$

电压源发出的复功率 \bar{S}_2

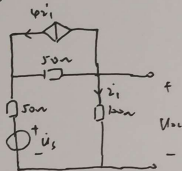
$$\bar{S}_2 = \dot{U}_2 \dot{I}_2^* = (250 - j250) \text{ V} \cdot \text{A}$$

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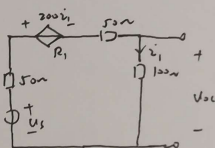
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11. 解: 先求戴维南等效电路

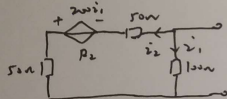


等效



$$R_1 = \frac{200\Omega}{2} = 100\Omega$$

$$U_{oc} = \frac{U_s \times 100}{200 + 100 + 50 \times 2} = \frac{1}{4} U_s$$



$$100\Omega \cdot i_1 = 100\Omega \cdot i_2 - 200\Omega \cdot i_1$$

$$300\Omega \cdot i_1 = 100\Omega \cdot i_2$$

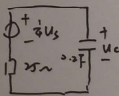
$$i_2 = 3i_1$$

$$R_2 = \frac{-200\Omega \cdot i_1}{i_2} = -\frac{200}{3}\Omega$$

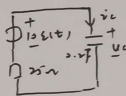
$$-\frac{200}{3}\Omega + 50\Omega + 50\Omega = \frac{100}{3}\Omega$$

$$R_{eq} = \frac{100}{\frac{100}{3} + 100} = 25\Omega$$

∴ 戴维南等效电路为



$$(1) U_s = 40\delta(t), \quad \frac{1}{4}U_s = 10\delta(t)$$

由换路定律 $U_c(0_+) = U_c(0_-) = 0V$

$$U_c(\infty) = 10\delta(t) = 10V$$

$$U_c(t) = U_c(\infty) + (U_c(0_+) - U_c(\infty))e^{-\frac{t}{\tau}}$$

$$\tau = RC = 5s$$

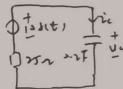
$$U_c(t) = 10 - 10e^{-\frac{t}{5}} (V) \quad (t \geq 0_+)$$

$$i_c(t) = \frac{10\delta(t) - U_c(t)}{25}$$

$$\therefore U_c(t) = 10(1 - e^{-\frac{t}{5}})\delta(t) (V)$$

$$i_c(t) = \frac{10\delta(t) - U_c(t)}{25} = \frac{2}{5}e^{-\frac{t}{5}}\delta(t) (A)$$

$$(2) U_s = 40\delta(t), \quad \frac{1}{4}U_s = 10\delta(t)$$



$$10\delta(t) = 25i_c + U_c$$

$$10\delta(t) = 25C \frac{dU_c}{dt} + U_c$$

两边积分.

$$\int_0^+ 10\delta(t) dt = \int_0^+ 25C \frac{dU_c}{dt} dt + \int_0^+ U_c dt$$

$$10 = 5(U_c(0_+) - U_c(0_-)) + 0$$

$$U_c(0_+) = 2V$$

t > 0_+ 时, 电路为零输入响应

$$\tau = RC = 5s$$

$$U_c(t) = 2e^{-\frac{t}{5}}\delta(t)$$

$$i_c(t) = \frac{10\delta(t) - U_c(t)}{25}$$

$$= \frac{10\delta(t) - 2e^{-\frac{t}{5}}\delta(t)}{25} A$$

$$= \frac{2}{5}\delta(t) - \frac{2}{25}e^{-\frac{t}{5}}\delta(t) (A)$$