Wednesday, April 6, 2016

Therefore, the total input power: $P_{in} = P_{total} = 40{,}650$ W

$$\eta = \frac{P_{out}}{P_{in}} = \frac{37{,}300}{40{,}650} \times 100\%$$

$$= 91.76\%$$

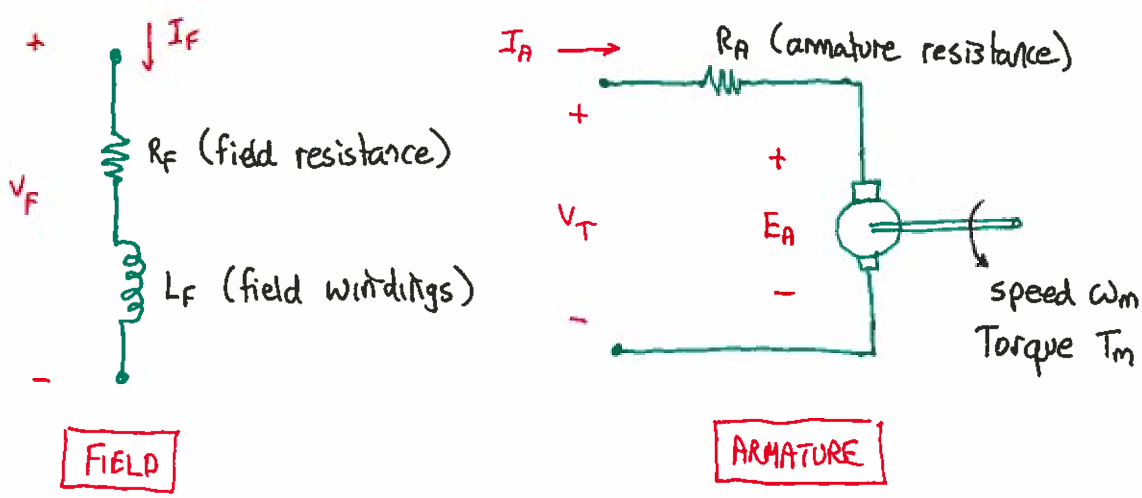
Input current: $i = \frac{P_{in}}{V} = \frac{40{,}650}{220} = 184.77$ A

Speed regulation: $SR = \frac{n_{no\text{-}load} - n_{full\text{-}load}}{n_{full\text{-}load}} \times 100\%$

$$= \frac{1200 - 1150}{1150} \times 100\% = 4.35\%$$

Electric circuit of DC motors

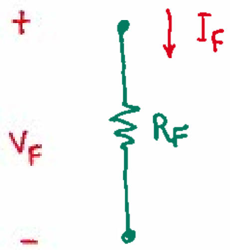
DC motors can be modeled with two simple circuits



For a rotating DC machine, we have

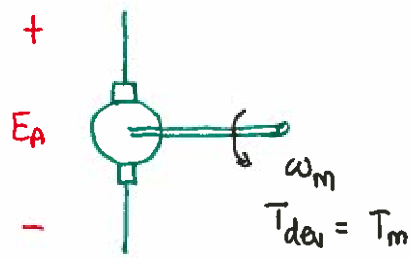
ω_m — rotational speed, rad/sec
T_m — torque, Nm (Newton-meters)

Since we are operating at DC, the field circuit reduces to.



(L_F is acting like a short circuit)

The induced armature voltage



$$E_A = K\phi\,\omega_m,$$

ϕ = magnetic flux

K = machine constant

And total developed mechanical torque

$$T_{dev} = K\phi\, I_A$$

And total developed mechanical power

$$P_{dev} = T_{dev}\,\omega_m$$

Together, these three equations are key to analyzing DC motor/generator circuits.

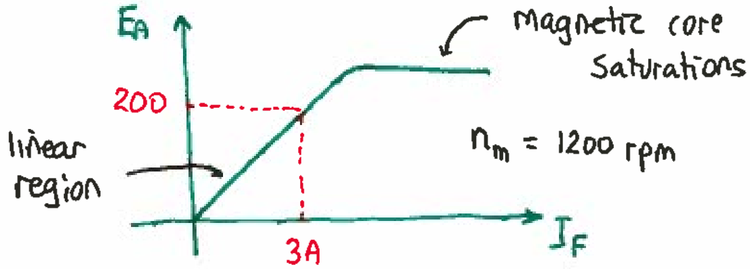
$$\boxed{\begin{aligned} E_A &= K\phi\,\omega_m \\ T_{dev} &= K\phi\, I_A \\ P &= T\omega_m \end{aligned}}$$

KEY MACHINE EQUATIONS

Normally, we lump K and ϕ together

$\boxed{K\phi}$ MACHINE CONSTANT

The magnetization curve



Typical magnetization curve for a given speed

- A point on this curve gives us $K\phi$

– $K\phi$ tells us everything,

Note: may not always get such a curve, but $K\phi$ can almost always be calculated from info' given.

Example: We have a DC motor that obeys the above curve.

- $n_m = 1500$ rpm
- $P_{dev} = 10$ HP
- $I_F = 3A$
- $R_A = 0.3\Omega$
- $R_F = 50\Omega$

Find developed torque, armature I_A, applied voltage V_T, efficiency.

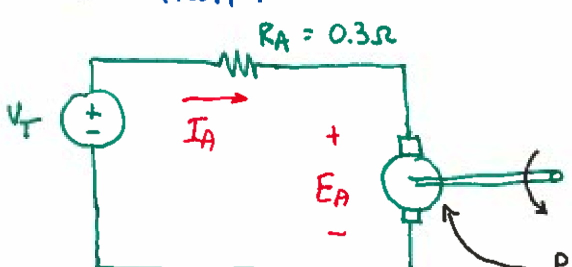
We have

$$\omega_m = n_m \times \frac{2\pi}{60} = 157.1 \text{ rads/sec}$$

$$P_{dev} = 10 \text{ HP} \times 746 = 7460 \text{ W}$$

$$T_{dev} = \frac{P_{dev}}{\omega_m} = 47.49 \text{ Nm}$$

The armature circuit:



$P_{dev} = E_A I_A = 7460 \text{ W}$

(electrical world meets the mechanical world)

Machine equations:

$$\boxed{\begin{aligned} E_A &= K\phi\,\omega_m \\ T_{dev} &= K\phi\, I_A \end{aligned}}$$

We need E_A to find $I_A = P_{dev} / E_A$

From information given

$$E_A = 200\text{ v} \quad \text{when } I_F = 3A$$

$$\text{and at } n_m = 1200$$

Using E_A and n_m

$$E_A = K\phi\omega_m, \quad \text{so} \quad K\phi = \frac{E_A}{\omega_m}$$

$$K\phi = \frac{200}{1200 \times \frac{2\pi}{60}} = 1.59$$

The motor is run at $n_m = 1500$ rpm, so

$$E_A = K\phi\omega_m = 1.59 \times 1500 \times \frac{2\pi}{60}$$

$$= 250\text{v}.$$