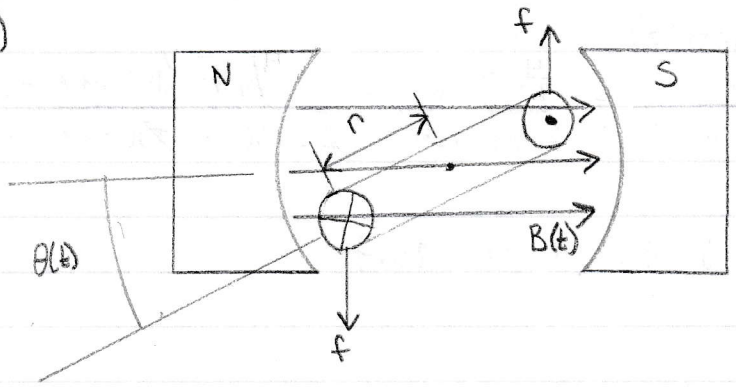
a)



$f = Bli\sin\theta = Bli \quad (i \perp B)$

$T_m = N(2r\cos\theta)Bli \qquad (N=1)$

$$\boxed{T_m = 2rB(t)l\,i_a(t)\cos(\theta(t))}$$

$$E_b(t) = N\frac{d\phi}{dt}$$

$$\phi = B(t)A$$

$$A = 2rl\sin(\theta(t))$$

$$\phi = B(t)2rl\sin(\theta(t))$$

$$E_b(t) = \frac{d}{dt}\left(B(t)2rl\sin(\theta(t))\right) = 2rl\frac{d}{dt}\left(B(t)\sin(\theta(t))\right)$$

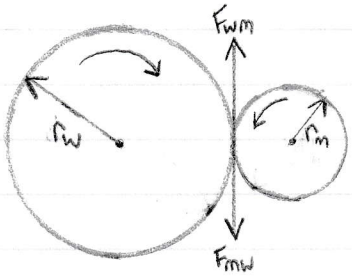
$$E_b(t) = 2rl\left[B(t)\cos(\theta(t))\dot{\theta}(t) + \dot{B}(t)\sin(\theta(t))\right]$$

$$\boxed{E_b(t) = 2rl\dot{B}(t)\sin(\theta(t)) + 2rlB(t)\cos(\theta(t))\dot{\theta}(t)}$$

b) $B = 21\times10^{-3}$ T $\quad i_a = 1700$ A

$l = 0.5$ m $\quad T_{max} = 1457.4$ Nm

$r = \frac{1}{6}$ m $\quad \theta = 0°$



$F_{mw} = F_{wm}$

$$\frac{T_m}{r_m} = \frac{T_w}{r_w} \qquad C = 2\pi r \rightarrow r = \frac{C}{2\pi}$$

$$\frac{T_m}{\frac{C_m}{2\pi}} = \frac{T_w}{\frac{C_w}{2\pi}} \longrightarrow \frac{T_m}{C_m} = \frac{4T_{max}}{C_w} \qquad (T_w = \text{total wheel torque} = 4T_{max})$$

$$T_m = \frac{4C_m}{C_w}T_m = \frac{4}{9.73}T_m \qquad \left(\frac{C_m}{C_w} = \frac{1}{9.73}\right)$$