$$\frac{di_a}{dt} = -\frac{R_a}{L_a} i_a - \frac{r_2}{r_1 r_3} \frac{K_b}{L_a} v + \frac{K_b}{L_a} e_{in}$$

$$\frac{dx}{dt} = v$$

$$\frac{dv}{dt} = \left(\frac{r_2}{r_1 r_3} K_t i_a - kx - cv \right) \left(m + \frac{r_2^2}{r_1^2 r_3^2} J_1 + \frac{1}{r_3^2} J_2 \right)^{-1}$$