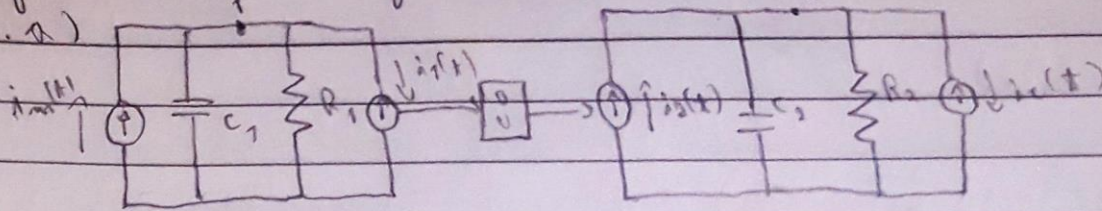


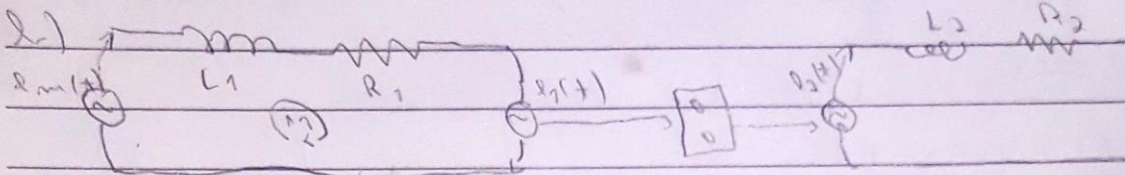
1. a)



$$1: V_1(C_1 D + \frac{1}{R_1}) = i_m - i_1 \Rightarrow J_1 \ddot{\theta}_1 + D_1 \dot{\theta}_1 = T_m - T_1$$

$$2: V_2(C_2 D + \frac{1}{R_2}) = i_2 - i_1 \Rightarrow J_2 \ddot{\theta}_2 + D_2 \dot{\theta}_2 = T_2 - T_1$$

$$i_2 = m \cdot i_1 \Rightarrow \dot{\theta}_2 = \frac{D_1}{m} \dot{\theta}_1$$

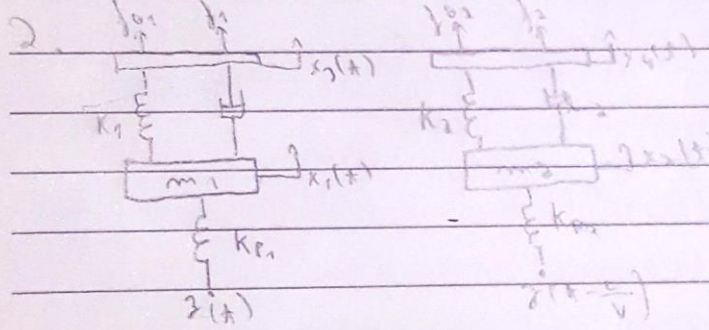


$$i_m(t) = i_1(L_1 + R_1) + v_1(t) \Rightarrow J_1 \ddot{\theta}_1 + D_1 \dot{\theta}_1 = T_m - T_1$$

$$v_2(t) = m v_1(t)$$

$$v_2(t) = i_2(L_2 + R_2) + v_1(t) \Rightarrow J_2 \ddot{\theta}_2 + D_2 \dot{\theta}_2 = T_2 - T_1$$

$$\dot{\theta}_2 = \frac{D_1}{D_2} \dot{\theta}_1$$

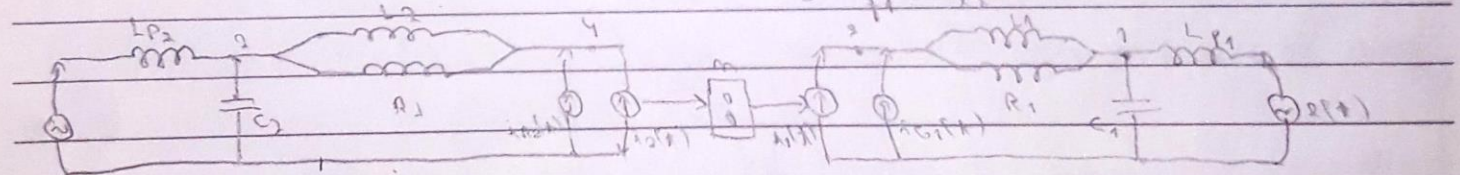


$$f_1(t) = k_1(x_2 - x_1) + b_1(\dot{x}_2 - \dot{x}_1)$$
  

$$f_2(t) = k_2(x_1 - x_0) + b_2(\dot{x}_1 - \dot{x}_0)$$
  

$$f_3(t) = k_3(x_2 - x_0) + b_3(\dot{x}_2 - \dot{x}_0)$$
  

$$P_1 = P_2 \Rightarrow \frac{D_1}{J_1} = \frac{D_2}{J_2} = m$$



$$V_1(C_1 D + \frac{1}{R_1} + \frac{1}{L_1 D} + \frac{1}{L_2 D}) - v(t) \frac{1}{L_1 D} - V_2(\frac{1}{R_2} + \frac{1}{L_2 D}) = 0$$

$$V_2(C_2 D + \frac{1}{L_2 D} + \frac{1}{L_1 D}) - v(t - \alpha) \frac{1}{L_2 D} - V_1(\frac{1}{R_1} + \frac{1}{L_1 D}) = 0$$

$$V_2(\frac{1}{R_1} + \frac{1}{L_1 D}) = i_1(t) + i_{C1}(t) \quad V_2(C_1 D + \frac{1}{R_1} + \frac{1}{L_1 D} + \frac{1}{L_2 D}) = v(t) \frac{1}{L_2 D} + i_1(t) + i_{C1}(t)$$

$$V_1(\frac{1}{R_2} + \frac{1}{L_2 D}) = -i_2(t) + i_{C2}(t) \quad V_2(C_2 D + \frac{1}{R_2} + \frac{1}{L_2 D} + \frac{1}{L_1 D}) = v(t - \alpha) \frac{1}{L_1 D} - i_2(t) + i_{C2}(t)$$

$$\Rightarrow m_1 \ddot{x}_1 + b_1 \dot{x}_1 + (k_1 + k_2)x_1 = k_2 z(t) + f_1(t) + f_{C1}(t) \Rightarrow f_1 + f_{C1} - f_2 + f_{C2} = M \ddot{x}_1$$

$$\Rightarrow m_2 \ddot{x}_2 + b_2 \dot{x}_2 + (k_3 + k_2)x_2 = k_2 z(t - \alpha) - f_1(t) + f_{C1}(t) + f_{C2}(t) + f_2(t) = M \ddot{x}_2$$

$$3. J_1 \dot{\omega}_1 + D_1 \omega_1 + T_1 = T_m \quad ; \quad J_2 \dot{\omega}_2 + D_2 \omega_2 + T_2 = T_1 \Rightarrow T_1 \omega_1 = T_2 \omega_2$$

$$J_2 \dot{\omega}_2 + D_2 \omega_2 + T_2 = m T_1 \quad ; \quad T_1 = T_m - J_1 \dot{\omega}_1 - D_1 \omega_1 \quad ; \quad L_1 T_2 = \frac{T_1 \omega_1}{\omega_2} = m T_1$$

$$\Rightarrow D_2 \omega_2 + D_2 \omega_2 + T_2 = m(T_m - J_1 \dot{\omega}_1 - D_1 \omega_1)$$

$$\omega_1 = m \omega_2 \quad ; \quad \dot{\omega}_1 = m \dot{\omega}_2 \quad ; \quad J_2 \dot{\omega}_2 + D_2 \omega_2 + T_2 = m(T_m - J_1 m \dot{\omega}_2 - D_1 \omega_2 m)$$

$$\omega_2 (J_1 m^2 + J_2) + \omega_2 (D_1 m^2 + D_2) + T_2 = T_m \cdot m$$