

## 参考答案

1-1 各元件吸收的功率分别为

$$P_A = 10\text{W}, P_B = -10\text{W}, P_C = 10\text{W}, P_D = -10\text{W}$$

1-2 6A, 5A, -5A, -5A

1-3  $I_1 = -3\text{A}$ ,  $I_2 = 8\text{A}$

1-4  $I_2 = 2\text{A}$ ,  $I_1 = -6\text{A}$

1-5  $u_5 = 18\text{V}$ ,  $u_3 = 8\text{V}$ ,  $u_2 = -10\text{V}$

1-6  $u_1 = 15\text{V}$ ,  $u_4 = -6\text{V}$ ,  $u_5 = 11\text{V}$

1-7  $P_1 = 20\text{W}$ ,  $P_2 = -30\text{W}$ ,  $P_3 = 15\text{W}$ ,  $P_4 = -5\text{W}$

1-8 (a)  $i = -10\text{A}$ ,  $u = 60\text{V}$ ; (b)  $i = -10\text{A}$ ,  $u = -100\text{V}$ ; (c)  $i = 3\text{A}$ ,  $u = [-2\cos t - 2]\text{V}$

1-9 (a)  $i = -1\text{A}$ ,  $u = 4\text{V}$ ; (b)  $u_b = 6\text{V}$ ,  $u_a = 5\text{V}$ ; (c)  $u = 10\text{V}$ ,  $i = -1\text{A}$ ,  $i_0 = 2\text{A}$

1-10  $P_B = 50\text{W}$

1-11  $P_{4\text{A}} = -36\text{W}$ ,  $P_{5\text{V}} = 5\text{W}$

1-12  $P = 12\text{W}$

1-13  $I = -1\text{A}$ ;  $U = 4\text{V}$ , 元件 A 可能是  $4\Omega$  电阻, 也可能是  $-1\text{A}$  电流源, 还可能是  $4\text{V}$  电压源。

1-14 (a)  $I = 2\text{A}$ ,  $U = -24\text{V}$ ; (b)  $U = 5\text{V}$ ; (c)  $i_1 = 2\text{A}$ ,  $i_2 = 5\text{A}$ ,  $u = 6\text{V}$

(d)  $U = -1\text{V}$ ,  $I = 2\text{A}$

1-15 受控电流源发出的功率为  $2\text{W}$ ;  $2\text{V}$  电压源吸收的功率为  $-5\text{W}$ 。

1-16  $I = 1.4\text{A}$ ,  $U = 7.2\text{V}$ ,  $P_{2\Omega} = 3.92\text{W}$

2-1  $I = 8\text{A}$ ,  $P_{120\text{V}} = -960\text{W}$ ,  $P_{30\Omega} = 1920\text{W}$ ,  $P_{2\text{U}} = -1920\text{W}$ ,  $P_{15\Omega} = 960\text{W}$

2-2  $U = 12\text{V}$ ,  $P_{4\text{A}} = -48\text{W}$ ,  $P_{6\Omega} = 24\text{W}$ ,  $P_{2\Omega} = 72\text{W}$ ,  $P_{2\text{I}} = -48\text{W}$

2-4  $I = 1\text{A}$

2-5  $i = 0.5\text{A}$

2-6 (a)  $I = 2\text{A}$  (b)  $I = 0.5\text{A}$

2-7 (a)  $u = 5i + 5$  (b)  $u = 3.5i + 1$

2-8  $R = 1\Omega$  时,  $I = 1\text{A}$ ;  $R = 2\Omega$  时,  $I = 0.6\text{A}$ 。

2-9  $P = 4\text{W}$

2-10  $U = 12\text{V}$

2-11 (a)  $R_{ab} = 14\Omega$  (b)  $R_{ab} = 3\Omega$  (c)  $R_{ab} = 1\Omega$

2-12 (a)  $R_{ab} = \frac{2}{3}R$  (b)  $R_{ab} = \frac{4}{5}R$

2-13 (a)  $R_{in} = 4\Omega$  (b)  $R_{in} = \frac{4}{3}\Omega$  (c)  $R_{in} = 5\Omega$  (d)  $R_{ab} = 25\Omega$

2-14  $I = 1\text{A}$ ,  $I_1 = 0.5\text{A}$

3-1  $I_1 = 6\text{A}$ ,  $I_2 = 2\text{A}$ ,  $I_3 = 4\text{A}$

3-2  $U_1 = -28\text{V}$ ,  $U_2 = U_3 = 28\text{V}$

3-3 (a) 
$$\begin{cases} U_{n1} - 0.5U_{n3} = 5 \\ 2U_{n2} - U_{n3} = -10 \\ -0.5U_{n1} - U_{n2} + 2.5U_{n3} = 0 \end{cases}$$
 (b) 
$$\begin{cases} 4U_{n1} - 2U_{n2} - U_{n3} = -2 \\ -2U_{n1} + 5U_{n2} - U_{n3} = 4 \\ -U_{n1} - U_{n2} + 3U_{n3} = 4 \end{cases}$$

$$(c) \begin{cases} 7U_{n1} - 3U_{n2} - 2U_{n3} = 44 \\ -3U_{n1} + 7U_{n2} = 16 \\ -2U_{n1} + 3U_{n3} = -28 \end{cases} \quad (d) \begin{cases} U_{n1} = 10 \\ -0.5U_{n1} + U_{n2} + 0.25U_{n3} = 0 \\ U_{n2} - U_{n3} = 5 \end{cases}$$

3-4  $I_1 = 2A$

3-5  $I = 3A \quad U = 10V$

$$3-6 \quad (a) \begin{cases} U_{n1} - 0.5U_{n2} - 0.5U_{n3} = 2 \\ -0.5U_{n1} + 2U_{n2} = 9 \\ -0.5U_{n1} - U_{n2} + U_{n3} = -5 \end{cases} \quad (b) \begin{cases} 2U_{n1} - 0.5U_{n2} - U_{n3} = 5 \\ -11.5U_{n1} + 2U_{n2} + 10U_{n3} = 0 \\ 9U_{n1} - 8U_{n3} = 0 \end{cases}$$

$$(c) \begin{cases} 5U_{n1} - 2U_{n2} - U_{n3} = 4 \\ U_{n1} + U_{n2} = 0 \\ -3U_{n1} + 4U_{n3} = 9 \end{cases} \quad (d) \begin{cases} U_{n1} - 2U_{n2} = 0 \\ -6U_{n1} + 13U_{n2} + 2U_{n3} = -2 \\ U_{n2} - U_{n3} = 10 \end{cases}$$

3-7  $U = 6.2V$

3-8  $P = -112.5W$

$$3-10 \quad (1) \begin{cases} 6U_{n1} - 2U_{n2} - U_{n3} - 2U_{n4} = 2 \\ -2U_{n1} + 4U_{n2} - 2U_{n3} = 3 \\ U_{n1} - 2U_{n2} + 6U_{n3} - 2U_{n4} = 0 \\ -2U_{n1} - 2U_{n3} + 6U_{n4} = -1 \end{cases} \quad (2) \begin{cases} 6U_{n1} - 2U_{n2} - U_{n3} - 2U_{n4} = 0 \\ -2U_{n1} + 4U_{n2} - 2U_{n3} = 5 \\ U_{n1} - 2U_{n2} + 5U_{n3} - U_{n4} = 0 \\ -2U_{n1} - U_{n3} + 5U_{n4} = -1 \end{cases}$$

$$(3) \begin{cases} 6U_{n1} - 2U_{n2} - U_{n3} - 2U_{n4} = 2 \\ -2U_{n1} + 4U_{n2} - 2U_{n3} = 3 \\ 3U_{n1} - 4U_{n2} + 5U_{n3} - U_{n4} = 0 \\ -2U_{n1} - U_{n3} + 5U_{n4} = -1 \end{cases} \quad (4) \begin{cases} 6U_{n1} - 2U_{n2} - U_{n3} - 2U_{n4} = 0 \\ -2U_{n1} + 4U_{n2} - 2U_{n3} = 5 \\ 3U_{n1} - 4U_{n2} + 6U_{n3} - 2U_{n4} = 0 \\ -2U_{n1} - 2U_{n3} + 6U_{n4} = -1 \end{cases}$$

$$3-11 \quad (a) \begin{cases} 200I_{m1} - 100I_{m3} = -180 \\ 600I_{m2} - 200I_{m3} = 60 \\ -100I_{m1} - 200I_{m2} + 700I_{m3} = 120 \end{cases} \quad (b) \begin{cases} 7I_{m1} - 3I_{m2} - I_{m3} = 36 \\ -3I_{m1} + 7I_{m2} = 24 \\ -I_{m1} + 4I_{m3} = -42 \end{cases}$$

$$(c) \begin{cases} I_{m1} = -3 \\ -8I_{m1} + 7I_{m2} + 7I_{m3} = -3 \\ I_{m2} - I_{m3} = 5 \end{cases} \quad (d)$$

$$\begin{cases} I_{m1} = I_{s1} \\ -R_2 I_{m1} + R_5 I_{m2} + (R_2 + R_6) I_{m3} = U_{s1} + U_{s2} - U_{s3} \\ I_{m2} - I_{m3} = I_{s2} \end{cases}$$

3-12  $I_1 = 1\text{A}$

3-13  $U = 2I_2 = 2 \times 2 = 4\text{V}$

3-14 (a) 
$$\begin{cases} 6I_1 - 4I_2 = 12 \\ -4I_1 + 8I_2 - 3I_3 = -2U \\ I_3 = -1 \end{cases}$$
 (b) 
$$\begin{cases} I_{m1} = 5 \\ -4.5I_{m1} + 12I_{m2} + 1.5I_{m3} = 0 \\ I_{m1} + 5I_{m3} = 0 \end{cases}$$

(c) 
$$\begin{cases} I_{m1} - 2I_{m2} + 2I_{m3} = 0 \\ -I_{m1} + 3I_{m2} - I_{m3} = 2 \\ -3I_{m2} + 2I_{m3} = 0 \end{cases}$$
 (d) 
$$\begin{cases} 6I_{m1} - 6I_{m2} + 17I_{m3} = 4 \\ I_{m2} = -3 \\ -I_{m1} + 2I_{m2} - I_{m3} = 0 \end{cases}$$

3-18 
$$\begin{cases} 4i_{l1} - 2i_{l2} - i_{l3} - 2i_{l4} = 20 \\ -2i_{l1} + 4i_{l2} - i_{l3} + i_{l4} = -2 \\ -i_{l1} - i_{l2} + 4i_{l3} + 2i_{l4} = 0 \\ -2i_{l1} + i_{l2} + 2i_{l3} + 4i_{l4} = 0 \end{cases}$$

3-19  $I = 3.6\text{A}$

3-20  $I_x = 0.25\text{A}$

4-1 (a)  $U = 7\text{V}$  (b)  $I = 3\text{A}$

4-2  $P_{3\Omega} = 75\text{W}$

4-3  $I = \frac{2}{3}\text{A}$

4-4  $I = -2\text{A}$

4-5  $U = 16\text{V}$

4-6  $I_1 = \frac{15}{19}\text{A}$

4-7  $U = 22\text{V}$

4-8  $P_{I_s} = 96\text{W}$

4-9  $I = 190\text{mA}$

4-10  $I_0 = 10\text{A}$

4-12  $R_x = 1\Omega$

4-13  $I = -0.75\text{A}$

4-14  $I_L = \frac{4}{3}\text{A}$

4-16 (a)  $I = \frac{9}{5+4} = 1\text{A}$  (b)  $U = 12\text{V}$

4-17  $P_{R_L} = 0.25\text{W}$

4-18  $I = 5\text{A}$

4-19  $I = 2\text{A}$

4-20  $U = 4\text{V}$

4-21  $P_{\max} = 16\text{W}$

4-22  $P_{\max} = \frac{U_{oc}^2}{4R_0} = \frac{0.4^2}{4 \times 1.6} = 0.025\text{W}$

4-23  $P_{\max} = 25\text{W}$

4-24  $P_{\max} = 5000\text{W}$

4-25  $\hat{U}_2 = 1.6\text{V}$

4-26  $\hat{U}_{s2} = 54\text{V}$

4-27  $I = -0.25\text{A}$

4-28  $I = 0.5\text{A}$

4-29  $I_1 = 1\text{A}$

4-30  $U = 6\text{V}$

4-31 (1)  $R_5 = 2\Omega$  时,  $P_{\max} = \frac{U_{oc}^2}{4R_{eq}} = \frac{(200)^2}{4 \times 2} = 5000\text{W}$ ; (2)  $R_5 = \frac{2}{3}\Omega$

4-32  $R = 1\Omega$   $i_1 = i_2 = 3\text{A}$

5-1 (a)  $\mathbf{R} = \frac{1}{3} \begin{bmatrix} 5 & 4 \\ 4 & 5 \end{bmatrix} \Omega$   $\mathbf{G} = \mathbf{R}^{-1} = \frac{1}{3} \begin{bmatrix} 5 & -4 \\ -4 & 5 \end{bmatrix} \text{S}$ ; (b)  $\mathbf{R} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \Omega$   $\mathbf{G} = \mathbf{R}^{-1} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \text{S}$

5-2  $\mathbf{R} = \begin{bmatrix} 3 & 1 \\ 3 & 5 \end{bmatrix}$

5-3  $\mathbf{G} = \begin{bmatrix} 1.5 & -0.5 \\ 4 & 0 \end{bmatrix} \text{S}$

5-4  $\mathbf{T} = \begin{bmatrix} -0.3 & -0.5R \\ -\frac{1}{10R} & 0.5 \end{bmatrix}$   $\mathbf{H} = \begin{bmatrix} -R & -0.4 \\ -2 & -\frac{1}{5R} \end{bmatrix}$

5-5  $R_{22} = R_{11} = 4\Omega$ ,  $R_{12} = R_{21} = 3\Omega$

5-6  $\mathbf{G} = \begin{bmatrix} 0.112 & 0.26 \\ 0.26 & 0.3 \end{bmatrix} \text{S}$

5-7  $h_{11} = 100\Omega$ ,  $h_{12} = 0$   $h_{21} = 50$ ,  $h_{22} = 10^{-3}\text{S}$

5-8  $\mathbf{T} = \begin{bmatrix} 5/3 & 2 \\ 1/3 & 1 \end{bmatrix}$

5-9  $R_1 = 5\Omega$ ,  $R_2 = 5\Omega$ ,  $R_0 = 5\Omega$ ,  $r = 3\Omega$

5-10  $\mathbf{G} = \begin{bmatrix} \frac{1}{5} & -\frac{1}{15} \\ -\frac{1}{15} & \frac{2}{15} \end{bmatrix} \text{S}$

$$5-12 \quad \mathbf{T} = \begin{bmatrix} 13 & 8 \\ 8 & 5 \end{bmatrix}$$

$$5-13 \quad u = 11 \text{ V}$$

$$5-14 \quad P_{R_L} = 15 \text{ mW}$$

$$5-15 \quad P = 24 \text{ W}$$

$$5-16 \quad \mathbf{T} = \begin{bmatrix} 2.5 & 10.5 \\ 0.5 & 2.5 \end{bmatrix} \quad R_L = 4.2 \Omega$$

$$5-17 \quad R_L = 4 \Omega \quad P_{\max} = 9 \text{ W}$$

$$5-18 \quad P = 18.9 \text{ W}$$

$$5-22 \quad \begin{cases} 5U_{n1} - 3U_{n2} - 4U_{n3} + 3U_{n4} = 10 \\ -3U_{n1} + 4U_{n2} + 3U_{n3} - 3U_{n4} = 0 \\ -U_{n2} + 6U_{n3} - 5U_{n4} = -1 \\ -U_{n1} + U_{n2} - 5U_{n3} + 6U_{n4} = 0 \end{cases}$$

$$5-23 \quad u_0 = 15 \text{ V}$$

$$5-24 \quad i = 3 \text{ A}$$

$$5-25 \quad U_o = 2(U_2 - U_1)$$

$$5-26 \quad U_o = -20 \text{ V}$$

$$5-27 \quad R = 100 \Omega$$

$$5-28 \quad i = \frac{1}{6} \text{ A}$$

$$5-29 \quad \frac{u_o}{u_s} = -4$$

$$5-30 \quad U_o = -4 \text{ V}$$

$$5-32 \quad R_{11} = R_s, \quad R_{12} = 0, \quad R_{21} = -R_f, \quad R_{22} = R_o$$

$$5-33 \quad u_2 = 5 \text{ V}$$

$$5-34 \quad \mathbf{T} = \begin{bmatrix} 1 & 5 \\ 0.75 & 2.75 \end{bmatrix}$$

$$6-1 \quad u_C(t) = \begin{cases} 10 \text{ V} & t < 0 \\ 10 + 6.25t^2 \text{ V} & 0 \leq t < 2\text{s} \\ -12.5t^2 + 75t - 65 \text{ V} & 2\text{s} \leq t < 4\text{s} \\ 6.25t^2 - 75t + 235 \text{ V} & 4\text{s} \leq t < 6\text{s} \\ 10 \text{ V} & t \geq 6\text{s} \end{cases}$$

$$6-2 \quad i_L(t) = \begin{cases} 2 \text{ A} & t < 1\text{s} \\ (5t - 3) \text{ A} & 1 \leq t < 3\text{s} \\ 12 \text{ A} & t \geq 3\text{s} \end{cases}$$

$$6-3 \quad (\text{a}) \quad C_{ab} = 2.5 \text{ F}, \quad (\text{b}) \quad L_{ab} = 2 \text{ H}$$

$$6-4 \quad (1) \quad C = 1.6 \mu\text{F}, \quad u_C(t) = (5 - 15e^{-5t}) \text{ V}; \quad (2) \quad u_{C_1}(t) = (7 - 12e^{-5t}) \text{ V}, \quad u_{C_2}(t) = (-2 - 3e^{-5t}) \text{ V}$$

$$6-5 \quad (1) \quad L = 1.2 \text{ H}, \quad i(t) = (2.5 - 2.5e^{-2t}) \text{ A}; \quad (2) \quad i_1(t) = (2.5 - 0.5e^{-2t}) \text{ A}, \quad i_2(t) = -2e^{-2t} \text{ A}$$

6-6  $L = 0.5\text{H}$  ,  $R = 1.5\Omega$  ,  $C = 1\text{F}$

6-7  $i(t) = -2e^{-2t} \text{ A}$  ,  $u(t) = 10e^{-2t} \text{ V}$

7-1 (a)  $20 \frac{d^2 i_L}{dt^2} + 5 \frac{di_L}{dt} + 2i_L = 20$  (b)  $\frac{d^2 u_C}{dt^2} + 2 \frac{du_C}{dt} + 2u_C = u_s$  (c)  $\frac{d^2 u_C}{dt^2} + 1.5 \frac{du_C}{dt} + 1.5u_C = u_s(t)$

7-2  $i(0_+) = 0.75\text{A}$

7-3  $i(0_+) = 2.5\text{A}$

7-4  $u_C(0_+) = 16\text{V}$  ,  $i_L(0_+) = 5\text{A}$   $u(0_+) = 0\text{V}$   $\left. \frac{du_C}{dt} \right|_{t=0_+} = 0$  ,  $\left. \frac{di_L}{dt} \right|_{t=0_+} = 3\text{A/s}$

7-5  $u_C(t) = 8e^{-0.5t} + 4t - 8 \text{ V}$  ( $t > 0$ )

7-6  $u_k(t) = 10 + \frac{10}{3}e^{-2t} \text{ V}$  ( $t > 0$ )

7-7  $u_C(t) = 6e^{-0.1t} \text{ V}$  ( $t > 0$ )  $i_C(t) = -0.6e^{-0.1t} \text{ A}$  ( $t > 0$ )  $i(t) = 0.4e^{-0.1t} \text{ A}$  ( $t > 0$ )

7-8  $u(t) = -45e^{-10^4 t} \text{ V}$  ( $t > 0$ )  $i(t) = -0.45e^{-10^4 t} \text{ mA}$  ( $t > 0$ )

7-9  $u_C(t) = 12 - 6e^{-2t} \text{ V}$  ( $t > 0$ )

7-10  $i_L(t) = 4 + e^{-5t} \text{ A}$  ( $t \geq 0$ )

7-11  $u_C(t) = (2 + 6e^{-0.5t}) \text{ V}$   $t \geq 0$

7-12  $i(t) = 4(1 - e^{-7t}) \text{ A}$  ( $t \geq 0$ )

7-13  $i(t) = (1.5 + 0.5e^{-0.4t} - 0.5e^{-5t}) \text{ A}$  ( $t > 0$ )

7-14  $i(t) = \left( \frac{U_s}{R_2} + \frac{U_s}{R_1} e^{-\frac{t}{R_1 C}} - \frac{U_s}{R_2} e^{-\frac{R_2 t}{L}} \right)$  ( $t > 0$ )  $R_1 = R_2 = \sqrt{\frac{L}{C}}$

7-15  $R_1 = R_2 = 4\Omega$   $C = 0.25\text{F}$   $u_C(t) = 2.5\text{V}$

7-16  $i_1(t) = 4e^{-10t} \text{ A}$  ( $t > 0$ )

7-17  $u(t) = 14 - 0.8e^{-t} \text{ V}$  ( $t > 0$ )

7-18  $u_C(t) = 12 - 15e^{-2t} \text{ V}$  ( $t \geq 0$ )

7-19 (1)  $u_{zi}(t) = 8e^{-t} \text{ V}$  ( $t > 0$ ) , (2)  $u_{zs}(t) = (10 - 4e^{-t}) \varepsilon(t) \text{ V}$

7-20  $u_0(t) = 1 - 0.5e^{-t} \text{ V}$  ( $t > 0$ )

$$7-21 \quad u_C(t) = \left( -0.8 + 0.8e^{-\frac{5}{12}t} \right) \varepsilon(t) \text{ V}$$

$$7-22 \quad i_2(t) = 7.5 - 2.5e^{-40t} \text{ A } (t > 0)$$

$$7-23 \quad i_L(t) = 3 - 0.5e^{-2t} \text{ A } (t \geq 0)$$

$$7-24 \quad u_2(t) = 10(1 - e^{-t})\varepsilon(t) - 10[1 - e^{-(t-1)}]\varepsilon(t-1) \text{ V}$$

$$7-25 \quad U = -3.68 \text{ V}$$

$$7-26 \quad u_C(t) = 30(1 - e^{-0.1t})\varepsilon(t) \text{ V}$$

$$7-27 \quad i_L(t) = 5(1 - e^{-10t})\varepsilon(t) \text{ A}$$

$$7-28 \quad u_C(t) = 3 - e^{-t} \text{ V } (t \geq 0) \quad , \quad u_R(t) = 3 - 0.25e^{-t} \text{ V } (t > 0)$$

$$7-29 \quad Q_1 = \frac{R_1}{R_1 + R_2} CU_0 \quad , \quad Q_2 = \frac{R_2}{R_1 + R_2} CU_0$$

$$7-30 \quad i_C(t) = -0.8e^{-2t}\varepsilon(t) \text{ A}$$

$$7-31 \quad u_L(t) = u_L(0) + u_L(0_+)e^{-\frac{t}{\tau}} = 2\delta(t) - 2000e^{-1000t}\varepsilon(t) \text{ V}$$

$$7-32 \quad u_L(t) = \frac{2}{3}\delta(t) - \frac{2000}{3}e^{-1000t}\varepsilon(t) \text{ V}$$

$$7-33 \quad R > \frac{\sqrt{2}}{2}$$

$$7-34 \quad u_C(t) = -6e^{-t} + 3e^{-1.5t} + 4 \text{ V } (t \geq 0)$$

$$7-34$$

$$7-35 \quad i_L(t) = (1 + 2t)e^{-2t} \text{ A } (t \geq 0)$$

$$7-36 \quad u_C(t) = \frac{2}{\sqrt{3}}e^{-0.5t} \sin \frac{\sqrt{3}}{2}t + 1 = 1 + 1.15e^{-0.5t} \sin 0.866t \text{ V } (t \geq 0)$$

$$7-37 \quad u_C(t) = -3.75e^{-2t} + 3.75e^{-3t} + 1 \text{ V } (t \geq 0)$$

$$7-37$$

$$7-38 \quad u_C(t) = 10(e^{-0.25t} - e^{-t})\varepsilon(t) \text{ V}$$

$$7-39 \quad \text{( a )} \quad \begin{bmatrix} \frac{du_C}{dt} \\ \frac{di_L}{dt} \end{bmatrix} = \begin{bmatrix} -0.5 & 2 \\ -0.5 & -1 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 0 \\ 0.5 \end{bmatrix} u_s \quad \text{( b )}$$

$$\begin{bmatrix} \frac{du_C}{dt} \\ \frac{di_L}{dt} \end{bmatrix} = \begin{bmatrix} -1 & 2 \\ -0.5 & -0.5 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0.5 \end{bmatrix} \begin{bmatrix} u_s(t) \\ i_s(t) \end{bmatrix}$$

$$7-40 \quad (a) \quad \begin{bmatrix} \frac{du_C}{dt} \\ \frac{di_{L1}}{dt} \\ \frac{di_{L2}}{dt} \end{bmatrix} = \begin{bmatrix} 0 & 1 & -1 \\ -1 & -1 & 0 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} u_C \\ i_{L1} \\ i_{L2} \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} u_s(t)$$

$$(b) \quad \begin{bmatrix} \frac{du_C}{dt} \\ \frac{di_L}{dt} \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} u_C \\ i_L \end{bmatrix} + \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} u_s \\ i_s \end{bmatrix}$$

8-2  $u_1$  超前  $i_1$   $69^\circ$   $u_2$  滞后  $i_2$   $144^\circ$   $u_3$  超前  $i_3$   $90^\circ$

8-6 (1)  $5\angle 36.9^\circ$  (2)  $5\angle 36.9^\circ$

8-7 (1)  $x(t) = \frac{1}{6\sqrt{2}} \sin 2t$  (2)  $x(t) = 0.044 \cos(2t - 142.13^\circ)$  (3)  $x(t) = 0.22 \sin(3t - 52.12^\circ)$

8-8 (1) 电感元件,  $L = 12.5\text{mH}$ ; (2) 电容元件,  $C = 500\mu\text{F}$ ; (3) 电阻元件,  $R = 1.6\Omega$

8-10 (1)  $u_1(t) = 3\sqrt{2} \cos 2t\text{V}$ ,  $u_2(t) = 4\sqrt{2} \cos(2t + 90^\circ)\text{V}$ ,  $u(t) = 5\sqrt{2} \cos(2t + 53.1^\circ)\text{V}$ ;

(2)  $i_1(t) = 2.5\sqrt{2} \sin 5t\text{A}$ ,  $i_2(t) = 5\sqrt{2} \sin(5t + 90^\circ)\text{A}$ ,  $i(t) = 5.59\sqrt{2} \sin(5t + 63.4^\circ)\text{A}$

8-11 (1)  $U = 25\text{V}$ ; (2)  $I = 5\sqrt{2} = 7.07\text{A}$

9-1 (1) 电路呈现容性; (2)  $C = 50\mu\text{F}$

9-2  $Z_L = j30\Omega$

9-4  $Z = (100 + j100\sqrt{3})\Omega$  或  $Z = (50 + j50\sqrt{3})\Omega$

当  $Z = (100 + j100\sqrt{3})\Omega$  时,  $Z_{in} = 100\Omega$ ; 当  $Z = (50 + j50\sqrt{3})\Omega$  时,  $Z_{in} = (50 - j50\sqrt{3})\Omega$ 。

9-5 (1)  $C = 1\mu\text{F}$  (2)  $Z_{in} = 1\text{k}\Omega$

9-6  $I_L = 30\text{A}$

9-7  $\dot{I} = 4\angle 0^\circ\text{A}$   $\dot{I}_2 = \sqrt{2}\angle 45^\circ\text{A}$   $\dot{I}_1 = 3.16\angle -18.4^\circ\text{A}$   $Z_{in} = 2\Omega$

9-8  $15.65\text{V}$

9-9  $\dot{U}_s = -8 + j3 = 8.54\angle 159.4^\circ\text{V}$

9-10 电流表  $A_0$  的示数为  $10\text{A}$ , 电压表  $V_0$  的示数为  $141.4\text{V}$

9-12  $\dot{I}_1 = \dot{I}_2 = 1\angle -45^\circ\text{A}$   $\dot{I}_3 = 0$   $\dot{I}_4 = 1\angle -45^\circ\text{A}$   $\dot{I}_5 = 1\angle 135^\circ\text{A}$

9-13 (1)  $P = 780\text{W}$ ,  $Q = 450\text{var}$   $S = 900\text{VA}$   $pf = \cos\theta = 0.8667$

(2)  $P = 10867\text{W}$ ,  $Q = -2912\text{var}$   $S = 11250\text{VA}$   $pf = \cos\theta = 0.966$

(3)  $P = 25.76\text{W}$ ,  $Q = -6.9\text{var}$  (容性)  $S = 26.67\text{VA}$   $pf = \cos\theta = 0.966$

(容性)

(4)  $S = 1144\text{VA}$   $P = 1072\text{W}$   $pf = \cos\theta = 0.937$

(5)  $S = 4000\text{VA}$   $P = 2500\text{W}$   $Q = 3122\text{var}$   $pf = \cos\theta = 0.625$

9-14  $P_s = 0$   $P_R = 18\text{W}$   $P_C = 0$   $P_L = 0$   $P_I = -18\text{W}$

9-15  $Q_R = 0$   $Q_L = 37.5\text{var}$   $Q_{2I} = 0$   $Q_s = -37.5\text{var}$

9-16  $pf = 1$

9-17  $28.28\text{V}$

9-18  $P = 200\text{W}$

9-19  $Z = R + jX = 10 - j19.6\Omega$

$Z_1 = 1.11 + j5.02 = 5.14\angle 77.53^\circ\Omega$  或者  $Z_1 = 1.11 + j34.18 = 34.20\angle 88.14^\circ\Omega$

9-20  $\tilde{S} = (120 + j160) \text{ VA}$

9-21 (1)  $\begin{cases} Z_1 = (2.5 + j6.6)\Omega \\ Z_2 = (2.5 - j6.6)\Omega \end{cases}$  或  $\begin{cases} Z_1 = (2.5 - j6.6)\Omega \\ Z_2 = (2.5 + j6.6)\Omega \end{cases}$

(2)  $R_1 = R_2 = 2.5\Omega \quad L = 2.6 \text{ mH} \quad C = 60.3 \mu\text{F}$

9-22 (1)  $21.246 \text{ A} \quad P \approx 1800 \text{ W}$

(2)  $P \approx 2778 \text{ W} \quad pf = 0.926$

(3)  $C = 25.92 \mu\text{F}$

9-23  $\tilde{S}_1 = -7000 + j5000 \text{ VA} \quad \tilde{S}_2 = \dot{U}_2 \dot{I}_2^* = 7500 + j5000 \text{ VA}$

$\tilde{S}_s = \dot{U}_s \dot{I}_s^* = -500 - j2500 \text{ VA}$

9-24 
$$\begin{cases} -j8\dot{I}_{m1} + (8 - j5)\dot{I}_{m2} - (3 - j8)\dot{I}_{m3} = 5\angle 30^\circ \\ j8\dot{I}_{m1} - 3\dot{I}_{m2} + (4 - j7)\dot{I}_{m3} = -5\angle 30^\circ \\ -\dot{I}_{m1} + \dot{I}_{m2} = 3\angle 30^\circ \end{cases}$$

9-25  $i_1(t) = 0, \quad i_2(t) = 6\sin(3000t + 90^\circ) \text{ mA}$

9-26 各元件吸收的平均功率分别为

$P_{I_s} = -500 \text{ W}, \quad P_C = 0, \quad P_{\mu\dot{U}_C} = -500 \text{ W}, \quad P_{R_1} = 500 \text{ W}, \quad P_{R_2} = 500 \text{ W}$

各元件吸收的无功功率分别为

$Q_{I_s} = 1500 \text{ var}, \quad Q_C = -2000 \text{ var}, \quad Q_{\mu\dot{U}_C} = 500 \text{ var}, \quad Q_{R_1} = 0, \quad Q_{R_2} = 0$

9-27 
$$\begin{cases} \dot{U}_{n1} = 10\angle 0^\circ \\ -(1 + j8)\dot{U}_{n1} + \left(1 + \frac{1}{1 + j8}\right)\dot{U}_{n2} + (1 + j8)\dot{U}_{n3} = 1\angle 120^\circ \\ \dot{U}_{n2} - \dot{U}_{n3} = 10\angle 0^\circ \end{cases}$$

9-28  $\dot{I}_C = 6 - j2 = 6.32\angle -18.43^\circ \text{ A}$

9-29  $\dot{U} = 3.6\angle 53.1^\circ \text{ V}$

9-31  $\dot{I} = 10\angle 0^\circ \text{ A}$

9-32  $P_R = 2 \text{ kW}$

9-33  $\omega = \frac{1}{\sqrt{LC}}$

9-34  $P_{\max} = 0.125 \text{ W}$

9-35  $P_{\max} \approx 8.11 \text{ W}$

9-36  $L = 0.02 \text{ H} \quad R = 1\Omega \quad Q = 50$

9-37 电流表  $A_1$  的示数为  $2 \text{ A}$  功率表  $W$  的示数为  $100 \text{ W}$  电流表  $A_3$  的示数为  $3 \text{ A}$

9-38 (a) 并联谐振频率为  $\omega_{01} = \frac{1}{\sqrt{CL_2}}$

串联谐振频率为  $\omega_{02} = \frac{1}{\sqrt{(L_1 // L_2)C}} = \sqrt{\frac{L_1 + L_2}{L_1 L_2 C}}$

(b) 串联谐振频率为  $\omega_{01} = \frac{1}{\sqrt{C_2 L}}$

并联谐振频率为  $\omega_{02} = \frac{1}{\sqrt{(C_1 // C_2)L}} = \sqrt{\frac{C_1 + C_2}{C_1 C_2 L}}$

(c)  $\omega_0 = \frac{1}{\sqrt{3LC}}$

(d) 并联谐振频率分别为  $\omega_{01} = \frac{1}{\sqrt{C_1 L_1}}, \omega_{02} = \frac{1}{\sqrt{C_2 L_2}}$

串联谐振频率为  $\omega_{03} = \frac{1}{\sqrt{(C_1 + C_2)(L_1 // L_2)}} = \sqrt{\frac{L_1 + L_2}{L_1 L_2 (C_1 + C_2)}}$

9-39 (1)  $L_2 = 0.004\text{H}$  (2)  $i_{c1}(t) = 10\sqrt{2} \cos(10^3 t + 36.9^\circ) \text{mA}$

9-40  $R_1 = 6\Omega$   $R_2 = 4\Omega$   $X_L = |X_C| = 8\Omega$

9-41 电流表  $A_1$  的示数为 9A

9-42  $X_L = 3\Omega, X_C = -\frac{25}{3}\Omega, R = 10\Omega$

9-43  $R = 4\Omega$   $X_L = 3\Omega$   $X_C = -3\Omega$

9-44  $R = 4.15\Omega$   $L = 40.7\text{mH}$

9-45  $R = 15\Omega$   $X_C = -5\sqrt{3}\Omega$   $X_L = 5\sqrt{3}\Omega$

10-1  $i(t) = 2\sqrt{2} \sin(10^3 t - 53.1^\circ) \text{A}$

10-2  $C = 0.25\mu\text{F}$   $i(t) = 5 \cos 10^3 t \text{A}$

10-3  $i(t) = 2\sqrt{2} \sin(10t - 36.9^\circ) \text{A}$   $P = 160\text{W}$   $Q = 120 \text{var}$

10-4  $M = 20\text{mH}$   $\dot{I}_1 = 66 \angle 0^\circ \text{A}$   $\dot{U}_{L_1} = 4.4 \angle -90^\circ \text{V}$

10-5  $P_s = 360\text{W}$

10-6 使  $\dot{I}_2 = 0$  的频率为  $f_0 = \frac{1}{2\pi\sqrt{MC}}$ ; 使  $\dot{I}_1 = 0$  的频率为  $f_0 = \frac{1}{2\pi\sqrt{L_2 C}}$

10-7 (a) 串联谐振频率为  $\omega_{01} = \frac{1}{\sqrt{(L_2 + M)C}}$   $\omega_{02} = \frac{1}{\sqrt{\frac{L_1 L_2 - M^2}{L_1} C}}$

并联谐振频率为  $\omega_{03} = \frac{1}{\sqrt{(L_1 + L_2 + 2M)C}}$

(b)  $\omega_0 = \frac{1}{\sqrt{\frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M} \cdot C}}$  (c)  $\omega_0 = 2 \times 10^4 \text{rad/s}$

10-8  $L_4 = 0.05\text{H}$   $u_{ab}(t) = 3\sqrt{2} \sin(2 \times 10^3 t + 53.1^\circ) \text{V}$   $P = 0.2\text{W}$

10-9  $P_1 = 1800\text{W}$   $P_2 = 0$   $P_s = -1800\text{W}$

$$10-10 \begin{cases} 2\dot{I}_{m1} + j\dot{I}_{m2} - j2\dot{I}_{m3} = j10 \\ j\dot{I}_{m1} + 2\dot{I}_{m2} - (2-j)\dot{I}_{m3} = 0 \\ -j2\dot{I}_{m1} - (2-j)\dot{I}_{m2} + (4+j2)\dot{I}_{m3} = -10 \end{cases}$$

$$10-11 \quad M = 50mM$$

$$10-12 \quad Z_{ab} = 18\Omega$$

$$10-13 \quad \dot{I}_1 = 2\angle 53.1^\circ \text{ A} \quad \dot{I}_2 = \frac{1}{2}\dot{I}_1 = 1\angle 53.1^\circ \text{ A}$$

$$10-14 \quad P_{40V} = 16W \quad P_{R_L} = 4W$$

$$10-15 \quad n = \frac{1}{\sqrt{5}}$$

$$10-16 \quad \dot{I} = \sqrt{2}\angle 45^\circ \text{ A}$$

$$10-17 \quad P_{R1} = 32W \quad P_{R2} = 16W \quad Q_s = -64 \text{ var}$$

$$10-18 \quad I_C = 5A \quad M = 0.5H$$

$$10-19 \quad Y_a = \frac{1-n}{Z}, \quad Y_b = \frac{n(n-1)}{Z}, \quad Y_c = \frac{n}{Z}$$

$$10-20 \quad Z_L = 20 - j15 \Omega \quad P_{\max} = 45W$$

$$10-21 \quad i(t) = (e^{-t} - e^{-3t})\varepsilon(t) \text{ A}$$

$$11-1 \quad \dot{U}_{AB} = 380\angle 30^\circ \text{ V} \quad \dot{U}_{BC} = 380\angle -90^\circ \text{ V} \quad \dot{U}_{CA} = 380\angle 150^\circ \text{ V}$$

$$11-2 \quad U_{AN} = 190V, \quad U_{AN} = 329V$$

$$11-3 \quad U_{N'N} = 110V$$

$$11-4 \quad (1) \quad I_A = I_B = 4.55A, \quad I_C = 0.91A, \quad I_N = 3.64A \quad (2) \quad \dot{U}_{AN'} = \dot{U}_{BN'} = 192.75V$$

$$U_{CN'} = 300.8V$$

$$11-5 \quad 80.5V$$

$$11-6 \quad I_R = \frac{\sqrt{3}U}{X_L}$$

$$11-8 \quad \dot{I}_{AB'} = \frac{22}{\sqrt{3}}\angle -23.1^\circ \text{ A} \quad \dot{U}_{B'C'} = 297.6\angle -92.9^\circ \text{ V}$$

11-9 Y形负载的相电压为172V、相电流为17.2A； $\Delta$ 形负载的相电压为298V、相电流为9.93A；总的线电流为34.4A。

$$11-10 \quad I_{PY} = I_{IY} = 22A, \quad P_Y = 8.694kW; \quad I_{P\Delta} = 38A, \quad I_{I\Delta} = 65.82A \quad P_{\Delta} = 26kW$$

$$11-11 \quad P = 8712W$$

11-12  $P = 5400\text{W}$

11-13  $P = 29040\text{W}$

11-14 (1)  $U_l = 200\sqrt{3}\text{V}$  (2)  $P = 6000\text{W}$

11-15 (1)  $\dot{I}_A = 20.87\angle -18.4^\circ\text{A}$  ,  $\dot{I}_B = 20.87\angle -138.4^\circ\text{A}$   $\dot{I}_C = 20.87\angle 101.6^\circ\text{A}$

(2)  $U_p = 246.7\text{V}$  ,  $U_l = \sqrt{3}U_p = 427.3\text{V}$  (3)  $P = 14371\text{W}$   $Q = 5661\text{var}$

11-16 (1) 电源线电压的有效值为  $398.4\text{V}$  (2)  $P = 1104\text{W}$   $Q = 828.6\text{var}$

11-17  $P = 1620\text{W}$

11-18  $P_1 = 834.1\text{W}$   $P_2 = 1668.2\text{W}$

11-19 功率表读数的物理意义是对称三相电路无功功率的  $\frac{1}{\sqrt{3}}$  倍。

11-20  $P = 658.2\text{W}$

11-21  $P_1 = 0$   $P_2 = 2166\text{W}$

11-22 (1)  $\text{S}$  断开时  $I_A = I_B = I_C = 2.2\text{A}$  ,

(2)  $\text{S}$  闭合时  $I_A = 3.154^\circ\text{A}$  ,  $I_B = 4.1\text{A}$  ,  $I_C = 2.2\text{A}$

11-23  $L = 110\text{mH}$  ,  $C = 91.9\mu\text{F}$

11-24  $C = 10.876\mu\text{F}$

12-2 (1) 网络  $N$  对基波呈现容性; (2)  $Z_2 = j0.2\Omega$  ; (3)  $P = 10\text{W}$

12-3  $P = 30\text{W}$

12-4  $i(t) = \left[ 5.85\sqrt{2}\cos(\omega t + 79^\circ) + \frac{25}{3}\sqrt{2}\cos 3\omega t \right]\text{A}$ ; 电压表的示数为  $80\text{V}$

电流表的示数为  $10.18\text{A}$

12-5  $i(t) = 5\sqrt{2}\sin \omega t + 6\sqrt{2}\sin(3\omega t + 60^\circ)\text{A}$

12-6  $i(t) = 3 + 2\sqrt{2}\sin(\omega t + 83.1^\circ) + 5\sqrt{2}\sin 3\omega t\text{A}$  ; 源提供的平均功率为  $P = 1230\text{W}$

12-7  $u_R(t) = U_{R0} + u_{R2}(t) = \left[ 150 + 37.5\cos(2\omega_1 - 150^\circ) \right]\text{V}$  ; 电压的有效值为

$U_R = 152.33\text{V}$

12-8 (1)  $i(t) = -1 + \sqrt{2}\cos(t - 23.1^\circ)\text{A}$  , 电流的有效值为  $I = \sqrt{2}\text{A}$  ; (2)  $P = 15\text{W}$

12-9  $i_2(t) = \left[ 2 + 1.92\sin(\omega t - 30.3^\circ) + 9\sin(3\omega t + 60^\circ) \right]\text{A}$

12-10  $i_L(t) = -1 + 1.5\cos(10^4 t + 90^\circ)\text{A}$  ; 两电源发出的功率之和为  $P = 4.5\text{W}$

12-11  $R = 4\Omega$  ,  $L = 2\text{H}$  ,  $C = 0.125\text{F}$

12-12  $L = 10\text{mH}$  ,  $C_2 = 33.3\mu\text{F}$  ,  $R = 10\Omega$  ,  $R_3 = 30\Omega$  ,

$u_{R_3}(t) = 15 + 6\cos(2000t + 45^\circ)$  V

12-13  $L_1 = 1\text{H}$  ,  $L_2 = 0.067\text{H}$

12-14  $L = \frac{1}{9\omega_1^2}$  ,  $C = \frac{1}{49\omega_1^2}$  或  $L = \frac{1}{49\omega_1^2}$  ,  $C = \frac{1}{9\omega_1^2}$

12-15 (1) S 闭合时: 负载端相电压的有效值为  $U_p \approx 76.16\text{V}$

负载端线电压的有效值为  $U_l \approx 122.5\text{V}$

相电流的有效值为  $I_p \approx 7.16\text{A}$

中线电流的有效值为  $I_0 = 3.42\text{A}$

(2) S 打开时: 负载端相电压的有效值为  $U_p \approx 70.7\text{V}$

负载端线电压的有效值为  $U_l \approx 122.5\text{V}$

相电流的有效值为  $I_p \approx 7.07\text{A}$

两中性点间电压的有效值为  $U_{N'N} \approx 28.28\text{V}$

12-16  $I_l = 1.5\text{A}$  ,  $P = 162\text{W}$

13-1  $i = 0.5u - 2.5$  , 电阻元件是非线性电阻元件。

13-2 增量电阻分别为:  $R_d|_{i=1\text{A}} = 3\Omega$  ,  $R_d|_{i=3\text{A}} = 11\Omega$

增量电导分别为:  $G_d|_{u=2\text{V}} = 80\text{S}$  ,  $G_d|_{u=-1\text{V}} = 5\text{S}$

13-3  $u = 2i^2 - 1$

13-4 静态电感为:  $L_s|_{i=2\text{A}} = 4\text{H}$ ; 动态电感为:  $L_d|_{i=2\text{A}} = 12\text{H}$

13-5  $C_d = C_0 \left( 1 - \frac{u}{\Phi_0} \right)^{-\frac{1}{3}}$

13-6 
$$\begin{cases} (R_1 + R_2)i_{m1} - R_2i_{m2} = U_s \\ -R_2i_{m1} + 20i_{m2}^2 = 0 \end{cases}$$

13-7 
$$\begin{cases} (G_1 + G_2)u_{n1} + 5(u_{n1} - u_{n2})^{\frac{1}{2}} - G_2u_{n3} = 0 \\ -5(u_{n1} - u_{n2})^{\frac{1}{2}} + 10(u_{n2} - u_{n3})^{\frac{1}{2}} + 15u_{n2}^{\frac{2}{5}} = 0 \\ -G_2u_{n1} + G_2u_{n3} - 10(u_{n2} - u_{n3})^{\frac{1}{2}} = i_s \end{cases}$$

13-9 当  $I_s = 6\text{mA}$  时,  $I_d = 0$ ; 当  $I_s = -6\text{mA}$  时,  $I_d = 2.5\text{mA}$

13-10  $u = 1\text{V}$

13-11 (2)  $i = 3\text{A}$  ,  $u = 9\text{V}$ ; (3)  $I_0 = 2\text{A}$

13-12  $P = 1.125\text{W}$

$$13-14 \quad i(t) = 4 + \frac{1}{9} \sin t \quad \text{A}$$

$$13-15 \quad u(t) = 2 + 0.4 \times 10^{-3} \cos \omega t \text{V}$$

$$13-16 \quad (2) \quad \begin{cases} i = 2\text{A} \\ u = i^2 = 4\text{V} \end{cases}, \quad (3) \quad u(t) = 4 + 0.08 \sin t \text{V}$$

$$13-17 \quad i = 0.8\text{A}$$

$$13-19 \quad u_C(t) = \left[ -\frac{b}{a} + \frac{a + bU_0}{aU_0} e^{\frac{a}{C}t} \right]^{-1}$$

$$13-20 \quad \left. \begin{aligned} u(t) &= e^{-\frac{t-t_a}{4}} \text{V} \\ i(t) &= -C \frac{du}{dt} = 0.5 e^{-\frac{t-t_a}{4}} \text{A} \end{aligned} \right\} (t > t_a)$$

$$14-1 \quad (1) \quad F(s) = \frac{2}{s(s+2)}, \quad (2) \quad F(s) = \frac{3+2s}{s^2+1}, \quad (3) \quad F(s) = \frac{s-2}{\sqrt{2}(s^2+4)}, \quad (4)$$

$$F(s) = \frac{2s^2 + 8s + 9}{s^3 + 6s^2 + 13s + 10}$$

$$(5) \quad F(s) = \frac{1}{s+1} (1 + e^{-s}) + e^{-2s}$$

$$14-2 \quad (1) \quad f(t) = 5e^{-3t} - 3e^{-2t} \quad (t > 0), \quad (2) \quad f(t) = \delta'(t) + 2\delta(t) + (2e^{-t} - e^{-2t})\varepsilon(t)$$

$$(3) \quad f(t) = (e^{-t} - te^{-2t} - e^{-2t})\varepsilon(t), \quad (4) \quad f(t) = (1 + 2e^{-2t} \sin t)\varepsilon(t)$$

$$(5) \quad f(t) = (e^{-t} - e^{-2t})\varepsilon(t) + [e^{-(t-1)} - e^{-2(t-1)}]\varepsilon(t-1) + [e^{-(t-2)} - e^{-2(t-2)}]\varepsilon(t-2)$$

$$14-5 \quad i_L(t) = (1.25e^{-2t} - 0.25e^{10t})\varepsilon(t) \text{A}$$

$$14-6 \quad u_C(t) = 10 - \frac{32}{3}e^{-0.5t} + \frac{2}{3}e^{-2t} \text{V} \quad (t \geq 0)$$

$$14-7 \quad u(t) = \frac{2}{3}(1 - e^{-3t})\varepsilon(t)$$

$$14-8 \quad i(t) = (0.5 - 0.1e^{-2t} - 0.4e^{-\frac{t}{3}})\varepsilon(t) \text{A}$$

$$14-9 \quad i(t) = (3 - 5e^{-t} + 8e^{-2.5t})\varepsilon(t) \text{A}$$

$$14-10 \quad i_2(t) = (e^{-0.5t} - e^{-2.5t})\varepsilon(t) \text{A}$$

$$14-11 \quad u_C(t) = (6 - 3.75e^{-t} + 7.75e^{-5t})\varepsilon(t) \text{V}$$

$$14-12 \quad i(t) = 10(t-1)e^{-5t} + 10e^{-6t} \quad (\text{A}) \quad t > 0$$

$$14-13 \quad u_C(t) = 10e^{-t} \cos(3t + 53.1^\circ) \quad \text{V} \quad (t \geq 0)$$

$$14-14 \quad i_R(t) = (1 - 2e^{-t} \sin t)\varepsilon(t) \text{A}$$

$$14-15 \quad u_k(t) = 3\delta(t) + 6\cos t \varepsilon(t) \text{V}$$

$$14-16 \quad i_L(t) = 2(1 - e^{-t})\varepsilon(t) - 2[1 - e^{-(t-2)}]\varepsilon(t-2)$$

$$14-17 \quad H(s) = \frac{1}{s^2 + 2s + 2}$$

14-18  $H(s) = \frac{3s+4}{(s+1)(s+2)}$

14-19 (1)  $H(s) = \frac{3s+4}{(s+1)(s+2)}$ , (2)  $s(t) = (2 - e^{-t} - e^{-2t})\varepsilon(t)$

14-20  $y_{zs}(t) = (e^{-2t} - e^{-3t})\varepsilon(t)$

14-21  $u_0(t) = (4e^{-5t} - 3e^{-10t})\varepsilon(t) \text{ V}$

14-22  $u'(t) = 2(e^{-0.5t} - e^{-2t})\varepsilon(t) \text{ V}$

14-23  $u(t) = 4e^{-6t}\varepsilon(t) \text{ V}$

14-24  $u(t) = 109.68\sqrt{2}\cos(10t - 27.89^\circ) \text{ V}$

14-25 (1)  $u_0(t) = 2\cos(\sqrt{2}t + 90^\circ) \text{ V}$ , (2)  $h(t) = (3e^{-3t} - 2e^{-2t})\varepsilon(t)$

15-1 (1) (a) 关联矩阵  $\mathbf{A}$  为

$$\mathbf{A} = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 & 1 \\ 0 & -1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & -1 \end{bmatrix}$$

(b) 关联矩阵  $\mathbf{A}$  为

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & -1 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 0 & -1 & 0 & -1 & 0 & 0 & 0 & -1 & 0 \\ -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & -1 \end{bmatrix}$$

15-2 (a)  $\mathbf{B}_f = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 1 & 1 & 0 \\ 0 & -1 & -1 & 0 & 1 & 1 \end{bmatrix}$ ,  $\mathbf{Q}_f = \begin{bmatrix} -1 & 1 & 0 & 0 & 0 & 1 \\ -1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & -1 & 1 & -1 \end{bmatrix}$

(b)  $\mathbf{B}_f = \begin{bmatrix} 1 & 1 & 1 & -1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & 0 & 1 & -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & -1 & 0 \\ -1 & -1 & 0 & 0 & -1 & 0 & 0 & 1 & 1 \end{bmatrix}$ ,  $\mathbf{Q}_f = \begin{bmatrix} 1 & 0 & -1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & -1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & -1 \end{bmatrix}$

15-3 (1) 支路导纳矩阵为

$$\mathbf{Y}_b = \text{diag} \left[ j\omega C_1, \frac{1}{R_2}, \frac{1}{R_3}, \frac{1}{R_4}, \frac{1}{R_5}, \frac{1}{j\omega L_6} \right]$$

(2) 支路阻抗矩阵为

$$\mathbf{Z}_b = \text{diag} \left[ \frac{1}{j\omega C_1}, R_2, R_3, R_4, R_5, j\omega L_6 \right]$$

(3) 支路电压源列向量和支路电流源列向量分别为

$$\dot{\mathbf{U}}_s = [-\dot{U}_{s1}, \dot{U}_{s2}, 0, 0, 0, 0]^T, \quad \dot{\mathbf{I}}_s = [0, -i_{s2}, 0, 0, 0, 0]^T$$

15-4 关联矩阵为

$$\mathbf{A} = [1 \ 1 \ 1]$$

支路阻抗矩阵和支路导纳矩阵分别为

$$\mathbf{Z}_b = \text{diag}[s \ 2/s \ 1], \quad \mathbf{Y}_b = \text{diag}[1/s \ 0.5s \ 1]$$

支路电压源列向量和支路电流源列向量分别为

$$15-5 \quad \mathbf{U}_s(s) = \begin{bmatrix} -\frac{s+1}{s} & 0 & 0 \end{bmatrix}^T, \quad \mathbf{I}_s(s) = \begin{bmatrix} 0 & 0.5 & -\frac{1}{s} \end{bmatrix}^T$$

$$\mathbf{A} = \begin{bmatrix} 1 & -1 & 0 & 0 & 0 \\ 0 & 1 & -1 & 1 & 0 \\ 0 & 0 & 0 & -1 & -1 \end{bmatrix}, \quad \mathbf{B}_f = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & -1 & -1 & 1 \end{bmatrix}, \quad \mathbf{Q}_f = \begin{bmatrix} 1 & -1 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\mathbf{U}_s = [0 \ 10 \ -5 \ 0 \ 0]^T, \quad \mathbf{I}_s = [10 \ 0 \ -3 \ 0 \ 0]^T$$

$$\mathbf{R}_b = \begin{bmatrix} 10 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 4 & 0 \\ 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 \\ 50 & 0 & 0 & 0 & 1 \end{bmatrix} \Omega, \quad \mathbf{G}_b = \begin{bmatrix} 0.1 & 0 & 0 & 0 & 0 \\ 0 & 0.5 & 0 & -0.4 & 0 \\ 0 & 0 & 0.5 & 0 & 0 \\ 0 & 0 & 0 & 0.2 & 0 \\ -5 & 0 & 0 & 0 & 1 \end{bmatrix} \text{S}$$

15-6

$$\mathbf{Z}_b = \begin{bmatrix} \frac{1}{G_1} & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{G_2} & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{G_3} & 0 & 0 & \frac{g}{j\omega C_6 G_3} \\ 0 & 0 & 0 & j\omega L_4 & j\omega M & 0 \\ 0 & 0 & 0 & j\omega M & j\omega L_5 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{j\omega C_6} \end{bmatrix}$$

$$\mathbf{Y}_b = \begin{bmatrix} G_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & G_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & G_3 & 0 & 0 & -g \\ 0 & 0 & 0 & \frac{L_5}{\Delta} & -\frac{M}{\Delta} & 0 \\ 0 & 0 & 0 & -\frac{M}{\Delta} & \frac{L_4}{\Delta} & 0 \\ 0 & 0 & 0 & 0 & 0 & j\omega C_6 \end{bmatrix}$$

$$\dot{\mathbf{U}}_s = [-\dot{U}_s \ 0 \ 0 \ 0 \ 0 \ 0]^T, \quad \dot{\mathbf{I}}_s = [0 \ 0 \ 0 \ 0 \ 0 \ 0]^T$$

$$15-7 \quad \begin{bmatrix} \frac{1}{R_1} + \frac{1}{R_2} + j\omega C & -j\omega C & -\frac{1}{R_2} \\ -j\omega C & \frac{1}{R_3} + j\omega C + \frac{1}{j\omega L} & -\frac{1}{j\omega L} \\ -\frac{1}{R_2} & -\frac{1}{j\omega L} & \frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{j\omega L} \end{bmatrix} \begin{bmatrix} \dot{U}_{n1} \\ \dot{U}_{n2} \\ \dot{U}_{n3} \end{bmatrix} = \begin{bmatrix} -\dot{I}_{s1} + \frac{\dot{U}_{s2}}{R_2} \\ 0 \\ -\frac{\dot{U}_{s2}}{R_2} + \frac{\dot{U}_{s4}}{R_4} \end{bmatrix}$$

15-8

$$\begin{bmatrix} 2 & -0.5 & 0.5 \\ -0.5 & \frac{11}{6} & 1 \\ 0.5 & 1 & 2.5 \end{bmatrix} \begin{bmatrix} I_{t1} \\ I_{t2} \\ I_{t3} \end{bmatrix} = \begin{bmatrix} -1 \\ \frac{1}{3} \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 6 & 1 & -3 \\ 1 & 4 & 1 \\ -3 & 1 & 5 \end{bmatrix} \begin{bmatrix} U_{t1} \\ U_{t2} \\ U_{t3} \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ -1 \end{bmatrix}$$