4.7.5 $\quad L_1 \dfrac{di_1}{dt} + \dfrac{1}{C_2}\int(i_1 - i_2)dt + R(i_1 - i_2)$

$$+ \dfrac{1}{C_1}\int i_1 dt = 0$$

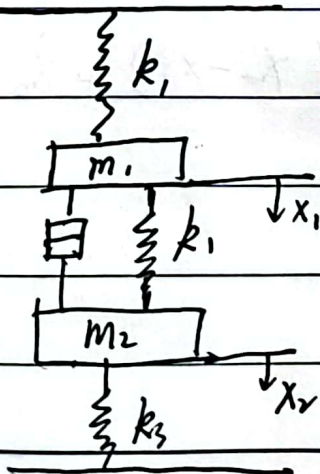$$L_2 \dfrac{di_2}{dt} + \dfrac{1}{C_3}\int i_2 dt + R(i_2 - i_1) + \dfrac{1}{C_2}\int(i_2 - i_1)dt$$
$$= 0$$

$\Rightarrow$ 令 $\dot{q}_1 = i_1$, $\dot{q}_2 = i_2$

$\Rightarrow \begin{cases} L_1 \ddot{q}_1 + \dfrac{1}{C_2}(q_1 - q_2) + R(\dot{q}_1 - \dot{q}_2) + \dfrac{1}{C_1}\cdot q_1 = 0 \\[4mm] L_2 \ddot{q}_2 + \dfrac{1}{C_2}(q_2 - q_1) + R(\dot{q}_2 - \dot{q}_1) + \dfrac{1}{C_3} q_2 = 0 \end{cases}$

$\Rightarrow$ 机械系统运动方程.

$\begin{cases} m_1 \ddot{x}_1 + k_2(x_1 - x_2) + b(\dot{x}_1 - \dot{x}_2) + k_1\cdot x_1 = 0 \\[2mm] m_2 \ddot{x}_2 + k_2(x_2 - x_1) + b(\dot{x}_2 - \dot{x}_1) + k_3 \cdot x_2 = 0 \end{cases}$

$k_1$

$m_1$ $\quad \downarrow x_1$

$k_1$

$m_2$

$\quad \downarrow x_2$

$k_3$

## 4.7.6

电系统:
$$e_0 = \frac{1}{c_1} \int i \cdot dt \quad \Rightarrow \dot{e}_0 = \frac{1}{c_1} \cdot i$$

$$\frac{e_1 - e_0}{R_2} + C \cdot \frac{d(e_1 - e_0)}{dt} = i$$

$$\Rightarrow \frac{e_1 - e_0}{R_2} + C\left(\frac{de_1}{dt} - \frac{de_0}{dt}\right) = \dot{e}_0 \cdot C_1$$

$$\Rightarrow \frac{1}{R_2}(e_1 - e_0) + C\dot{e}_1 - C\dot{e}_0 - C_1 \cdot \dot{e}_0 = 0 \quad ①$$

力系统:
$$b_2(\dot{x}_0 - \dot{y}) + k_1(x_0 - x_1) = 0$$
$$b_2(\dot{y} - \dot{x}_0) + ky = 0$$

$$\begin{cases} b_2(\ddot{x}_0 - \ddot{y}) + k_1(\dot{x}_0 - \dot{x}_1) = 0 \\ b_2(\ddot{y} - \ddot{x}_0) + k\dot{y} = 0 \end{cases}$$

$$\Rightarrow k_1(\dot{x}_0 - \dot{x}_1) + k_2\left(\frac{k_1}{b_2}(x_0 - x_1) + \dot{x}_0\right) = 0 \quad ②$$

由①.②得为 相似系统

$$K_1 \left( X_0(s) - X_1(s) \right) \cdot S + K_2 \left( \frac{k_1}{b_1} (X_0(s) - X_1(s)) + S \cdot X_0(s) \right)$$

$$= 0$$

$$\Rightarrow \frac{X_0(s)}{X_1(s)} = \frac{b_2 K_1 s + k_1 k_2}{k_1 b_2 S + k_1 k_2 + k_2 b_2 S}$$

## 5.9.1

$$C_T = \frac{n_p N_a}{2\pi a} = \frac{2 \times 468}{2\pi \times 1} = 149$$

$$C_E = \frac{C_T}{9.55} = 15.6$$

$$E_a = C_E \Phi \cdot n = 15.6 \times 1.03 \times 10^{-2} \times 1500$$
$$= 241 \, (V)$$

$$I_N = \frac{P_N}{U_N} = 74A.$$

## 5.9.3

(1) $\quad I_f = \frac{110}{220} = 0.5A$

$$I_{aN} = I_N - I_f = 70 - 0.5 = 69.5(A)$$

$$E_{aN} = U_N - I_{aN} \times R_a$$
$$= 110 - 69.5 \times 0.08 = 104.44(V)$$

(2) $P_{eN} = U_N I_N - I_{aN}^2 \times R_a - I_f^2 \times R_f$

$$= 110 \times 70 - 69.5 \times 69.5 \times 0.08 - 0.5 \times 0.5 \times 220$$
$$= 7258 \, (W)$$

$$T_{eN} = 9.55 \, C_E \Phi_N I_a$$

$$= 9.55 \times \frac{U_N - I_a \cdot R_a}{n_N} \times I_a$$

$$= 9.55 \times \frac{110 - 69.5 \times 0.08}{1440} \times 69.5$$

$$= 48 \quad (N \cdot m)$$

$$\eta = \frac{R}{U_N \times I_N} \times 100\% = 78\%$$

5.9.5. (1) $$T_{oN} = 9.55 \times \frac{P_o}{n_N}$$

$$= 9.55 \times \frac{395}{1000} = 3.77 \, (N \cdot m)$$

(2) $$T_{eN} = 9.55 \times \frac{P_N + P_o}{n_N}$$

$$= 9.55 \times \frac{6 \times 10^3 + 395}{1000}$$

$$= 61 \quad (N \cdot m)$$

13) $P_{eN} = P_0 + P_N = 6395 (w)$

14) $\eta_N = \dfrac{P_N}{P_{eN} + P_{cua} + P_{anf}} \times 100\%$

$= 85.78\%$

6.7.1

$$C_1 \, dH_1 = (Q - Q_1) \, dt$$

$$Q = 0$$

$$C_2 \, dH_2 = (Q_1 - Q_2) \, dt$$

其中 $Q_1 = \dfrac{H_1 - H_2}{R_1}$

$$Q_2 = \dfrac{H_2 - 0}{R_2} = \dfrac{H_2}{R_2}$$

$\Rightarrow$
$$\begin{cases} C_1 \cdot \dfrac{dH_1}{dt} = -Q_1 = \dfrac{H_2 - H_1}{R_1} \\ \\ C_2 \dfrac{dH_2}{dt} = \dfrac{H_1 - H_2}{R_1} - \dfrac{H_2}{R_2} \end{cases}$$

**6.7.2**  $C_1 \dfrac{dh_1}{dt} = q - q_1$

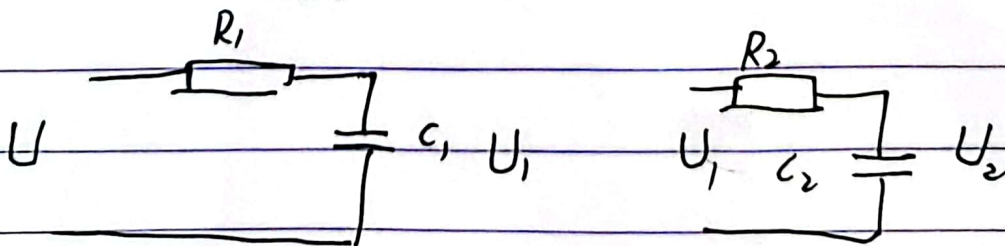其中  $R_1 = \dfrac{h_1 - 0}{q_1}$ ,  $\Rightarrow q_1 = \dfrac{h_1}{R_1}$

$C_2 \dfrac{dh_2}{dt} = q_1 - q_2$

其中  $R_2 = \dfrac{h_2 - 0}{q_2}$ ,  $q_2 = \dfrac{h_2}{R_2}$

$\Rightarrow \begin{cases} C_1 \dfrac{dh_1}{dt} = q - \dfrac{h_1}{R_1} \\ C_2 \dfrac{dh_2}{dt} = \dfrac{h_1}{R_1} - \dfrac{h_2}{R_2} \end{cases} \Rightarrow \begin{cases} C_1 R_1 \dfrac{dq_1}{dt} + q_1 = q \\ C_2 R_2 \dfrac{dq_2}{dt} + q_2 = q_1 \end{cases}$

**6.7.3**  $\begin{cases} C_1 \dfrac{dh_1}{dt} + \dfrac{h_1}{R_1} = q \\ C_2 \dfrac{dh_2}{dt} + \dfrac{h_2}{R_2} = \dfrac{h_1}{R_1} \end{cases} \Rightarrow \begin{cases} C_1 R \dfrac{dq_1}{dt} + q_1 = q \\ C_2 R_2 \dfrac{dq_2}{dt} + q_2 = q_1 \end{cases}$

$\Rightarrow \begin{cases} C_1 R_1 \dfrac{dU_1}{dt} + U_1 = U \\ C_2 R_2 \dfrac{dU_2}{dt} + U_2 = U_1 \end{cases}$

6.7.4  $C_1 \dfrac{dh_1}{dt} = q - q_1$

其中 $R_1 = \dfrac{h_1 - h_2}{q_1}$ $\Rightarrow q_1 = \dfrac{h_1 - h_2}{R_1}$ $\Rightarrow h_1 - h_2 = q_1 \cdot R_1$

$$\Rightarrow \dfrac{dh_1}{dt} - \dfrac{dh_2}{dt} = R_1 \cdot \dfrac{dq_1}{dt}$$

$C_2 \dfrac{dh_2}{dt} = q_1 - q_2$

其中 $R_2 = \dfrac{h_2}{q_2}$ $\Rightarrow q_2 = \dfrac{h_2}{R_2}$ , $\dfrac{dh_2}{dt} = R_2 \dfrac{dq_2}{dt}$

$$\Rightarrow \begin{cases} C_1 \dfrac{dh_1}{dt} = q - \dfrac{h_1 - h_2}{R_1} \\ C_2 \dfrac{dh_2}{dt} = \dfrac{h_1 - h_2}{R_1} - \dfrac{h_2}{R_2} \end{cases}$$

$$\begin{cases} C_1 \dfrac{dh_1}{dt} + \dfrac{h_1 - h_2}{R_1} = q \\ C_2 \dfrac{dh_2}{dt} + \dfrac{h_1 - h_2}{R_1} + \dfrac{h_2}{R_2} = 0 \end{cases} \Rightarrow \begin{cases} C_1 \left( R_2 \dfrac{dq_2}{dt} + R_1 \dfrac{dq_1}{dt} \right) + q_1 = q \\ C_2 R_2 \dfrac{dq_2}{dt} + q_2 + q_1 = 0 \end{cases}$$

$$\Rightarrow R_1 R_2 C_1 C_2 \dfrac{d^2 q_2}{dt^2} + (R_1 C_1 + R_2 C_2 + R_2 C_1) \dfrac{dq_2}{dt} + q_2 = q$$

$$\Rightarrow R_1 R_2 C_1 C_2 \dfrac{d^2 \ell_2}{dt^2} + (R_1 C_1 + R_2 C_2 + R_2 C_1) \dfrac{d\ell_2}{dt} + \ell_2 = q$$