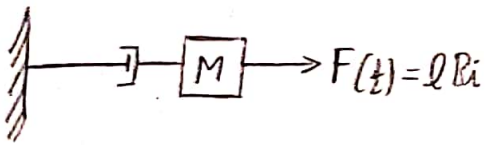
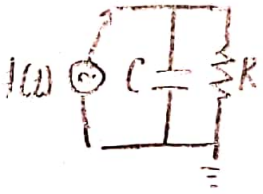
1) Sistema mecânico do alto falante:



analogia tipo ≡

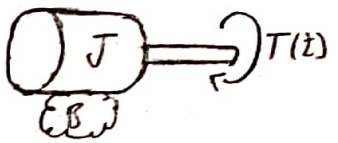


$i(t) = V(CD + \frac{1}{R})$

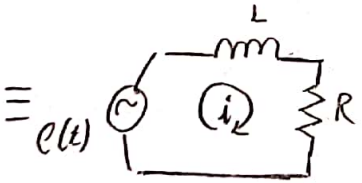
$F(t) = \dot{x}(MD + b)$

$\ell Bi = \dot{x}M + \dot{x}b$

2) a)



≡



$e(t) = (LD + R)i \Rightarrow T(t) = \dot{\theta}(JD + B) = J\ddot{\theta} + B\dot{\theta}$

$K i_a(t) = J\ddot{\theta} + B\dot{\theta}$

Lagrange

$T = \frac{J\dot{\theta}^2}{2} + \frac{La\dot{q}a^2}{2} \quad V = 0 \quad R = \frac{B\dot{\theta}^2}{2} + \frac{Ra\,\dot{q}a^2}{2}$

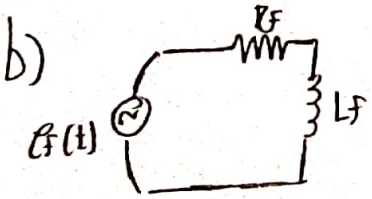
$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}}\right) = J\ddot{\theta} \quad \frac{\partial L}{\partial \theta} = 0 \quad \frac{\partial R}{\partial \dot{\theta}} = B\dot{\theta}$

$J\ddot{\theta} + B\dot{\theta} = K\dot{q}a$

$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}a}\right) = La\ddot{q}a \quad \frac{\partial L}{\partial qa} = 0 \quad \frac{\partial R}{\partial \dot{q}a} = Ra\dot{q}a$

$La\ddot{q}a + Ra\dot{q}a = -K_b(t)\,\dot{\theta}(t)$

b)



Lagrange $\quad T = \frac{J\dot{\theta}^2}{2} + \frac{Lp\,\dot{q}p^2}{2} \quad V = 0 \quad R = \frac{B\dot{\theta}^2}{2} + \frac{Rp\,\dot{q}p^2}{2}$

$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}}\right) = J\ddot{\theta} \quad \frac{\partial L}{\partial \theta} = 0 \quad \frac{\partial R}{\partial \dot{\theta}} = B\dot{\theta} \quad J\ddot{\theta} + B\dot{\theta} = K\dot{q}p$

$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}p}\right) = Lp\ddot{q}p \quad \frac{\partial L}{\partial qp} = 0 \quad \frac{\partial R}{\partial \dot{q}p} = Rp\,\dot{q}p \quad Lp\ddot{q}p + Rp\,\dot{q}p = ep(t)$