3-2 $\quad \bar{V}_{abs} = p\bar{\lambda}_{abs}$

where $\quad \bar{V}_{abs} = [v_{as}\ v_{bs}]^T$, $\bar{\lambda}_{abs} = [\lambda_{as}\ \lambda_{bs}]^T$

$$\bar{V}_{qds} = \bar{K}_{2s}\bar{V}_{abs} = \bar{K}_{2s}\, p\bar{\lambda}_{abs} = \bar{K}_{2s}\, p\left[(\bar{K}_{2s})^{-1}\bar{\lambda}_{qds}\right]$$

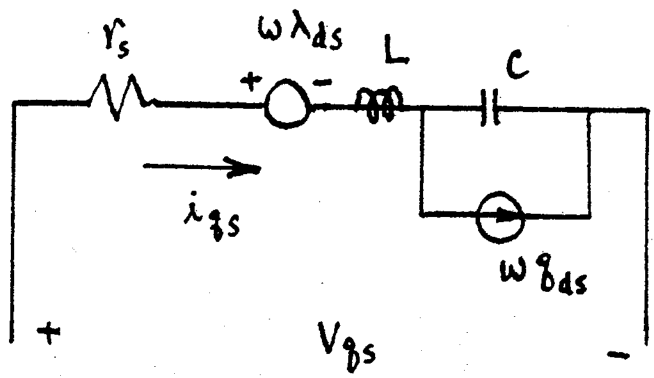
$$= \bar{K}_{2s}(\bar{K}_{2s})^{-1} p\bar{\lambda}_{qds} + \bar{K}_{2s}\left[p(\bar{K}_{2s})^{-1}\right]\bar{\lambda}_{qds}$$

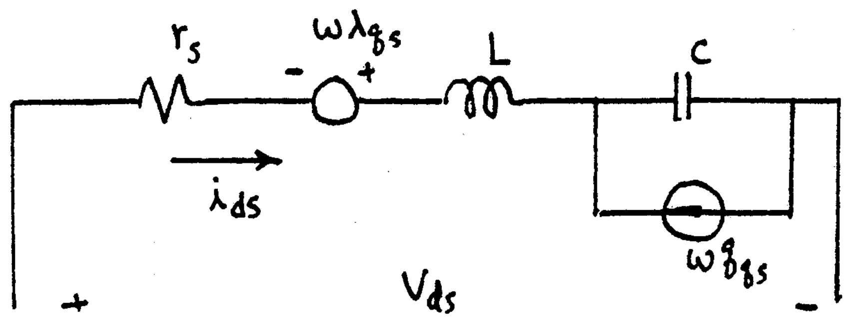
$$= p\bar{\lambda}_{qds} + \bar{K}_{2s}\begin{bmatrix}-\sin\theta & \cos\theta \\ \cos\theta & \sin\theta\end{bmatrix}\frac{d\theta}{dt}\bar{\lambda}_{qds}$$

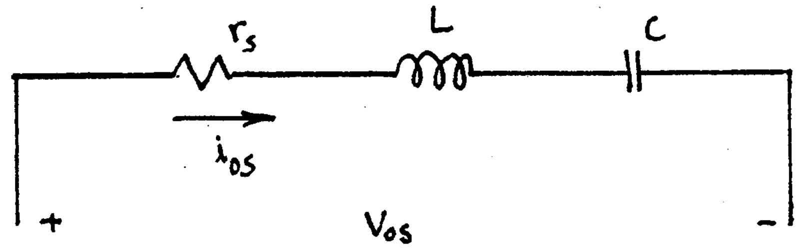
$$= \begin{bmatrix}0 & 1 \\ -1 & 0\end{bmatrix}\omega\bar{\lambda}_{qds} + p\bar{\lambda}_{qds}$$

That is $\quad v_{qs} = \omega\lambda_{ds} + p\lambda_{qs}$, $\quad v_{ds} = -\omega\lambda_{qs} + p\lambda_{ds}$

3-4. According to equations (3.4-2), (3.4-3), (3.4-9), (3.4-16) (3.4-22) and (3.4-28), the equivalent circuit can be drawn as follows.







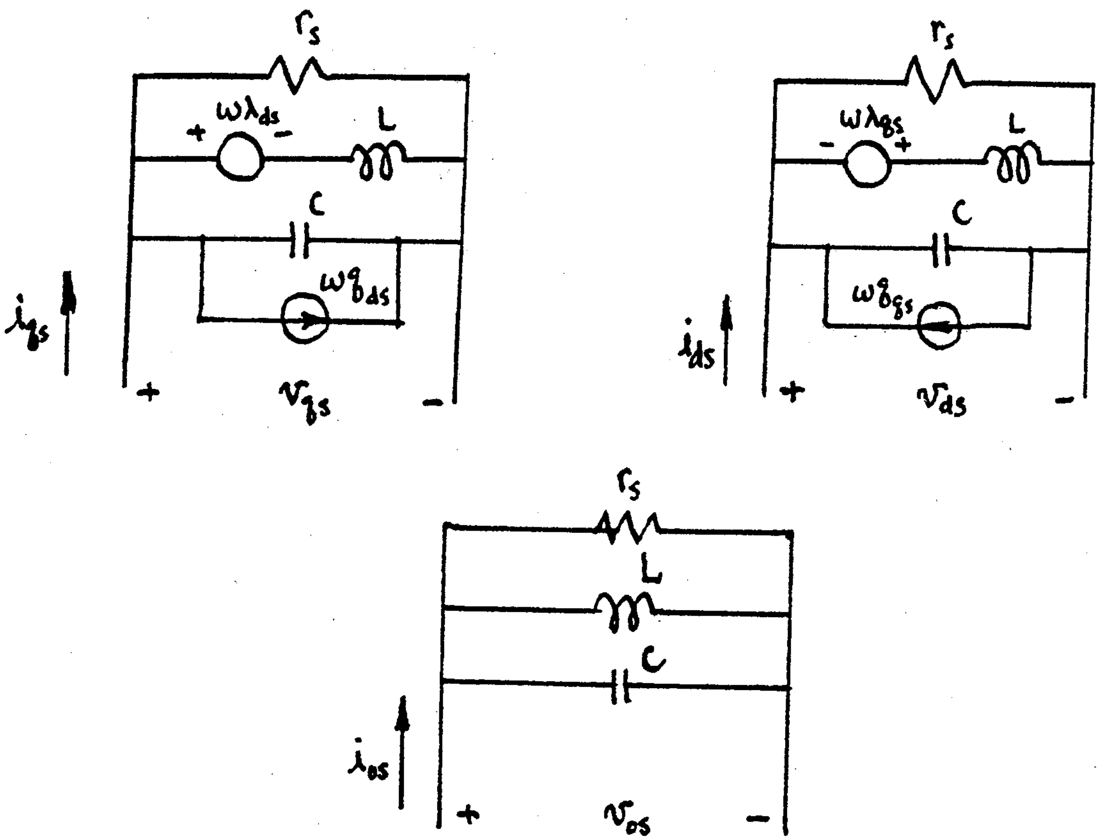
The current sources ωq_{qs} and ωq_{ds} can be replaced by equivalent voltage sources. Then the voltage equations in arbitrary reference frame are easily obtained.

$$V_{qs} = (r_s + pL + \frac{1}{Cp})\, i_{qs} + \omega \lambda_{ds} - \frac{\omega}{Cp} q_{ds}$$

$$V_{ds} = (r_s + pL + \frac{1}{Cp})\, i_{ds} - \omega \lambda_{qs} + \frac{\omega}{Cp} q_{qs}$$

$$V_{os} = (r_s + pL + \frac{1}{Cp})\, i_{os}$$

3-5 The equivalent circuit :



$$i_{qs} = \left(\frac{1}{r_s} + \frac{1}{pL} + pC\right) v_{qs} + \omega q_{ds} - \frac{\omega}{pL}\lambda_{ds}$$

$$i_{ds} = \left(\frac{1}{r_s} + \frac{1}{pL} + pC\right) v_{ds} - \omega q_{qs} + \frac{\omega}{pL}\lambda_{qs}$$

$$i_{os} = \left(\frac{1}{r_s} + \frac{1}{pL} + pC\right) v_{os}$$

3-9 See formulas (5.2-8), (5.2-11), (5.2-12) and (5.5-5) of chapter 5.

3-10.

$$
{}^{B}\bar{K}^{A} = \begin{bmatrix} \cos(\theta_A-\theta_B) & -\sin(\theta_A-\theta_B) & 0 \\ \sin(\theta_A-\theta_B) & \cos(\theta_A-\theta_B) & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

$$
= \begin{bmatrix} \cos(\theta_B-\theta_A) & \sin(\theta_B-\theta_A) & 0 \\ -\sin(\theta_B-\theta_A) & \cos(\theta_B-\theta_A) & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

$$
= \begin{bmatrix} \cos(\theta_B-\theta_A) & -\sin(\theta_B-\theta_A) & 0 \\ \sin(\theta_B-\theta_A) & \cos(\theta_B-\theta_A) & 0 \\ 0 & 0 & 1 \end{bmatrix}^{-1} = \left({}^{A-B}K\right)^{-1}
$$

3-14 $$\frac{3}{2}\left(V_{qs} I_{qs} + V_{ds} I_{ds}\right)$$

$$= 3V_s I_s \cos\left[(\omega_e-\omega)t + \theta_{ev}(0) - \theta(0)\right] \cos\left[(\omega_e-\omega)t + \theta_{ei}(0) - \theta(0)\right]$$

$$+ 3V_s I_s \sin\left[(\omega_e-\omega)t + \theta_{ev}(0) - \theta(0)\right] \sin\left[(\omega_e-\omega)t + \theta_{ei}(0) - \theta(0)\right]$$

$$= 3V_s I_s \cos\left[\theta_{ev}(0) - \theta_{ei}(0)\right] = P_e$$

$$\frac{3}{2}\left(V_{qs} I_{ds} - V_{ds} I_{qs}\right)$$

$$= 3V_s I_s \cos\left[(\omega_e-\omega)t + \theta_{ev}(0) - \theta(0)\right] \sin\left[(\omega_e-\omega)t + \theta_{ei}(0) - \theta(0)\right]$$

$$- 3V_s I_s \sin\left[(\omega_e-\omega)t + \theta_{ev}(0) - \theta(0)\right] \cos\left[(\omega_e-\omega)t + \theta_{ei}(0) - \theta(0)\right]$$

$$= 3V_s I_s \sin\left[\theta_{ev}(0) - \theta_{ei}(0)\right] = Q_e$$