$I\dot{\omega} = T_M - T_L$

$v = Ri + L\frac{\partial i}{\partial t} + \frac{\omega}{K_V} \qquad \rightarrow \qquad i = \frac{1}{R}\left(v - L\frac{\partial i}{\partial t} - \frac{\omega}{K_V}\right)$

$T_M = \frac{(i - i_0)}{K_Q}$

$I\dot{\omega} = \frac{(i - i_0)}{K_Q} - T_L$

$= (i - i_0)\frac{1}{K_Q} - T_L$

$= \left[\frac{1}{R}\left(v - L\frac{\partial i}{\partial t} - \frac{\omega}{K_V}\right) - i_0\right]\frac{1}{K_Q} - T_L$

$= \left[\frac{1}{R}\left(v - \frac{\omega}{K_V}\right) - i_0\right]\frac{1}{K_Q} - T_L$

Linearization:

$\Delta\dot{\omega} = \left[-\frac{1}{RK_V K_Q I} - \frac{2b_{D_1}\omega_0}{I} - \frac{2b_{D_2}\omega_0\alpha_0^2}{I} - \frac{b_{D_3}\alpha_0}{I}\right]\Delta\omega + \begin{bmatrix} \frac{1}{RK_Q I} & \frac{-2b_{D_2}\omega_0^2\alpha_0}{I} - \frac{-b_{D_3}\omega_0}{I} \end{bmatrix}\begin{bmatrix} \Delta v \\ \Delta\alpha \end{bmatrix}$

$\Delta L = \left[2b_L\omega_0\alpha_0\right]\Delta\omega + \begin{bmatrix} 0 & b_L\omega_0^2 \end{bmatrix}\begin{bmatrix} \Delta v \\ \Delta\alpha \end{bmatrix}$