HW #17 Solutions EE301

1) 125 VDC Motor rated for 32A

$R_a = 0.135\Omega$ (armature resistance)

a) $P_{in} = V_T I_a$ V_T = terminal voltage

$= (125V)(32A)$

$\boxed{P_{in} = 4kW}$

b) $P_{\substack{elec \\ loss}} = I_a^2 R_a = (32A)^2(.135\Omega)$

$\boxed{P_{\substack{elec \\ loss}} = 138.2W}$

c) From $P_{in} = P_{out} + P_{loss} + P_{\substack{elec \\ loss}}$

P_d assume no mechanical loss

$P_d = P_{in} - P_{\substack{elec \\ loss}} = 4000W - 138.2W$

$\boxed{P_d = 3862W}$

d) From $P_d = E_g I_a$

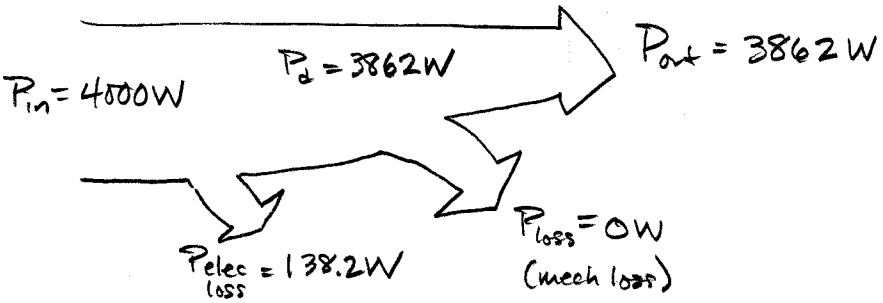
$E_g = \frac{P_d}{I_a} = \frac{3862W}{32A}$

$\boxed{E_g = 121V}$

e) $\eta = \frac{E_g}{V_T} = \frac{121V}{125V}$

$\boxed{\eta = 96.8\%}$

f)



2) Design 5 hp, 120 VDC motor, $\eta = 95\%$

$K_V = 0.138\ V{\cdot}s$, $P_{loss} = 0$ (no mechanical losses)

To determine current draw, let's first find P_{in}

$$P_{in} = \frac{P_{out}}{\eta} = \frac{5\ hp}{0.95}\left(\frac{746\ W}{1\ hp}\right) = 3926\ W$$

From $P = IE$

$$I_a = \frac{P_{in}}{V_T} = \frac{3926\ W}{120\ V} = \boxed{32.7\ A}$$

From $P_{out} = T_{load}\,\omega = K_V I_a \omega$

$$T_{load} = K_V I_a = (0.138\ V{\cdot}s)(32.7\ A)\left[\left(\frac{W}{V{\cdot}A}\right)\left(\frac{N{\cdot}m/s}{W}\right)\right]$$

$$\boxed{T_{load} = 4.52\ N{\cdot}m}$$

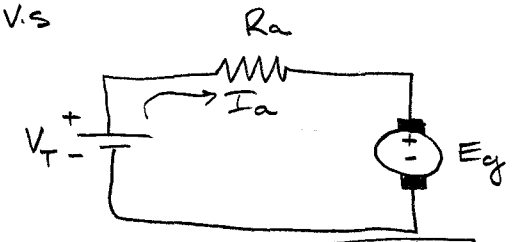
From $P_{out} = T_{load}\,\omega$

$$\omega = \frac{P_{out}}{T_{load}} = \frac{(5\ hp)\left(\frac{746\ W}{1\ hp}\right)}{4.52\ N{\cdot}m}\left[\frac{N{\cdot}m/s}{W}\right]\left[\left(\frac{rev}{2\pi\ rad}\right)\left(\frac{60\ sec}{min}\right)\right]$$

$$\boxed{\omega = 7880\ rpm}$$

3) DC Motor rated for 120 V, 2A

$R_a = 0.175\ \Omega$, $K_V = 0.175\ V{\cdot}s$



a) $I_a = \dfrac{V_T - E_g}{R_a}$

Solving for E_g,

$$E_g = V_T - I_a R_a = 120\ V - (2A)(.175\ \Omega) = \boxed{119.7\ V}$$

b) $T_d = K_V I_a = (0.175\ V{\cdot}s)(2A)$

$$\boxed{T_d = 0.35\ N{\cdot}m}$$

c) From $E_g = K_V \omega$

$$\omega = \frac{E_g}{K_V} = \frac{119.7\ V}{0.175\ V{\cdot}s}\left(\frac{60\ sec}{min}\right)\left(\frac{rev}{2\pi\ rad}\right)$$

$$\boxed{\omega = 6530\ rpm}$$