SALIENT POLE SYNCHRONOUS MACHINE INDUCTANCES

\[ L_{xy}(\theta_r) = \mu_0 r \, l_{eff} \int_0^{2\pi} N_x(\alpha) N_y(\alpha) h(\alpha, \theta_r) \, d\alpha + \sigma_{xy} L_{lxx} \]

where

\[ \sigma_{xy} = \begin{cases} 0 & \text{if } x \neq y \\ 1 & \text{if } x = y \end{cases} \]

\[ N_x(\alpha) = \frac{N_x}{2} \cos(\alpha - \gamma_x) \]

\[ N_y(\alpha) = \frac{N_y}{2} \cos(\alpha - \gamma_y) \]

\[ h(\alpha, \theta_r) = h + \Delta h \cos(2\alpha - 2\theta_r) \]

\[ L_{xy}(\theta_r) = khN_xN_y \cos(\gamma_y - \gamma_x) + \frac{k \Delta h}{2} N_xN_y \cos(2\theta_r - \gamma_y - \gamma_x) + \sigma_{xy} L_{lxx} \]

\[ k = \frac{\mu_0 \, r \, l_{eff} \, \pi}{4} \]

\[ L_{ss} \equiv hkN_{se}^2 = \frac{h \mu_0 \, r \, l_{eff} \, \pi N_{se}^2}{4} \]

\[ L_{\Delta} \equiv \frac{\Delta h}{2} k N_{se}^2 = \frac{\Delta h \mu_0 \, r \, l_{eff} \, \pi N_{se}^2}{8} \]

\[ L_{sf} \equiv \left( h + \frac{\Delta h}{2} \right) k N_{se}N_{fe} = \left( h + \frac{\Delta h}{2} \right) \frac{\mu_0 \, r \, l_{eff} \, \pi N_{se}N_{fe}}{4} \]

\[ L_m \equiv \frac{3}{2} L_{ss} \]
\[ N_a(\alpha) = \frac{N_{se}}{2} \cos(\alpha), \quad N_b(\alpha) = \frac{N_{se}}{2} \cos(\alpha - \frac{2\pi}{3}), \quad N_c(\alpha) = \frac{N_{se}}{2} \cos(\alpha + \frac{2\pi}{3}) \]

\[ N_a = N_{se}, \quad \gamma_a = 0 \quad N_b = N_{se}, \quad \gamma_b = \frac{2\pi}{3} \quad N_c = N_{se}, \quad \gamma_c = -\frac{2\pi}{3} \]

\[ N_f(\alpha) = \frac{N_{fe}}{2} \cos(\alpha - \theta_r) \quad N_f = N_{fe}, \quad \gamma_f = \theta_r \]

\[ L_{aa}(\theta_r) = (L_{ss} + L_{ls}) + L_\Delta \cos(2\theta_r) \]

\[ L_{bb}(\theta_r) = (L_{ss} + L_{ls}) + L_\Delta \cos(2(\theta_r - 2\pi/3)) = (L_{ss} + L_{ls}) + L_\Delta \cos(2\theta_r + 2\pi/3) \]

\[ L_{cc}(\theta_r) = (L_{ss} + L_{ls}) + L_\Delta \cos(2(\theta_r + 2\pi/3)) = (L_{ss} + L_{ls}) + L_\Delta \cos(2\theta_r - 2\pi/3) \]

\[ L_{ab}(\theta_r) = L_{ba}(\theta_r) = -\frac{L_{ss}}{2} + L_\Delta \cos(2\theta_r - \pi/3) = -\frac{L_{ss}}{2} + L_\Delta \cos(2\theta_r - 2\pi/3) \]

\[ L_{ac}(\theta_r) = L_{ca}(\theta_r) = -\frac{L_{ss}}{2} + L_\Delta \cos(2\theta_r + \pi/3) = -\frac{L_{ss}}{2} + L_\Delta \cos(2\theta_r + 2\pi/3) \]

\[ L_{bc}(\theta_r) = L_{cb}(\theta_r) = -\frac{L_{ss}}{2} + L_\Delta \cos(2\theta_r) \]

\[ L_{af}(\theta_r) = L_{fa}(\theta_r) = \frac{L_{sf}}{2} \cos(\theta_r) \]

\[ L_{bf}(\theta_r) = L_{fb}(\theta_r) = \frac{L_{sf}}{2} \cos(\theta_r - 2\pi/3) \]

\[ L_{cf}(\theta_r) = L_{fc}(\theta_r) = \frac{L_{sf}}{2} \cos(\theta_r + 2\pi/3) \]

\[ L_{ff}(\theta_r) = k(h + \frac{\Delta h}{2})N_{fe}^2 + L_{lf} \]