P17. More understandings.

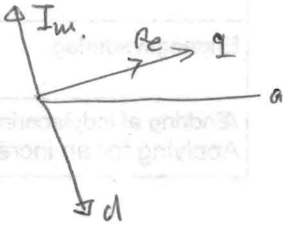
Original torque equation. $\tau = \frac{3}{2} p \cdot L_m (i_{qs} i'_{dr} - i_{ds} i'_{qr})$

Using the cross product expression.

$$\tau = \frac{3}{2} p L_m \left| \bar{i}_{qds} \times \bar{i}'_{qdr} \right| \quad ---- \text{①}$$

where: $\bar{i}_{qds} = i_{qs} - j i_{ds}$ $\bar{i}'_{qdr} = i'_{qr} - j i'_{dr}$.

(Prove is on P16)   (qd0 - reference frame!)

Use flux linkage equation.   ()

$$\bar{\lambda}_{qds} = \underbrace{(L_{ls} + L_m)}_{= L_s} \bar{i}_{qds} + L_m \bar{i}'_{qdr} \quad --- \text{②}$$

$$\Big\Downarrow \times \bar{i}'_{qdr}$$

$$\bar{\lambda}_{qds} \times \bar{i}'_{qdr} = L_s \bar{i}_{qds} \times \bar{i}'_{qdr} + L_m \bar{i}'_{qdr} \times \bar{i}'_{qdr}$$

two vectors aligned!
$\Rightarrow = 0$!

Therefore, $\Big\Downarrow$

$$\bar{\lambda}_{qds} \times \bar{i}'_{qdr} = L_s \cdot \bar{i}_{qds} \times \bar{i}'_{qdr}$$

$\Rightarrow$ $\bar{i}_{qds} \times \bar{i}'_{qdr}$ in ① will $= \frac{1}{L_s} \bar{\lambda}_{qds} \times \bar{i}'_{qdr}$

Substitude this into ①, you will then get the new torque equation as.

$$\tau = \frac{3}{2} p \cdot \frac{L_m}{L_s} \left| \bar{\lambda}_{qds} \times \bar{i}'_{qdr} \right| = \frac{3}{2} p \cdot \frac{L_m}{L_m} I_m (\bar{\lambda}_{qds} \cdot \bar{i}'^{*}_{qdr})$$

prove on P16