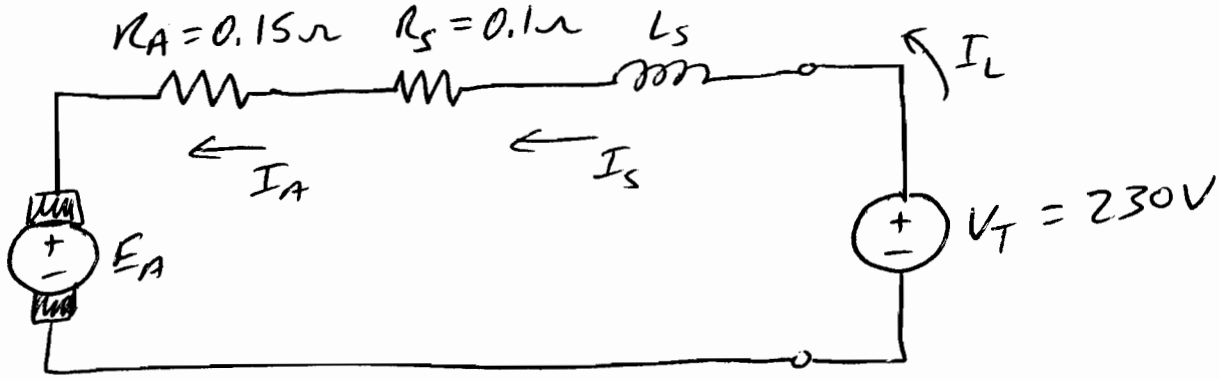
ex. A 230 V series DC motor has an armature resistance of 0.15 Ω and a field winding resistance of 0.1 Ω. When it operates at 750 RPM, the motor draws 80 A of current when supplied with the rated voltage. A lighter load is applied, causing the current to drop to 28 A. From a magnetization curve, it was found that the magnetic flux at 28 A is 40% of the flux at 80 A (non-linear). What is the new motor speed?



@ Steady-state, KVL gives

$$V_T = I_A R_S + I_A R_A + E_A$$

So, operating @ $n_m = 750$ RPM w/ 80A current gives

$$E_{A,80} = 230 - 80(0.1 + 0.15) = 210V$$

By (7-41), $E_A = K'\phi n_m$. So, $E_{A,80} = K'\phi_{80}\, 750 = 210$

$$\hookrightarrow K' = \frac{0.28}{\phi_{80}}$$

With a load drawing 20A –

$$E_{A,20} = 230 - 20(0.1 + 0.15) = 223V = K'\phi_{20}\, n_m$$

$$\hookrightarrow 223 = \left(\frac{0.28}{\phi_{80}}\right)(0.4\phi_{80})\, n_m \Rightarrow n_{m,20} = 1991.07 \text{ RPM}$$

$\Rightarrow$ lower load, faster speed $\Leftarrow$

ex. Next, the terminal voltage is changed from 230 V to 200 V while the current remains 80 A. What will be the new speed of the motor?

By KVL, $E_{A,new} = 200V - 80(0.1+0.25)$

$= 180V$

Using $E_A = K'\phi n_m$, where $K' = \frac{0.28}{\phi_{80}}$

$180 = \frac{0.28}{\phi_{80}} \phi_{80} n_{m,new}$

$\hookrightarrow n_{m,new} = 642.86\ RPM$

$\Rightarrow$ lower V_T, lower speed!