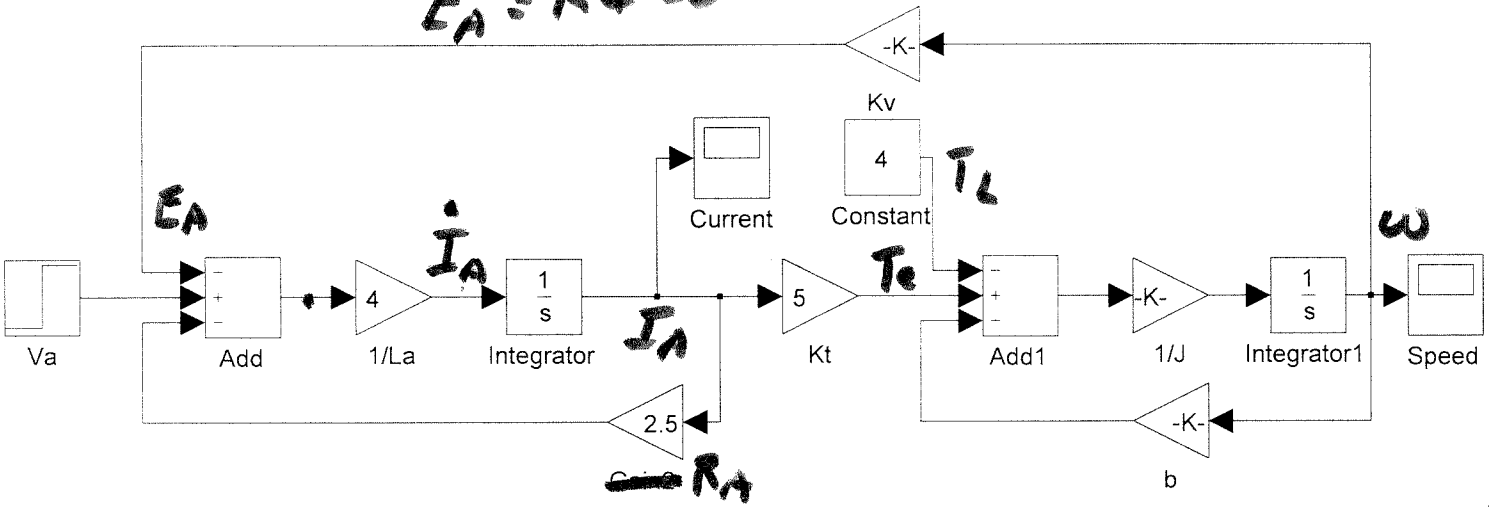
ECE 320 & ECE 329

ENERGY SYSTEMS I

BACKGROUND STUDY IN ENERGY SYSTEMS

SESSION no. 24

$E_A = K\phi\omega$



E_A $\dot{I}_A$ I_A T_L T_e ω R_A

$$+V_A - E_a - I_A R_A = L_a \frac{dI_A}{dt}$$

$$T_e - T_L - b\omega = J\frac{d\omega}{dt}$$

$$T_e = K_a \phi I_a$$

$$\omega = 120 \frac{rad}{sec}$$

$$P = 15\ hp$$

$$P = 12\ kw$$

$$P = T\omega \Rightarrow T = 100\ N \cdot m$$

$$b\omega = 1\ N \cdot m$$

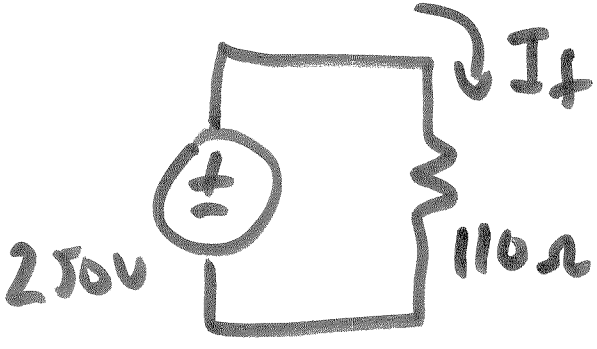
$$b = \frac{1}{120} \cdot N \cdot m \cdot sec$$

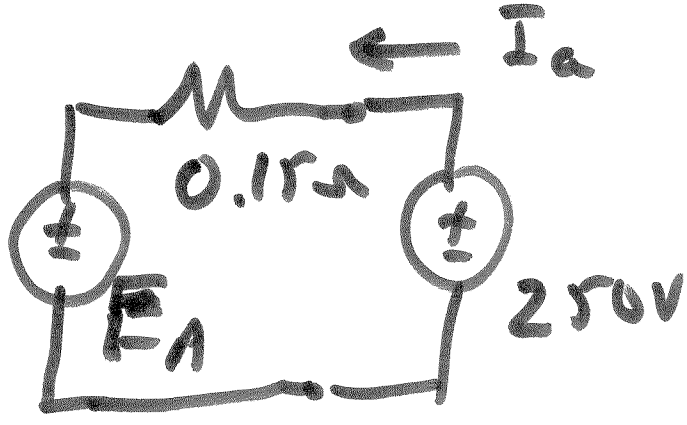
SEPARATELY EXCITED DC MOTOR

10kw 250V $R_f = 110\Omega$ $R_A = 0.1\Omega$

$V_f = 250V$ $V_a = 250V$ $n = 1640 RPM$

a) FIND E_A





$$I_A = \frac{P}{V_A} = \frac{10kW}{250V} = 40A$$

$$E_A = V_A - I_A R_A$$

$$E_A = 250V - (40A)(0.15\Omega)$$

$$E_A = 244V$$

IF WE LOAD UP THE MACHINE, WHAT HAPPENS TO SPEED?

$$\frac{E_A}{E_A} = \frac{K_a \phi_1 \omega}{K_a \phi_2 \omega} \qquad \frac{250V}{244V} = \frac{\omega_{NL}}{\omega_{FL}}$$

b) REDUCE V_A to 200 V. FIND SPEED. (SAME CURRENT I_f AND FLUX AND CURRENT I_A)

$$E_A = V_A - I_A R_A$$

$$E_A = 200\,V - (40\,A)(0.15\,\Omega)$$

$$E_A = 194\,V$$

$$\frac{E_{A\,NEW}}{E_{A\,OLD}} = \frac{K_a \phi_1 \omega_{NEW}}{K_a \phi_1 \omega_{OLD}}$$

$$\frac{2440}{1940} = \frac{1640\ \text{RPM}}{n_{m2}}$$

$$n_{m2} = 1304\ \text{RPM}$$

c) FIND TORQUE AT BOTH CONDITIONS

$$P_m = E_a I_a = T_e \omega$$

$$(244\text{V})(40\text{A}) = T_e \left(1640\ \text{RPM} \cdot \frac{2\pi\ \text{rad}}{60\ \text{sec}}\right)$$

$$T_e = 56.8\ \text{N·m}$$

$$K_a \phi_d = \frac{244 V}{\left(1640 \cdot \frac{2\pi}{60} \frac{rad}{sec}\right)} = 1.42 \; V \cdot sec$$

$$T_e = K_a \phi_d I_A$$

$$T_e = (1.42 \; V \cdot sec)(40 A)$$

$$T_e = 56.8 \; N \cdot m$$

$$T_e = K_a \phi_d I_A$$

d) Reduce I_A by $\frac{1}{2}$

$\Rightarrow$ Torque ?

$T_E \rightarrow \frac{1}{2} \ldots$

or $\frac{1}{2}(56.8)$ N·m

$= 28.4$ N·m

ECE 320

Energy Systems I

Lesson 24

DC Machine Examples

Torque is proportional to CURRENT!

Speed is proportional to VOLTAGE (generated voltage).