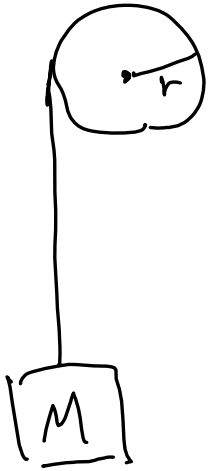
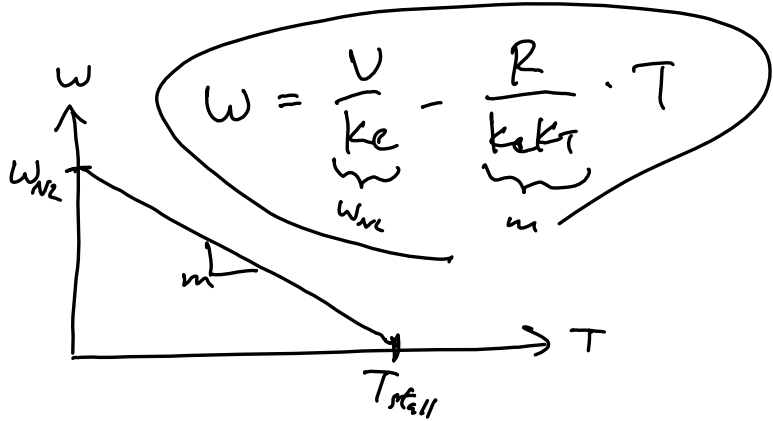


HW COK ch. 22



Useful Formulas:



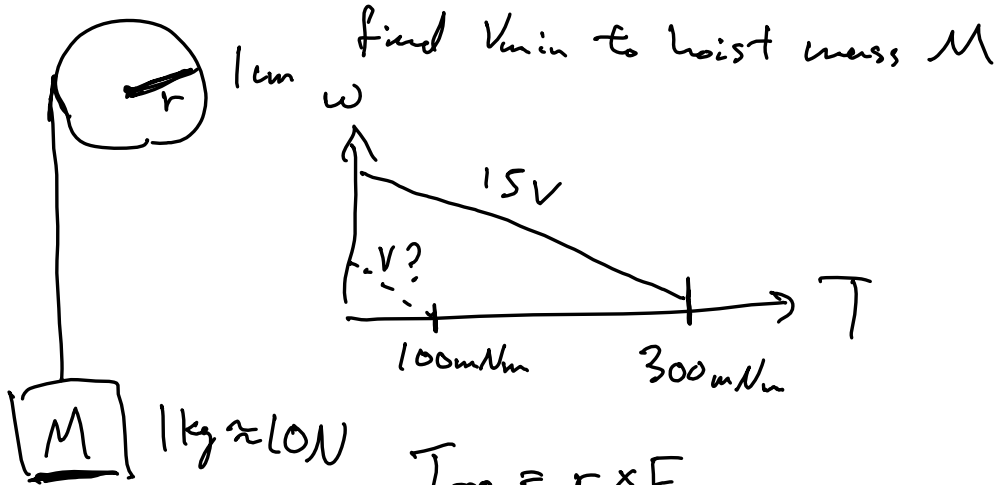
for 22-1

$$\omega_{NL} = \frac{V}{K_e}, \quad T_{stall} = \frac{K_T V}{R}$$

22.8 commutator: insulates / conducts current into coils at the right time so that torque is generated (i.e. Lorentz force) in the presence of a magnetic field.

brushes: makes contact with the commutator to supply current across a moving body

22.1 Given $T_{\text{stall}} \text{ @ } 15\text{V} = 300\text{mNm}$, (1)



$$g = 10\text{ kgms}^{-2}$$

$$T_{\text{req}} = r \times F$$

$$= 1\text{cm} \cdot 10\text{N}$$

$$= 100\text{mNm}$$

$$T_{\text{stall}} = \frac{k_T V}{R} \rightarrow V = T_{\text{stall}} \left(\frac{R}{k_T} \right) \quad (2)$$

$$\textcircled{1}: T_{\text{stall}} = 300\text{mNm} = \frac{k_T}{R} \cdot 15\text{V}$$

$$\frac{k_T}{R} = \frac{300\text{mNm}}{15\text{V}} \quad (2)$$

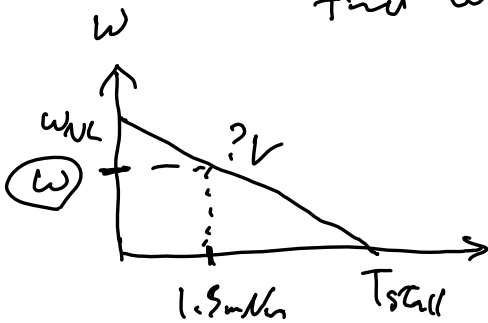
$$V_{\text{min}} = 100\text{mNm} \cdot \frac{15\text{V}}{300\text{mNm}} = \boxed{5\text{V}}$$

22.10

$$\omega_{NL} = 11,500 \text{ rpm}$$

$$T_{\text{stall}} = 4.47 \text{ mNm}$$

find ω when $T = 1.5 \text{ mNm}$



$$\omega = \omega_{NL} - m \cdot T$$

$$= \omega_{NL} - \frac{\omega_{NL}}{T_{\text{stall}}} \cdot T$$

$$m = \frac{\omega_{NL}}{T_{\text{stall}}}$$

$$= \omega_{NL} \left(1 - \frac{T}{T_{\text{stall}}} \right)$$

$$= 11.5 \text{ krpm} \left(1 - \frac{1.5 \text{ mNm}}{4.47 \text{ mNm}} \right)$$

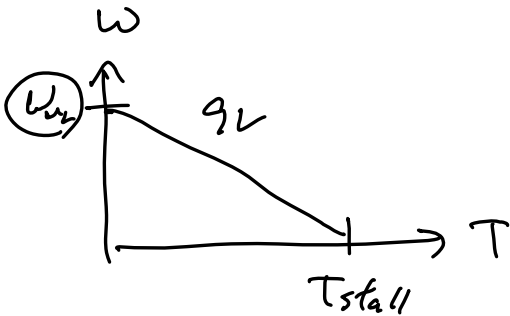
$$= \boxed{7.64 \text{ krpm}}$$

$$22.9 \quad R = 14.5 \Omega$$

$$T_{\text{stall}} = 4.47 \text{ mNm}$$

$$V_{\text{supply}} = 9 \text{ V}$$

find ω_{NL}



$$\omega_{NL} = \frac{V}{K_e}$$

$$\underline{K_e = K_t}$$

$$[V/\text{rad/s}] \quad [\text{Nm/A}]$$

$$\text{find } K_t : T_{\text{stall}} = \frac{K_t \cdot V}{R}$$

$$K_t = \frac{T_{\text{stall}} \cdot R}{V}$$

$$= \frac{4.47 \text{ mNm} \cdot 14.5 \Omega}{9 \text{ V}}$$

$$= 7.2 \text{ mNm/A}$$

$$K_e = 7.2 \text{ mV/rad/s}$$

$$\omega_{NL} = \frac{V}{K_e} = \frac{9 \text{ V}}{7.2 \text{ mV/rad/s}} = 1.25 \text{ krad/s}$$

$$1 \text{ rad/s} \cdot \frac{60 \text{ s}}{1 \text{ min}} \cdot \frac{1 \text{ rev}}{2\pi \text{ rad}} = \frac{30}{\pi} \text{ rpm}$$

$$= \boxed{1144 \text{ krpm}}$$

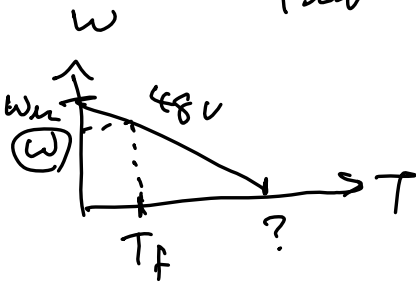
$$22.3 \quad k_T = 105 \text{ mNm/A}$$

$$R = 10 \Omega$$

$$\omega_{NL} @ 48V = 4320 \text{ rpm}$$

$$T_f = 55 \text{ mNm}$$

find ω



$$\omega = \omega_{NL} - \frac{R}{k_e k_T} \cdot T_f$$

$$\text{find } k_e : \omega_{NL} = \frac{V}{k_e}$$

$$k_e = \frac{V}{\omega_{NL}} = \frac{48V}{4320 \text{ rpm}} = 11.1V/\text{rpm}$$

$$\omega = 4320 \text{ rpm} - \frac{10\Omega \cdot 55 \text{ mNm}}{105 \text{ mNm/A} \cdot 11.1V/\text{rpm}}$$

$$\approx \boxed{3.85 \text{ krpm}}$$

22.6 (same as 22.3)

$$K_T = 16.1 \text{ mNm/A}$$

$$\omega = \omega_{NL} - \frac{RT}{k_e k_T}$$

$$R_{\text{coil}} = 1.33 \Omega$$

$$\omega_{NL} @ 18V = 10.3 \text{ krpm}$$

$$= 10.3 \text{ krpm} - \frac{(1.33 \Omega)(24.2 \text{ mNm})}{(1.788 \text{ V/krpm})(16.1 \text{ mNm/A})}$$

$$T_{\text{max}} = 24.2 \text{ mNm}$$

$$= \boxed{9.16 \text{ krpm}}$$

$$k_e = \frac{V}{\omega_{NL}} = \frac{18V}{10.3 \text{ krpm}} = 1.748 \text{ V/krpm}$$