1-1

$U_{gf} = U_{gb} = U_{gc} + U_{cb} = -7V + 10V + 3V = 6V$

$U_{ag} = U_{ab} - U_{gb} = 3V - 5V - 6V = -8V$

$U_{db} = U_{dc} + U_{cb} = 16V + 10V + 3V = 29V$

$I_{cd} = I_{bc} - I_{cg} = I_{fb} + I_{ab} - I_{cg} = 1.8A - 2A - 1.4A = -1.6A.$

1-2.

(a) 设：电流逆时针方向.

$U = 24 - 6 - 6 = 12V.$ $R = 1 + 1 + 6 + 2 = 10\Omega$

$I = \frac{U}{R} = 1.2A.$

$\therefore \varphi_A = 0 - IR_3 - U_{S3} - IR_4 = -9.6V$

$P_1 = P_3 = I^2R_1 = 1.44W.$ $P_2 = I^2R_2 = 8.64W.$ $P_4 = I^2R_4 = 2.88W$

(b). $I = \frac{U_{S2}}{R_2+R_3} = \frac{3V}{2\Omega + 1\Omega} = 1A.$ 顺时针.

$\varphi_A = U_{S1} - IR_3 = 5V.$

$P_1 = 0W$ $P_2 = I^2R_2 = 2W.$ $P_3 = I^2R_3 = 1W$

1-3.

$U_{ac} = U_{ab} + U_{bc} = 3V - 5V + 3V = 1V$

$U_{ad} = U_{ac} + U_{cd} = 1 + 36V = 37V$

$U_{ae} = U_{ac} - U_{o} - 3 \times R_4 = -U_o - 5$

又 $U_{ae} = V_a - V_e = -17V$

$\therefore U_o = 12V$

2-1

(a)

$$A_a = \begin{array}{c} \\ ① \\ ② \\ ③ \\ ④ \end{array} \begin{array}{c} \begin{array}{ccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 \end{array} \\ \left[\begin{array}{ccccccc} -1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & 1 & 0 \\ 0 & -1 & 0 & 0 & 0 & -1 & 1 \\ 1 & 0 & -1 & 0 & -1 & 0 & -1 \end{array}\right] \end{array}$$

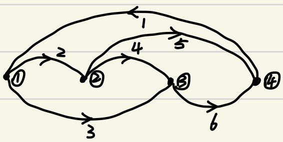
(b)

$$A_a = \begin{array}{c} \\ ① \\ ② \\ ③ \\ ④ \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \left[\begin{array}{cccccc} -1 & 1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 & 1 & 0 \\ 0 & 0 & -1 & -1 & 0 & 1 \\ 1 & 0 & 0 & 0 & -1 & -1 \end{array}\right] \end{array}$$

2-2.

$$A = \begin{array}{c} \\ ① \\ ② \\ ③ \\ ④ \end{array} \begin{array}{c} \begin{array}{cccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \end{array} \\ \left[\begin{array}{cccccccc} 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & -1 & 1 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{array}\right] \end{array}$$

2-3.



3-1

(a) $f(t) = r(t) - \varepsilon(t-1) - \varepsilon(t-2) - r(t-2)$

(b) $f(t) = \sin(\frac{\pi}{2}t)\ u(\sin\frac{\pi}{2}t)$

(c) $f(t) = \frac{2}{T}r(t) - \frac{4}{T}r(t-\frac{T}{2}) + \frac{2}{T}r(t-T)$

(d) $f(t) = \delta(t) - 2\delta(t-1) + \delta(t-2)$

3-2

$i_1 + i_2 + 1 = 0.$

$u_1 = i_1 R_1.$ $\therefore U_{cs} = 5U_1 = 5i_1R_1$

由KVL得. $i_3R_3 + U - U_{cs} - i_2R_2 = 0.$

$i_2R_2 + U_{cs} - U_s - U_1 = 0$

$\therefore i_1 = 1A.$ $i_2 = -2A$ $U = 10V$

U_s: $P_1 = -i_1U_s = -10W$

U_{cs}: $P_2 = -i_2U_{cs} = 50W$

U: $P_3 = -i_3U = -10W.$

3-3

$u_o = -Au_i$

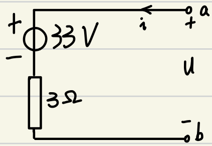
由虚断可得 $i_s = \frac{u_i}{R_i} + \frac{u_i + Au_i}{R_f} = u_i\left(\frac{1}{R_i} + \frac{1+A}{R_f}\right)$

$U_s = i_sR_s + u_i = u_iR_s\left(\frac{1}{R_i} + \frac{1+A}{R_f}\right) + u_i$

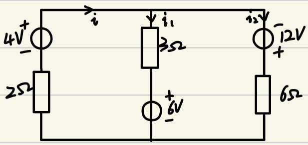
$\therefore R_{in} = \frac{U_s}{i_s} = R_s + \frac{1}{\frac{1}{R_i} + \frac{1+A}{R_f}} = \frac{R_sR_f + R_iR_f + (1+A)R_sR_i}{R_f + (1+A)R_i}$

$\therefore H = \frac{u_o}{u_s} = \frac{-A}{R_s(\frac{1}{R_i} + \frac{1+A}{R_f}) + 1} = -\frac{AR_iR_f}{R_iR_f + R_sR_f + (1+A)R_sR_i}$

4-1



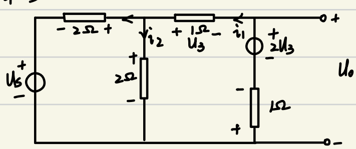
4-2



$$\begin{cases} i = i_1 + i_2 \\ 4 - 3i_1 - 6 - 2i = 0 \\ 12 - 6i_2 + 6 + 3i_1 = 0 \end{cases}$$

$\therefore i = 1A$

4-3



$$\left.\begin{aligned} &2(i_1 - i_2) + U_s - 2i_2 = 0 \\ &2i_2 + i_1 - 2U_3 + i_1 = 0 \\ &U_3 = -i_1 \end{aligned}\right\} \Rightarrow \begin{cases} U_s = 10U_3 \\ U_o = 3U_3 \end{cases}$$

$\therefore \dfrac{U_o}{U_s} = \dfrac{3}{10}$

5-1

设节点①.②.③的节点电压为 U_{n1}. U_{n2}. U_{n3}. 该电路的节点方程为

$$\begin{bmatrix} G_1+G_2 & -G_1 & -G_2 \\ -G_1 & G_1+G_3 & 0 \\ -G_2 & 0 & G_2+G_4 \end{bmatrix} \begin{bmatrix} U_{n1} \\ U_{n2} \\ U_{n3} \end{bmatrix} = \begin{bmatrix} -I_{s1}-I_{s2} \\ I_{s1}+I_0 \\ I_{s4}-I_0 \end{bmatrix}$$

$$\begin{cases} I_0 = I_{s4} - G_4 U_{n3} - I_x \\ U_{n3} - U_{n2} = \frac{I_x}{8} \end{cases}$$

解得. $U_{n1} = \frac{1}{2} V$. $U_{n2} = \frac{3}{2} V$. $U_{n3} = \frac{5}{2} V$

$\therefore I_x = 8 A$.

5-2

设：节点①.②的节点电压为 U_{n1}. U_{n2}.

由虚地得 $U_{n1} = 0$ $U_{n2} = 0$.

由虚断得 $-\frac{U_s}{R_1} = \frac{U_0}{R_4} + \frac{U'}{R_5}$

$\frac{U_s}{R_2} + \frac{U'}{R_5} = \frac{-U_0}{R_3}$

$\therefore U_0/U_s = (\frac{1}{R_2} - \frac{1}{R_1}) / (\frac{1}{R_4} - \frac{1}{R_3}) = \frac{R_3R_4(R_1-R_2)}{R_1R_2(R_3-R_4)}$

5-3.

该电路回路方程为

$$\begin{bmatrix} R_1+R_2 & -R_1 & R_2 \\ -R_1 & R_1 & 0 \\ R_2 & 0 & R_2 \end{bmatrix} \begin{bmatrix} I \\ I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0 \\ U-U_1 \\ U_2-U_1 \end{bmatrix}$$

且 $I_1 + I_2 = \beta I$

$\therefore I_2 = \frac{(\beta R_1 - R_1 - R_2) I_1}{R_1 + R_2 + \beta R_2}$, $U_1 = U_2 - \frac{R_1 R_2 \beta I_1}{R_1 + R_2 + \beta R_2}$

6-1

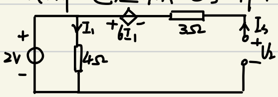
由虚短得 $U_+ = U_-$

由虚断得 $\frac{U_3-U_+}{R_3}=\frac{U_+-0}{R_4}$ ， $\frac{U_1-U_-}{R_1}+\frac{U_2-U_-}{R_2}=\frac{U_--U_0}{R_5}$

∴ $U_0=\frac{40}{7}U_3-5U_1-2U_2$

6-2.

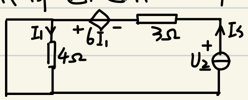
(1) 只有电压源 U_s 作用时



$I_1=0.5A$ $I_s=0A$

$U_2=2-6I_1=-1V$

只有电流源 U_2 作用时.

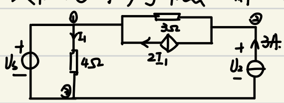


$I_1=0A$.

$I_s=\frac{U_2+6I_1}{3}A=3-0A$ 时 $U_2=9V$

由叠加定理得. $U=9-1=8V$

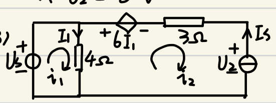
(2) 以节点③为参考节点 则 $U_{n1}=U_s=2V$. $U_{n2}=U_2$ $I_1=\frac{U_{n1}}{R_1}=0.5A$



$$\begin{bmatrix}\frac{1}{4}+\frac{1}{3} & -\frac{1}{3}\\ -\frac{1}{3} & \frac{1}{3}\end{bmatrix}\begin{bmatrix}U_{n1}\\ U_{n2}\end{bmatrix}=\begin{bmatrix}i\\ I_s-2I_1\end{bmatrix}$$

∴ $U_2=8V$

(3)



$$\begin{bmatrix}4 & -4\\ -4 & 7\end{bmatrix}\begin{bmatrix}i_1\\ i_2\end{bmatrix}=\begin{bmatrix}2\\ -6I_1-U_2\end{bmatrix}$$

且 $i_2=-I_s=-3A$. $i_1=I_1-I_s=(I_1-3)A$

∴ $U_2=8V$

6-3.

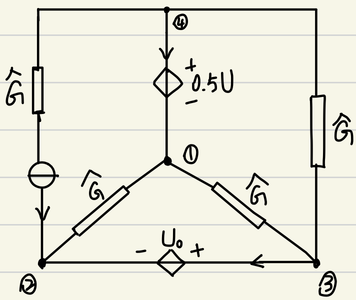
由互易定理 $\frac{i_2}{U_{s1}}=\frac{i_1}{U_{s2}}$ 得 $i_1=\frac{3}{4}A$

当 $U=15V$ 时 $i_2=\frac{5}{2}A$.

∴ $I=i_1+i_2=\frac{13}{4}A$

$U=15-4\times\frac{13}{4}=2V$

6-4



$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 2 & 0 \\ -1 & 0 & 2 \end{bmatrix} \begin{bmatrix} U_{n1} \\ U_{n2} \\ U_{n3} \end{bmatrix} = \begin{bmatrix} 0.5U \\ U_s+0.5i \\ -0.5i \end{bmatrix}$$

7-1

$U_{n1} - U_{n2} = -5i_6$. 又 $i_6 = \frac{U_{n4}}{2}$

$-U_{n1} + U_{n2} = -2 - i_3$. 又 $i_3 = 2U_3 - U_4 = 2(U_{n2} - U_{n3}) - U_{n4}$

$\frac{1}{2}U_{n3} = 5i_6 + i_3$. $\frac{1}{2}U_{n4} = 2 - i_4$

∴节点方程为 $\begin{bmatrix} 1 & -1 & 0 & 2.5 \\ -1 & 3 & -2 & -1 \\ 0 & -2 & 2.5 & -1.5 \\ 0 & 1 & -1 & 1.5 \end{bmatrix} \begin{bmatrix} U_{n1} \\ U_{n2} \\ U_{n3} \\ U_{n4} \end{bmatrix} = \begin{bmatrix} 0 \\ -2 \\ 0 \\ 2 \end{bmatrix}$

7-2

(1) $\begin{cases} 10i_1 + 15i_2 = U_1 \\ 5i_1 + 20i_2 = U_2 \end{cases}$ 又 $\begin{cases} U_S = i_1R_S + U_1 \\ U_2 = -i_2R_L \end{cases}$

∴ $\frac{U_2}{U_S} = \frac{1}{39}$

(2) $\begin{cases} 10i_1 + 15i_2 = U_1 \\ 5i_1 + 20i_2 = U_2 \end{cases}$

又 $U_S = i_1R_S + U_1$ 当 $U_S = 0$ 时 $\frac{U_2}{i_2} = \frac{425}{2}\Omega$ ∴即当 $R_L = \frac{425}{22}\Omega$ 时. 功率最大

7-3.

$r_{11} = \frac{U_1}{i_1}\Big|_{i_2=0} = R_1 + R_2 = 3\Omega$ $r_{12} = \frac{U_1}{i_2}\Big|_{i_1=0} = R_2 = 2\Omega$

$r_{21} = \frac{U_2}{i_1}\Big|_{i_2=0} = R_2 = 2\Omega$ $r_{22} = \frac{U_2}{i_2}\Big|_{i_1=0} = R_2 + R_3 = 5\Omega$

$U_1\Big|_{i_1=0,i_2=0} = U_{S2} = 6V$ $U_2\Big|_{i_1=0,i_2=0} = U_{S2} - U_{S3} = 3V$

∴ $\begin{bmatrix} 3 & 2 \\ 2 & 5 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} + \begin{bmatrix} 6 \\ 3 \end{bmatrix} = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix}$

$g_{11} = \frac{i_1}{U_1}\Big|_{U_2=0} = \frac{5}{11}S$ $g_{12} = \frac{i_1}{U_2}\Big|_{U_1=0} = -\frac{2}{11}S$

$g_{21} = \frac{i_2}{U_1}\Big|_{U_2=0} = -\frac{2}{11}S$ $g_{22} = \frac{i_2}{U_2}\Big|_{U_1=0} = \frac{3}{11}S$

$i_1\Big|_{U_1=0,U_2=0} = -\frac{24}{11}A$ $i_2\Big|_{U_1=0,U_2=0} = -\frac{3}{11}A$

∴ $\begin{bmatrix} \frac{5}{11} & -\frac{2}{11} \\ -\frac{2}{11} & \frac{3}{11} \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} + \begin{bmatrix} -\frac{24}{11} \\ -\frac{3}{11} \end{bmatrix} = \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

9-1

根据换路定理. $U_{c1}(0_+) = U_{c1}(0_-) = 5V$. $U_{c2}(0_+) = U_{c2}(0_-) = 0$

$\tau = RC_{eq} = R \times \frac{C_1 C_2}{C_1 + C_2} = \frac{2}{3}s$

且 $C_1 \frac{dU_{c1}}{dt} = C_2 \frac{dU_{c2}}{dt}$ $\therefore 2(U_{c1}(\infty) - U_{c1}(0_+)) = U_{c2}(\infty) - U_{c2}(0_+)$

且 $U_{c1}(\infty) + U_{c2}(\infty) = 0$. $\therefore U_{c1}(\infty) = \frac{10}{3}V$. $U_{c2}(\infty) = -\frac{10}{3}V$

$\therefore U_{c1} = (\frac{10}{3} + \frac{5}{3}e^{-\frac{3}{2}t})V$ $U_{c2} = (-\frac{10}{3} + \frac{10}{3}e^{-\frac{3}{2}t})V$

9-2

$\tau = \frac{L}{R} = 5 \times 10^{-6}s$

单位阶跃响应 $S(t) = i = \frac{1}{R}(1 - e^{-\frac{t}{\tau}})\varepsilon(t)$

电路激励为 $u = 10[\varepsilon(t) - \varepsilon(t - 5\times 10^{-6})]$

$i = 10[S(t) - S(t - 5\times10^{-6})]$

$\therefore i = 5(1 - e^{-\frac{10^6}{5}t})\varepsilon(t) - 5[1 - e^{-\frac{10^6}{5}(t - 5\times10^{-6})}]\varepsilon(t - 5\times10^{-6})$

即

$$i = \begin{cases} 0 & t \le 0 \\ 5(1 - e^{-2\times10^5 t}) & 0 \le t \le 5\times10^{-6} \\ 5e^{-2\times10^5 t}(e - 1) & t \ge 5\times10^{-6} \end{cases}$$

9-3.

$i_L(0_+) = i_L(0_-) = \frac{U_s}{R_1 + R_2} = 0.24A$. $U_c(0_+) = U_c(0_-) = R_1 i_L(0_-) = 24V$

$\tau_L = \frac{L}{R_1} = 10^{-3}s$. $\tau_c = R_3 C = 2\times10^{-3}s$

$\therefore U_c = U_c(0_+)e^{-\frac{t}{\tau_c}} = 24e^{-500t}V$

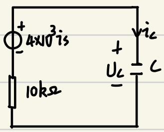
$i_L = i_L(0_+)e^{-\frac{t}{\tau_L}} = 0.24e^{-1000t}A$.

$\therefore i = -i_L - C\frac{dU_c}{dt} = -0.24e^{-1000t} + 20\times10^{-6}\times24\times500e^{-500t}$

$= 0.24(e^{-500t} - e^{-1000t})A$. $(t>0)$.

10-1

(1)



由换路定理得 $U_c(0_+) = U_c(0_-) = 0V$

$U_c(\infty) = 100V.$ $\tau = R\cdot C = 50ms$

$\therefore U_c = 100(1-e^{-20t})\varepsilon(t)\ V$ $i_c = C\frac{dU_c}{dt} = 0.01e^{-20t}\varepsilon(t)\ A$

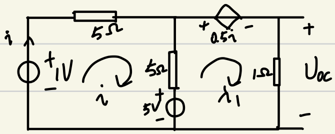
(2) 当 $i_s = 25\delta(t)$ mA 时

$U_c = \frac{d}{dt}[100(1-e^{-20t})\varepsilon(t)] = 2000e^{-20t}\varepsilon(t)\ V$

$i_c = \frac{d}{dt}[0.01e^{-20t}\varepsilon(t)] = -0.2e^{-20t}\varepsilon(t) + 0.01\delta(t)\ A.$

10-2.

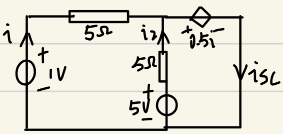
电容开路



$$\begin{cases} 10i - 5i_1 = -4 \\ -5i + 6i_1 = 5 - 0.5i \end{cases}$$

$\therefore i_1 = \frac{64}{75}A.$ $U_{oc} = R_3 \times i_1 = \frac{64}{75}V$

电容短路



$$\begin{cases} 5i + 0.5i = 1 \\ 5 - 5i_2 = 0.5i \end{cases}$$

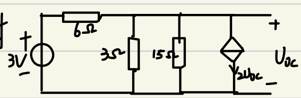
$\therefore i = \frac{2}{11}A.$ $i_2 = \frac{54}{55}A$ $i_{sc} = i + i_2 = \frac{64}{55}A.$

$\therefore R = \frac{U_{oc}}{i_{sc}} = \frac{11}{15}\Omega$ $\tau = RC = \frac{11}{15}s$

且 $U_c(0_+) = 0V.$ $\therefore U_2 = \frac{64}{75}(1-e^{-\frac{15}{11}t})\varepsilon(t)\ V$

10-3.

电容开路时



$U_{oc} + (\frac{U_{oc}}{3} + \frac{U_{oc}}{15} + 2U_{oc})\cdot 6 = 3$

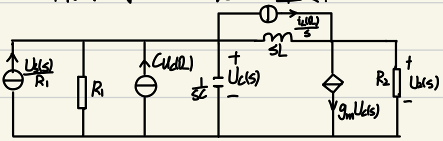
$\therefore U_{oc} = U(\infty) = \frac{15}{77}V$

且等效电阻为 $R_0 = \frac{1}{\frac{1}{3}+\frac{1}{15}+\frac{1}{6}} = \frac{30}{77}\Omega$ $\tau = R_0C = \frac{60}{77}\times 10^{-6}s$

$\therefore u_0 = \frac{15}{77} + (4 - \frac{15}{77})e^{-\frac{77\times10^6}{60}t}\ V = \frac{15}{77} + \frac{293}{77}e^{-\frac{77\times10^6}{60}t}\ V$ $(t\geq 0)$

11-1

(1) 零输入响应　将 U_s 置零.

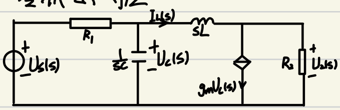


$$\begin{bmatrix} 1+2s+\frac{1}{2s} & -\frac{1}{2s} \\ -\frac{1}{2s} & 1+\frac{1}{2s} \end{bmatrix} \begin{bmatrix} U_C(s) \\ U_2(s) \end{bmatrix} = \begin{bmatrix} -4-\frac{1}{s} \\ \frac{1}{s}-\frac{1}{2}U_C(s) \end{bmatrix}$$

$$\therefore U_2(s) = \frac{2s-\frac{1}{4}}{s^2+s+\frac{5}{8}} = \frac{\frac{5}{4}\sqrt{\frac{8}{3}} \times \sqrt{\frac{3}{8}}}{(s+\frac{1}{2})^2+(\sqrt{\frac{3}{8}})^2}$$

$$\therefore u_2 = \mathcal{L}^{-1}(U_2(s)) = e^{-\frac{1}{2}t}\left(2\cos\sqrt{\tfrac{3}{8}}t - \tfrac{5}{\sqrt{6}}\sin\sqrt{\tfrac{3}{8}}t\right)\varepsilon(t)\ V$$

(2) 零状态响应



$$\begin{bmatrix} 1+\frac{1}{2s}+2s & -\frac{1}{2s} \\ \frac{1}{2}-\frac{1}{2s} & 1+\frac{1}{2s} \end{bmatrix} \begin{bmatrix} U_C(s) \\ U_2(s) \end{bmatrix} = \begin{bmatrix} \frac{1}{s^2+1} \\ 0 \end{bmatrix}$$

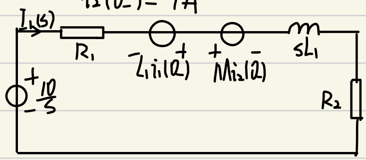
$$\therefore U_2(s) = \frac{2-2s}{(s^2+1)(8s^2+8s+5)} = \frac{-\frac{10}{73}s-\frac{22}{73}}{s^2+1} + \frac{\frac{10}{73}(s+\frac{1}{2})}{(s+\frac{1}{2})^2+(\sqrt{\frac{3}{8}})^2} + \frac{\frac{27}{73}\sqrt{\frac{8}{3}}\cdot\sqrt{\frac{3}{8}}}{(s+\frac{1}{2})^2+(\sqrt{\frac{3}{8}})^2}$$

$$\therefore u_2 = \mathcal{L}^{-1}(U_2(s)) = \left(\tfrac{10}{73}e^{-\frac{1}{2}t}\cos\sqrt{\tfrac{3}{8}}t + \tfrac{18\sqrt{6}}{73}\sin\sqrt{\tfrac{3}{8}}t - \tfrac{10}{73}\cos t - \tfrac{22}{73}\sin t\right)\varepsilon(t)\ V.$$

11-2.

$i_1(0_-) = 2A$　　$i_2(0_-) = 1A$

开关断开后

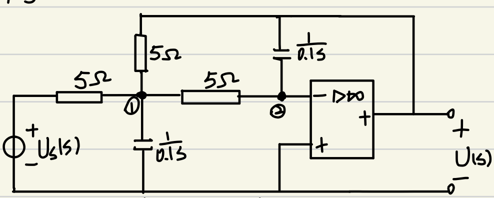


$$(4+2+4s)I_1(s) = \frac{10}{s} + [4\,i_1(0_-) - M i_2(0_-)]$$

$$\therefore I_1(s) = \frac{5}{3s} - \frac{\frac{1}{6}}{s+\frac{3}{2}}$$

$$\therefore i_1 = \mathcal{L}^{-1}(I_1(s)) = \left(\tfrac{5}{3} - \tfrac{1}{6}e^{-\frac{3}{2}t}\right)\varepsilon(t)\ A.$$

11-3



$$\begin{bmatrix} \frac{1}{5}+\frac{1}{5}+\frac{1}{5}+0.1s & -\frac{1}{5} & -\frac{1}{5} \\ -\frac{1}{5} & \frac{1}{5}+0.1s & -0.1s \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} U_{n1}(s) \\ U_{n2}(s) \\ U(s) \end{bmatrix} = \begin{bmatrix} \frac{U_s(s)}{5} \\ 0 \\ 0 \end{bmatrix}$$

$$\therefore U(s) = -\frac{4}{s^2+6s+4}U_s(s)$$

$$\therefore H(s) = \frac{U(s)}{U_s(s)} = -\frac{4}{s^2+6s+4}$$

$$\therefore h(t) = \mathcal{L}^{-1}(H(s)) = 0.89\left(e^{-5.24t} - e^{-0.76t}\right)\varepsilon(t)$$

12-1

$$\begin{cases} C_3\dfrac{du_{c3}}{dt} = i_{L5} - i_{R_2} \\ C_4\dfrac{du_{c4}}{dt} = i_{R_2} \\ L_5\dfrac{di_{L5}}{dt} = -u_{c3} + u_s - R_1 i_{R_1} \end{cases}$$

$$i_{R_1} = i_{L5} . \quad i_{R_2} = \frac{u_{c3} - u_{c4}}{R_2}$$

即
$$\begin{bmatrix} \dfrac{du_{c3}}{dt} \\ \dfrac{du_{c4}}{dt} \\ \dfrac{di_{L5}}{dt} \end{bmatrix} = \begin{bmatrix} -\dfrac{1}{C_3R_2} & \dfrac{1}{C_3R_2} & \dfrac{1}{C_3} \\ \dfrac{1}{C_4R_2} & -\dfrac{1}{C_4R_2} & 0 \\ -\dfrac{1}{L_5} & 0 & -\dfrac{R_1}{L_5} \end{bmatrix} \begin{bmatrix} u_{c3} \\ u_{c4} \\ i_{L5} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \dfrac{1}{L_5} \end{bmatrix} u_s$$

$$\begin{cases} i_{c3} = i_{L5} - i_{R_2} = -\dfrac{u_{c3}}{R_2} + \dfrac{u_{c4}}{R_2} + i_{L5} \\ u_{L5} = -u_{R_1} - u_{c3} + u_s = -u_{c3} + u_s - R_1 i_{L5} \end{cases}$$

即
$$\begin{bmatrix} i_{c3} \\ u_{L5} \end{bmatrix} = \begin{bmatrix} -\dfrac{1}{R_2} & \dfrac{1}{R_2} & 1 \\ -1 & 0 & -R_1 \end{bmatrix} \begin{bmatrix} u_{c3} \\ u_{c4} \\ i_{L5} \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u_s$$

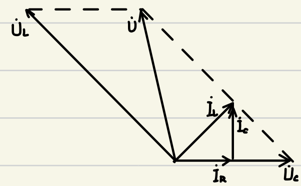
13-1　崔雨莳　519030910287

感抗 $X_L = wL = 200\Omega$　容抗 $X_c = -\frac{1}{wC} = -100\Omega$

$\dot{I}_R = 2\angle 0°A$　$\therefore\ \dot{U}_c = R\dot{I}_R = 400\angle 0° V$　$\dot{I}_c = \frac{\dot{U}_c}{jX_c} = \frac{400\angle 0°}{-j100}A = 4\angle 90°A$

$\dot{I}_L = \dot{I}_c + \dot{I}_R = 2\sqrt{5}\angle 63.43°A$　$\dot{U}_L = jX_L\dot{I}_L = 400\sqrt{5}\angle 153.43° V$

$\dot{U} = \dot{U}_L + \dot{U}_c = 400\sqrt{2}\angle 135° V.$



$\therefore\ i_c = 4\sqrt{2}\cos(wt+90°)A.$　$i_L = 2\sqrt{10}\cos(wt+63.43°)A$

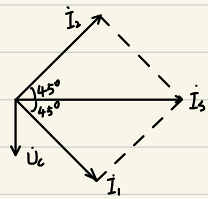
$u_R = u_c = 400\sqrt{2}\cos wt\ V.$　$u_L = 400\sqrt{10}\cos(wt+153.43°)V$

$u = 800\cos(wt+135°)V$

13-2　崔雨莳　519030910287

$\dot{I}_s = 10\angle 0°$

由KCL. KVL 得 $\begin{cases} \dot{I}_1 + \dot{I}_2 = \dot{I}_s \\ -\mu\dot{U}_c + \dot{I}_1R_1 = \dot{I}_2R_2 \\ \dot{U}_c = \frac{1}{jwC}\dot{I}_s \end{cases} \Rightarrow \begin{cases} \dot{I}_1 = 5\sqrt{2}\angle -45°A \\ \dot{I}_2 = 5\sqrt{2}\angle 45°A. \end{cases}$



13-3　崔雨莳　519030910287

令 $Z_1 = R_1 // \frac{1}{jwC_1}$，$Z_2 = R_2 // \frac{1}{jwC_2}$，则有.

$\frac{\dot{U}_2}{\dot{U}_1} = \frac{Z_2}{Z_2+Z_1} = \frac{R_2}{R_1+R_2} \times \frac{1+jwR_1C_1}{1+jw\frac{R_1R_2}{R_1+R_2}(C_1+C_2)}$

若 $\dot{U}_2$ 和 $\dot{U}_1$ 同相位　则 $wR_1C_1 = w\frac{R_1R_2}{R_1+R_2}(C_1+C_2)$

即 $R_1C_1 = R_2C_2$　故 $\frac{\dot{U}_2}{\dot{U}_1} = \frac{R_2}{R_1+R_2} = \frac{C_1}{C_1+C_2}$

13-4　崔雨莳　519030910287

设电容两端电压为 u_c.　2Ω 电阻两端电压为 u_R.

$\dot{U}_0 = 5\dot{U}_1$，$\dot{U}_R = \frac{2\dot{U}_0}{8j+2}$，$\dot{U}_c = \frac{\frac{1}{2j}\dot{U}_0}{\frac{1}{2j}+2}$.

$\dot{U}_C - \dot{U}_R = \dot{U}_s - \dot{U}_1$

$\therefore\ \dot{U}_0 = 5\dot{U}_s$

$\therefore\ u_0 = 50\cos(t+30°)\ V.$

14-1 崔雨潇 519030910287

由虚短、虚断得节点方程为.

$$\begin{bmatrix} G_1+G_2+G_3+jwC_1 & -G_2 & -G_3 \\ -G_3 & -jwC_2 & G_3+jwC_2 \\ 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} \dot{U}_{n1} \\ \dot{U}_{n2} \\ \dot{U}_{n3} \end{bmatrix} = \begin{bmatrix} G_1\dot{U}_1 \\ 0 \\ 0 \end{bmatrix}$$

由于 $\dot{U}_2 = \dot{U}_{n2}$. 得 $\frac{\dot{U}_2}{\dot{U}_1} = \frac{-G_1G_3}{G_2G_3 - w^2C_1C_2 + jwC_2(G_1+G_2+G_3)}$ （且 $G_1 = \frac{1}{R_1}$. $G_2 = \frac{1}{R_2}$ $G_3 = \frac{1}{R_3}$）

14-2 崔雨潇. 519030910287

(a)
$$Z_{ab} = \frac{(jwL_1 + \frac{1}{jwC_1})(jwL_2 + \frac{1}{jwC_2})}{jwL_1 + \frac{1}{jwC_1} + jwL_2 + \frac{1}{jwC_2}} = \frac{(1-w^2L_1C_1)(1-w^2L_2C_2)}{jw(C_1+C_2) - jw^3(L_1+L_2)C_1C_2}$$

可发生谐振. 谐振频率为

$1-w^2L_1C_1 = 0 \rightarrow w = \sqrt{\frac{1}{L_1C_1}}$

$1-w^2L_2C_2 = 0 \rightarrow w = \sqrt{\frac{1}{L_2C_2}}$

$w(C_1+C_2) - w^3(L_1+L_2)C_1C_2 = 0 \rightarrow w = \sqrt{\frac{C_1+C_2}{(L_1+L_2)C_1C_2}}$

∴ 能发生谐振. 谐振频率为 $\sqrt{\frac{1}{L_1C_1}}$. $\sqrt{\frac{1}{L_2C_2}}$. $\sqrt{\frac{C_1+C_2}{(L_1+L_2)C_1C_2}}$

(b) $\dot{U}_{ab} = \dot{U}_L + \mu\dot{U}_L = (1+\mu)\dot{U}_L$ $\quad \dot{I}_{ab} = \frac{\dot{U}_L}{jwL} = \frac{\dot{U}_{ab}}{(1+\mu)jwL}$

$Z_{ab} = \frac{\dot{U}_{ab}}{\dot{I}_{ab}} = (1+\mu)jwL$.

∴ 无法谐振.

15-1 翟雨萌 519030910287

设 $\dot{U}_U = U\angle 0^\circ V$ $\dot{U}_{UV} = \sqrt{3}U\angle 30^\circ V$ 负载对称 $\dot{I}_U = 2\angle 0^\circ A$ $\dot{I}_V = 2\angle -120^\circ A$

(1) $\dot{I}_1 = \frac{\dot{U}_{UV}}{R} = 2\angle 30^\circ A$

$\therefore \dot{I}_U' = \dot{I}_U + \dot{I}_1 = 3.86\angle 15^\circ A$. $\dot{I}_V' = \dot{I}_V - \dot{I}_1 = 3.86\angle -135^\circ A$

$\therefore$ 有效值均为 3.86A.

(2) $\dot{I}_1 = \frac{\dot{U}_{UV}}{1/(j\omega C)} = 2\angle 120^\circ A$

$\therefore \dot{I}_U' = \dot{I}_U + \dot{I}_1 = 2\angle 60^\circ A$ $\dot{I}_V' = \dot{I}_V - \dot{I}_1 = 3.46\angle -90^\circ A$.

$\therefore$ 有效值分别为 2A、3.46A.

15-2. 翟雨萌 519030910287

S 闭合前 $\dot{I}_U = \frac{\dot{U}_U}{Z} = \frac{\dot{U}_U}{1+2j}$.

S 闭合后 $(\frac{1}{Z} + \frac{1}{Z} + \frac{1}{Z})\dot{U}_{N'N} - \frac{\dot{U}_U}{Z} - \frac{\dot{U}_V}{Z} = \frac{\dot{U}_W}{Z}$. $\therefore \dot{U}_{N'N} = \frac{\dot{U}_U + \dot{U}_V + \dot{U}_W}{3} = 0$

$\therefore \dot{U}_{NN'} = \dot{U}_U - \dot{U}_{NN} = \dot{U}_U$ $\dot{I}_U = \frac{\dot{U}_W}{Z_L} + \frac{\dot{U}_{UN'}}{Z} = \frac{\dot{U}_U - \dot{U}_V}{Z_L} + \frac{\dot{U}_U}{Z}$

以 $\dot{U}_U$ 为参考量 $\dot{U}_U = 10|Z_L|\angle 0^\circ = 10\sqrt{5}\angle 0^\circ V$ $\dot{U}_U - \dot{U}_V = 10\sqrt{15}\angle 30^\circ V$

$Z_L = \frac{\dot{U}_U - \dot{U}_V}{10\angle 120^\circ - \arctan 2} = (2\sqrt{3} - \sqrt{3}j)\Omega$

15-3 翟雨萌 519030910287.

(1) $\dot{I}_{U1} = \frac{120}{100 \times 0.6} = 2\angle -53^\circ$ $\dot{I}_L = \frac{\dot{U}_U}{j\omega L} = \angle -90^\circ$

$\dot{I}_U = \dot{I}_{U1} + \dot{I}_L = 2.86\angle -65.2$ $\dot{I}_R = \frac{\dot{U}_W}{R} = \angle 120^\circ$

$\dot{I}_0 = \dot{I}_R + \dot{I}_L = 0.52\angle -165^\circ$

(2) $P = \dot{I}_U \cdot \dot{U}_U = 199.96\ W$

(3) $P_R = Re(\dot{U}_U \cdot \dot{I}_R) = 100W$ $P = 360 + 100 = 460\ W$

$Q = \frac{360}{0.6}\sqrt{1-0.6^2}(\dot{U}_U \cdot \dot{I}_L) = 580W$.

16-1 雀雨帆 519030910287

直流分量单独作用下 $I_0 = \frac{U_0}{R_1+R_2} = \frac{U_0}{150}$.

电容电流只有交流分量 $I_c = 1A$. 设 $\dot{I}_c = 1\angle 90° A$.

则 $\dot{I}_{R2} = \frac{1/j\omega C}{R_2} \dot{I}_c = 1\angle 0° A$.

$\therefore \dot{I}_1 = \dot{I}_{R2} + \dot{I}_c = (1+j) A = \sqrt{2}\angle 45° A$

$\dot{U}_1 = (R_1 + j\omega L)\dot{I}_1 + \dot{U}_c = 144.2\angle 56.3° V$.

由电流表 A_2 读数得. $I_0 = I_{R0} = \sqrt{1.5^2-1}\ A = 1.12A$.

$U_0 = (R_1+R_2) I_0 = 168 V$

电源电压有效值为 $U_S = \sqrt{U_0^2 + U_1^2} = 221.4V$

电源发出的功率为 $P = U_0 I_0 + U_1 I_1 \cos\varphi_1 = 388 W$.